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Implementation of Agenda 21 in European Ports at the example of Lübeck-Travemünde

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Captain Christian Bahlke

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5. Author(s), Name(s), First Name(s) Ralf	Giercke	8. Report date December 2004
Henning Christian	Schulz-Streeck Bahlke	9. Publication date June 2005
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16. Abstract: The aim of the research project was the investigation into different options to reduce the negative impacts of shipping in the ports of Lübeck-Travemünde. Project-partners are among the Stadtwerke Lübeck the Agenda 21 Bureau of the Hanseatic City of Lübeck-Travemünde and the GAUSS Institute for Environmental Protection and Safety in Shipping in Bremen. Based on the analysis of the actual situation solutions should be elaborated to reduce gaseous emissions, noise and vibrations of the vessels, mainly ferries, being alongside in order to address the potential of conflicts between the residents living close to the berths, the tourist industry and shipping. In the course of the project execution emission calculations have been carried out and proposals have been made to mitigate emissions, noise and vibration. Another aspect to be addressed was the consideration of legal aspects at the interface of the European environmental law and the international law of the sea to safeguard that the solutions identified are compatible herewith and may be implemented in practice. Beside the technical recommendations, among others the specification of the option to provide ships alongside with cold ironing, a draft of a memorandum of understanding on a sustainable development of port and shipping companies was produced. The results yielded can only be implemented reasonably within the framework of a transnational catalogue of measures between the competing ports and the shipping companies in the Baltic sea region. Therefore it is scheduled to communicate the results and include into further steps not only in German ports but also in ports of Baltic neighbouring states and to active these via the Union of the Baltic Cities (UBC) und die Agenda Baltic 21 on the implementation of the proposals.		
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Content

1 Introduction

In Lübeck-Travemünde, just as in other Baltic ports, tourism and port economy are extremely closely connected. The resort of Travemünde has been officially recognised as a Baltic spa since 1957 and the old city of Lübeck has been recognised by the UNESCO as a world cultural heritage. In opposition to this there is the ever increasing air pollution due to traffic increase, in particular due to the ferry- and shipping traffic in the ports, so that in parts of the Hanseatic city of Lübeck, the pollution of the environment through particular kinds of emission is substantially influenced by shipping.

The ships and ferries berthing in port cause various kinds of emissions, noise and vibrations which are transmitted even to buildings on land. In addition to this, the reception facilities for ships´ wastewater and general waste in port definitely have to be improved as regards environmental protection. The situation is becoming increasingly serious because of a continuous increase in shipping and ferry traffic and because of the further developments planned for the port of Lübeck-Travemünde. In order to further investigate reasons and effects, a research was undertaken within the scope of the project "Implementation of Agenda 21 in European Ports based on the example of Lübeck-Travemünde". The project was taken under the patronage of Baltic 21 and was chosen as the action level for the Union of the Baltic cities (UBC), a member of Baltic 21.

The named problems are more or less relevant for all Baltic ports. Due to the Baltic's similarity to inland waters, the Baltic ports find themselves competing with each other quite directly. Therefore a solution to the problem, however, can only be achieved in agreement between the most important Baltic ports, harbours and ship owners concerned.

- The aim and contents of this project are the examination of possibilities for the reduction of pollutants (exhaust fumes, waste water, and general waste), noise and vibrations caused by the ships and ferries berthing in Baltic ports. This was achieved by
- Measurement of emissions into the air in the area of Lübeck-Travemünde,
- Examination of the technical possibilities for the reduction of pollutants (e.g. shore-side electricity for ships and ferries at berth),
- Examination of the legal possibilities for the realisation of a reduction in pollutants within Baltic ports and on ships and ferries ,
- Development of a concept for a Memorandum of Understanding (MoU) for the most important Baltic ports and shipping companies. This concept is meant as a draft for agreement between the Baltic ports and shipping companies.

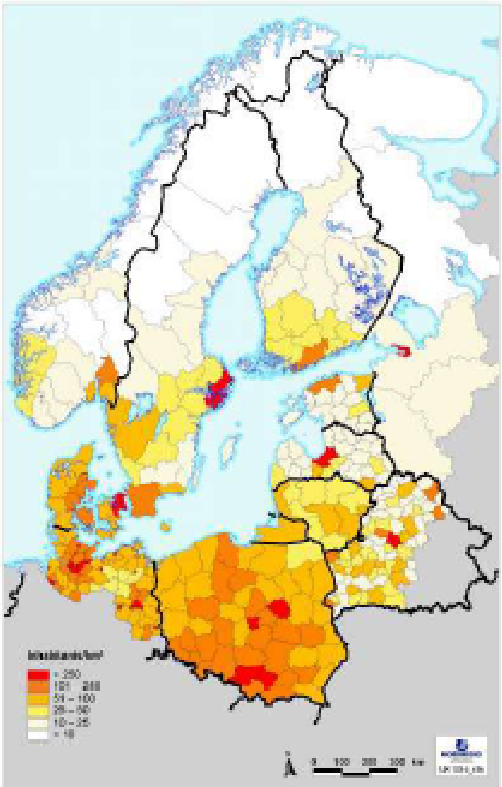
The capacity and technical development of shipping and ports corresponds closely to the political and economic development of the provinces and regions, because an exchange of goods still takes place to a great extent via the sea.

Today about ⅔ of all goods worldwide are transported by sea, and for goods crossing the borders of the Federal Republic of Germany it is about one third (Taubmann 1999 and Statistisches Bundesamt 2003). In particular because the opening of east European countries and markets to western partners means a continuous increase in the volume of trade and an increased movement of persons and goods, the area of the Baltic Sea is proving to be a region of primary economic importance.

In 1995 Sweden and Finland joined the EU; with the entry of Poland, Lithuania, Latvia and Estonia in 2004 the number of member states was increased once more. Thus the Baltic Sea has developed to becoming almost a EU inland water [5].

About 100 million people live in this area. Of the 75 million city dwellers in the Baltic area, 63 million live in cities of over 10.000 inhabitants. There are about 76 large ports in the Baltic for trade and tourism.

Picture 1: The catchment area of the Baltic



[5]: August, Michael: Hafenentwicklung und Schiffsverkehr im Wandel, Geographisches Institut der Universität Kiel Mittelseminar: Die Ostseeregion im Wandel, 2004

One third of all European exports were produced by the Baltic states in the year 2000 (Baltic Chambers of Commerce Association 2002). Since 1995 the volume of exports from the Baltic coastal states has increased on average by 5.2% per annum from about 1 bn tonnes to 1.3 bn tonnes. The Baltic states Norway and Russia show the highest relative increases in percentage, the latter two countries in particular due to their exports of oil and gas [5]. With about 400 million tonnes of transport annually, almost a quarter of the im- and exports of the Baltic coastal states is dealt with via the Baltic Sea – almost 7% of the quantitative world shipping. In this, according to Breitzmann, a division in the Baltic can be seen. There are intensive flows of goods between traditional trading countries, mainly composed of manufactured goods, while the exchange of raw materials has rather stagnated.

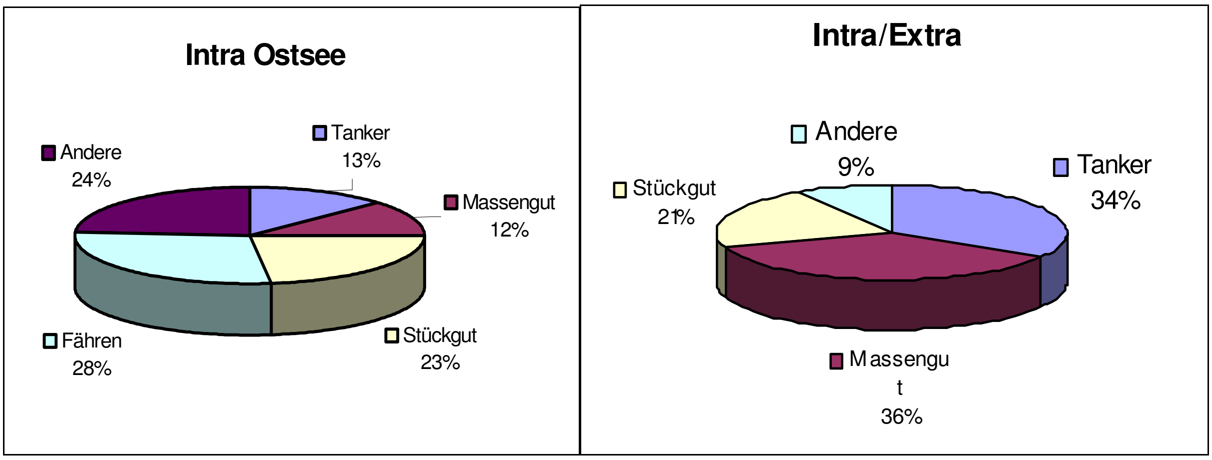
As regards trade with the transition countries, from the German point of view the east- west traffic is mainly a flow in one direction. Via ports in these transition countries, mainly raw materials are exported and finished products for consumer- and investment branches imported. And so scheduled shipping has the problem of insufficient use on the westward journey.

The flow of goods transported over the Baltic is quite complex. The goods are transported both within and cross-boundering the Baltic Sea. Different goods demand different ships. Within the scope of a report for the Federal Ministry of Transport, the Institute of Shipping Economics and Logistics prepared an analysis of the shipping in the Baltic area. This proves the enormous amount of traffic on the Baltic Sea.

For the period July to the end of September 2001, all the ships that entered a Baltic port were registered: there were 3594 ships with a total tonnage of 47.7 million tdw in the Baltic, among which were 137 ferries and 151 so-called “non-trade ships”, such as fishing vessels or tugs. The overwhelming number of ships entered not only ports within but also outside the Baltic. Only 500 ships (11.4% shipping, including ferries) functioned exclusively within the Baltic Sea.

This is equivalent to a proportion of only 4.8% of the total tonnage used. All in all in the period of examination around 66.000 port entries were registered, of which 25.783 entries were to the 245 Baltic ports and 1480 to ports frequented outside the Baltic. In addition, 137 ferries were included in the report, for which 66.293 port entries were registered in the period of examination. These numbers make impressively clear the amount of traffic in the Baltic Sea [5].

Picture 2: Ships used in the Baltic Sea area according to route (intra/extra) and ships type, period July to September 2001



[5]: Institute of Shipping Economics and Logistics 2001

Container transport outside the Baltic Sea belongs to the sector of Baltic transport that is increasing fastest. Up to the year 2000, in contrast to 1990, it increased to 186%. Whereas the annual average increase 1992 – 1995 was around 6.4%, in 2000 it rose to 7.1%. Container transfer in all Baltic ports was accordingly more than 3.4 million TEU in the year 2000. For transport within the Baltic Sea, feeder traffic use smaller and medium sized container ships to collect goods from overseas from the large North Sea ports (Hub ports) Hamburg, Bremerhaven or Rotterdam and to distribute them to the smaller Baltic ports, or respectively to take cargo from these to the North Sea for reloading (Sesemann 1999) [5].

Regarding traffic within the Baltic Sea, it is however, not Container traffic that dominates, but rather RoRo- loading and discharge. On ferries and RoRo-ships, it is mainly trucks and road trucks that are transported, but also rail-wagons and other transport units. This transport technology is preferred by carriers especially because of its efficient loading. In particular between Germany, Poland and the Scandinavian countries, regular RoRo-ferry services exist. The relatively young routes from/ to eastern transition countries show great increases in this line, so that one can reckon with a further concentration of passenger and trailer transport. Another not inconsiderable rise in transport is the passenger shipping of the Baltic Sea. More than 50 million travellers with 6 million private cars cross the Baltic Sea annually. For this, combined passenger/goods ships are mainly used. Some speed-ferries also travel, for example between Rostock and Trelleborg or between Helsinki and Tallinn; the tendency here is rising. The passengers are mainly tourists and, in particular between the western coastal states and the transition countries, business people, too. In addition to this, international cruise-shipping has discovered the Baltic area. Copenhagen, Stockholm, St.Petersburg, Tallinn and Helsinki have nearly 300 incoming ships per year. 95 cruise ships will probably berth in Kiel in 2004. Thus the provincial capital of Schleswig-Holstein is leading in Germany before Rostock (80 berthings) and Lübeck (20 berthings) (see Kieler Nachrichten 2004).

Various prognoses foresee to different extents a rapid growth of the Baltic Sea area in the coming years. In line to this is the impact of the environment caused by shipping. In particular in port areas, this impact leads to a conflict of interests between tourists, residents and the operation of ships/ports. Whereas shipping caused hardly any conflicts in the past, today the necessary expansions of ports as well as the rising amount of shipping services and the increasing size of ferries are causing increasing resistance. This is especially the case for ferry ports which, for historical reasons, are generally near to city – and tourist centres. Thus in these ports in particular an increasing area of tension is developing: on the one hand the function of the port as a turntable for international goods and passenger traffic must be maintained and developed, and supplies to the interior assured and fitted to rising market demands. On the other hand the interests of the steadily increasing economic factor of services in health and fitness and tourism in the coastal areas must be taken into consideration.

The initiative of the province of Schleswig-Holstein for *wellness* economy and tourism, as well as a working group of Lübeck founded for the promotion of this, both make recommendations for action which demand investments in the sectors of tourism, health- and "wellness", the basis for which are clean air, clean water, as little noise and other nuisances as possible. Large sporting events, such as the *Travemünder Woche* and the Olympic sailing events (meanwhile located elsewhere) were and are also affected by these conditions.

The increasing amount of shipping traffic in the Baltic Sea leads to increasing pollution of various kinds, to development of the ports and thus to an increased conflict of interests between shipping, population and tourism.

With the rising offer of ferry-routes and the increasing number and size of the ferries used ever more problems appear. These are e.g.:

- Pollution of air
- Pollution of water
- Noise caused by shipping as well as by port vehicles during load and discharge,
- Vibrations caused by shipping, which are transmitted further in coastal areas and in port.

These impacts can be negative factors especially for ports used for tourism. The reason for the increase in criticism on the annoyances caused by shipping can in particular be traced back to the international and national environmental standards on land and sea, which are drifting far apart. Normally, internationally agreed environmental standards are not as stringent as national standards (at least in Northern Europe), with the result that national efforts towards the protection of the environment are counteracted by international shipping in the area. Resulting from this, the rise in emission caused by ships, when compared in percentage to emissions from land, meets with increasing incomprehension among those concerned.

Because of international conditions and the extremely high competition between ports and shipping companies, national regulations cannot be enforced on ships sailing under foreign flag. Thus the ports are directly confronted with the negative results of differently accented environmental legislation. The reduction of environmental pollution and problems related to shipping and ports is being carried out, if at all, only locally and with reference to particular pollutants and it is obvious that they are not seen and dealt with as a whole.

Coordination of the different economic, environmental and social problems by interaction between ports, shipping, tourism and residents is absolutely necessary, to ensure a suitable development in shipping and tourism. This is a part of and one aim of this project.

1.1 Ships´ emissions worldwide

According to research by Lloyds Register [2], the proportion caused by international shipping in the worldwide total of sulphur emissions is c. 7% which is 7.5 to 11.5 million tons per year. The proportion of NOx emissions from international shipping in the global total is estimated at 11 to 13 & (c. 9.3 million tons NOx per year). These figures are at first sight surprising, because the proportion of shipping in the total fuel consumption of all traffic participants is only c. 3% [2].

This research has also shown that the proportions of SO_2 and NOx emissions caused by shipping is about three times higher than so far supposed over the north-east Atlantic. Thus the yearly emissions in this area amount to c. 1.37 million tons SO2 and 1.94 million tons NOx [2]. A review of existing and expected SO2 and NOx emissions is given in the following table:

Table 1: SO_2 and NOx emissions in shipping

Shipping emissions	Emission (Million Tonnes per year)		% of EU-15 1990		% of EU-15 2010 "Current Plans"	
	SO_x	NO_x	So_x	NO_x	SO_x	NO_x
World shipping (Corbett, 99)	8.5	10.1				
World shipping (A1: Table 1.8)	9.2	11.0				
N Atlantic (Corbett, 99)	4.4	5.3				
NE Atlantic (LR, 95)	1.4	1.9	8 %	14 %	30 %	28 %
N Sea & NE Atlantic (Tsyro, 97)	1.1	1.6	7 %	12 %	23 %	24 %
N Sea & NE Atlantic (EMEP, Tab. A.6.4)	1.4	2.0	8 %	15 %	29 %	29 %
N W European waters (A1: Tab. 1.8) & N E Atlantic (A1: Tab 1.8)	1.1	1.3	6%	10 %	23 %	18 %
Baltic (Mari Term, 91)	0.1	-	1 %	-	2 %	-
Baltic (EMEP, Tab. A 6.4)	0.2	0.4	1 %	3 %	5 %	5 %
Baltic (A1: Tab. 1.8)	0.3	0.3	2 %	2 %	6 %	5 %
Mediterranean (A1: Tab. 1.8)	0.4	0.5	2 %	4 %	8 %	7 %
Mediterranean & black Sea (LR 2000)	1.2	1.7	7 %	13 %	26 %	25 %
SO_2 from bunkers sold in Europe (A1)	2.6	-	16 %	-	55 %	-

Hübscher, ISL: Presentation of the project SEAM by GAUSS Ltd., 12. April 2004

Although the emission of pollutants in relation to transport performance has relatively decreased, in particular because of growing size of ships, the consumption of energy and thus the emission of pollutants by shipping will nevertheless increase in the coming years [11, 4]. The main reason for this is that on the one hand the volume of goods to be transported is increasing and on the other hand it can also be expected that for some types of ship, especially container transports, speeds and thus emissions, too, will continue to rise.

The pollutants from ships´ diesels also create a growing environmental and health problem. In the last few years there has been intensive reference to the high risk to health caused by soot particles. On land there are already strict regulations referring to this. The complete lack of legislation concerning the particle emission of international shipping allows a continuous increase of particle emissions from ships, as opposed to the situation with vehicles on land. The EU will therefore take the initiative for the limitation of particles in the foreseeable future. Legislation already exists locally, e.g. in Alaska and California. Measurements and calculations show that c. 15% of global pollution is caused by particles from ships´ diesels. Thus the most efficient medium speed rotor from MAN B&W emits c. 136,000 kg exhaust per hour, of which c. 11 kg are soot and particles [1] .

In the year 1994 more than 260,000 t of soot and ashes were emitted by ships´ diesels worldwide. This especially concerns ports with regular ferry services and regions which already need special protection, internationally (Antarctic) or locally (e.g. in Alaska, and in Germany near health resorts). As there is a lack of means of filtering the exhaust from larger ships´ engines, there is a trend away from the use of heavy fuel oil to diesel oil, because it is obvious that particle emissions stand in relation to fuel quality, resp. to sulphur content.

Table 2: Correlation of sulphur content and particle emissions[2]

Marine Fuel Sulfur Content	PM	SO_x
1.5% (15,000 ppm)	18%	44%
0.3% (3,000 ppm)	63%	89%

Source: Office of Transportation and Air Quality, U.S. EPA, "Draft Regulatory Support Document: Control of Emissions From Compression-Ignition Marine Diesel Engines at or Above 30 Liters per Cylinder," April 2002.

Note: Reductions are as compared to 27,000 ppm or 2.7 percent sulfur content.

[37] D. Bailey, T. Plenys, G. Solomon, T. Campbell, G. Ruderman Feuer, J. Masters, B. Tonkonogy: HARBORING POLLUTION- Strategies to Clean Up U.S. Ports, August 2004.

To some extent, reduction can be achieved by pre- or inner motoric measures (see chapter 6.1). On many ships however such a conversion is not feasible, or extremely expensive, or rather reduces only visible emissions[3].

CFC ´s are in use on board above all in refrigeration units and air-conditioners as well as in insulating materials. Estimates show that about 50% of the total CFC ´s in use on board are set free while the freezing- and refrigeration units are in use, and a further 15% are set free during the repair and maintenance of these units [3].

Finally when a ship is scrapped great amounts of CFC are also set free. By the year 2005 the capacity of reefer ships will increase by a further c. 25%, and thus the amounts of CFC too, or the alternative substances approved by the IMO [3]. As regards VOC emissions, it is estimated that they are around 1.5 million tons per year, which amounts to about 0.1 % of the total amount of oil transported [10].

1.2 Ships´ emissions near the coast

In former times it was generally supposed that the effects of emissions from shipping on the increasing acidity of the soil, woods, rivers and lakes on land were minimal, because these emissions of pollutants took place generally at high sea. Most recent research has shown this to be a false supposition, i.e. the proportion of ships near the coast and their emissions is substantially higher than had been supposed up to now.

In 1993/94 a Norwegian research project found out that, of the 605 Norwegian ships studied, 59.5% were lying in port, 23.5% were in coastal waters within 200 miles of the coast and only

[1] Horst W. Köhler: Weiterer Kampf um den Dieselruß und die NOx- Reduktion; Schiff & Hafen 9/ 2001

[2] http://www.coalitionforcleanair.org/pdf/reports/cca-reports-harboring-pollution-strategies-to-clean-up-US-ports.pdf

[3] see e.g. the concept "invisible smoke" by MAN B&W

17% of the ships studied were on the high seas, i.e. further than 200 miles away from the coast [7]. Further research initiated by Liberia also confirms this ratio. According to the Liberian studies, 37% of all ships were in port, 25% were within 12 to 200 nm away from land and only 27% were further than 200 nm at sea. It becomes clear through these studies that for most of the time ships remain in the immediate proximity of the coast, and thus (can) have considerable influence on negative effects on soil, rivers and lakes because of their harmful emissions.

This explains why, because of the relevant international and national legislation (e.g. Montreal Protocol, TA-Air), the proportion of land based emissions in industrial countries is decreasing continually, whereas the relative proportion of emissions caused by shipping is increasing in the same relation, especially as the absolute proportion from ships will rise continuously in the coming years.

Estimates by *Det Norske Veritas and Industry* regarding sulphur input in the North Sea also prognoses that the proportion of sulphur emissions in percentage caused by shipping will rise continuously [8]. This is going to happen partly to the same extent as European countries are going to reduce land based sulphur emissions by the year 2010. In the differentiated prognosis of the DNV-studies, the Norwegian scientists come to the conclusion that in the year 2010, in particular in coastal waters (the Netherlands, northern Germany, southern Norway the English Channel) shipping will be the main emitter as regards SOx, as their relative contribution to SOx emissions will double or even triple.

According to the estimates of the DNV, declaring the North Sea to be a special area in context with MARPOL Annex VI would not be a sufficient step to combat the problem of the increasing acidity of the North Sea, but it would be an unavoidable step towards achieving the aims set in the Sulphur-protocol (LRTAP-Convention). In ferry ports with heavy traffic in North and Baltic seas in particular, even today ships´ emissions (SOx and NOx) cause by far the largest input of pollutants [8].

Thus research in Sweden has shown that in the immediate vicinity of the southern coast of Sweden and in the Ferry ports there, the emission of pollutants in ships´ exhaust, in particular from the large ferries, causes up to 80% of total emissions into the air as regards NOx and SOx. In some areas, ships are the main emitters of CO_2.

1.3 Applicability of environmental problems to the ports in the Baltic area

Comparable situations and problems are already to be found in many ports on the Baltic Sea, and increasingly world wide, too. Here, local and regional residents come together in order to succeed in establishing their interests against transport and shipping companies. In these debates the emission paths via air and water, as well as the trouble of noise, are of especial importance. The following table gives an insight into shipping structures between the different Baltic States:

Table 3: Number of port calls in the Baltic Sea, II/ 1998 (SMA, 1999)

Country	*Bulk/ comb*	*Tankers*	*Gas*	*Gen. cargo*	*Con-tainer*	*Reefers*	*RoRo*	*Pass-enger*	*Others*	*Total*
Germany	197	388	10	2 601	20	12	955	356	5	**4 544**
Denmark	653	2 100	85	6 642	480	91	967	213	45	**11 276**
Estonia	104	531	1	1 711	60	34	142	22	0	**2 605**
Finland	362	1 128	53	3 904	374	10	2 086	384	5	**8 306**
Lithuania	168	118	0	929	17	86	146	110	1	**1 575**
Latvia	357	490	53	1 969	67	58	237	63	3	**3 297**
Norway	1 149	3 041	458	11 358	791	706	1 998	885	50	**20 436**
Poland	478	707	55	2 544	168	166	230	48	10	**4 406**
Russia	240	411	1	2 291	179	267	143	323	17	**3 872**
Sweden	446	3 002	241	8 382	648	83	1 831	245	45	**14 923**
TOTAL	4 154	11 916	957	42 331	2 804	1 513	8 735	2 649	181	**75 240**

[6]: Statistical Analyses of the Baltic Maritime Traffic, Customer: Finnish Environment Institute, Ministry of Traffic and Communications, RESEARCH REPORT NO VAL34-012344, 30.09.02.

It is clear that RoRo-Traffic in particular takes place between the Scandinavian countries and Germany. Presumably the other countries will try to make up their deficit in this area. Here it is foreseeable that shipping in the section of General Cargo will decrease. In the following table it becomes clear that Lübeck-Travemünde has a special status in Baltic Sea traffic because of its high proportion of RoRo Transport.

As traffic in the Baltic Sea consists mainly of the same ships, the effects of shipping – at least when ports are close to the cities – are always the same. When ports are in areas further away, negative effects are not noticed or hardly noticed at all. If the ports are near cities in areas with environmentally conscious residents, sooner or later protest will arise. Gothenburg, Stockholm and Lübeck are examples of this, and there are other cities where protest is starting to form as is obviously the case in Rostock. When general conditions remain the same, potential resistance from increasingly environmentally conscious residents will rise in the whole Baltic area and further a field.

Therefore a balance of interests on the basis of the targets of Agenda 21 is being sought in various seaports on the Baltic Sea, in order to set up sustainable ecological, social and economic development in the area. A first step in this direction was taken in e.g. the "Archipelago Seaport Project" of the towns Turku, Stockholm and Mariehamn, in which they attempted to create binding standards for shipping.

Table 4: Harbour cargo turnover and primary types of cargo in 1996 at the ten largest harbours in the Baltic Sea (EC 1997, Annual 1998)

Harbor	Country	Turnover (million tons)	Main Cargo types
Gothenburg / Brofjorden	Sweden	47.6	Bulk, general cargo, crude oil, oil products, containers and trailers
Ventspils	Latvia	35.7	Crude oil, oil products and bulk
Lübeck / Travemunde	Germany	21.9	Bulk general cargo, trailers and ferry cargo
Rostock	Germany	20.2	Bulk and general cargo
Gdansk/Gdynia	Poland	24.8	Bulk and general cargo
Porvoo	Finland	16.9	Oil and oil products
Swinoujscie / Szczecin	Poland	16.3	Bulk and general cargo
St. Petersburg	Russia	16.1	Bulk, general cargo, containers and trailers
Klaipeda	Lithuania	14.8	Bulk, oil products and general cargo
Tallinn	Estonia	14.1	Bulk, general Cargo and Trailers

[6]: Statistical Analyses of the Baltic Maritime Traffic, Customer: Finnish Environment Institute, Ministry of Traffic and Communications, RESEARCH REPORT NO VAL34-012344, 30.09.02.

2 Agenda 21 for the Implementation of a Sustainable Global Development

At the conference of the United Nations on the environment and development (UNECD) in 1992, the governments passed the “Agenda 21”, a programme of action for the 21st century which shall contribute to a sustainable global development[4]. In this way sustainable development has been raised to become a model valid worldwide which shall determine not only international and national politics but also the action taken in individual towns and communities.

As to the content, sustainable development means that the model must relate at least to the three dimensions ecology, economy and society. The main issue of chapter 17 Agenda 21 “Protection of the oceans, every kind of sea including enclosed and half-enclosed seas and coastal waters, as well as the protection, sensible use and development of their living resources” is to achieve a balance between the different diverging interests by means of precautionary and preventive measures so as to “check the gradual destruction of the marine environment ... and to make an integrated economic use and development of coastal areas possible” [1][5]. It is therefore necessary to develop a concept of action for an effective regional balance between ecology, economy and social aspects in the ports, so that the clash between transport vs. tourism can be solved or reduced.

Chapter 17 of Agenda 21 calls upon all governments and institutions dealing with shipping to introduce suitable measures for the reduction of air pollution by ships. This appeal by the UNO had been taken up earlier by the IMO and was passed at the 17th plenary meeting of the IMO in the year 1991 within the scope of Resolution A.719 (17). This resolution calls upon the “Marine Environment Protection Committee” (MEPC) to develop a new Annex to MARPOL 73/78, which deals with the prevention of air pollution caused by ships´ exhaust. This MARPOL Annex VI will come into force on the 19th May 2005 and will set limits for NOx and SOx emissions: in addition it contains clear directives as regards the reduction of Ozone-Depleting Potential (ODP).

Following the directives in paragraph 17.6 of Agenda 21, national coordinating bodies shall, among other things, take over the following tasks:

> Point g: “Periodic assessment of the impacts of external factors and phenomena to ensure that the objectives of integrated management and sustainable development of coastal areas and the marine environment are met”.
>
> Point i: ”Integration of sectoral programmes on sustainable development for settlements, agriculture, tourism, fishing, ports and industries affecting the coastal area”.
>
> Point n: “Development and simultaneous implementation of environmental quality criteria”.

Locally, Agenda 21 means that it is the special task of towns and local government to keep an eye on the aim of sustainable development, not only in individual projects but also in the long run.

Each town must find its own way to a balance of the differing interests, taking into consideration the particular prevailing conditions.

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[4] http://www.agrar.de/agenda/agd21k00.htm

[5] [1] Agenda 21: Chapter 17.21

2.1 Indicators for pursuing the aims of the Agenda 21 process

Indicators for sustainability are necessary prerequisites "to create a firm foundation for decisions at all levels and to contribute to a self-sufficient sustainability of integrated environmental and developmental systems": this is what is said in chapter 40.4 of Agenda 21. In addition, indicators are important in order to recognise progress and failure.

One consequence of the Conference of Rio was therefore the foundation of the *Commission of Sustainable Development* (CSD), which in 1995 presented around 130 indicators containing ecological, economic and social aspects. The system was tested and further developed in 21 countries, including the Federal Republic of Germany. After this testing 58 indicators were finalised. The concept of sustainability depends on the level of development of each country and, respectively, the emphasis set by each town within the Agenda process. The starting point for working out a system of indicators at town level is therefore the definition of aims for action to support the direction in which a town shall develop.

In Article 28, towns are explicitly required to work out their local Agenda 21 together with non-governmental organisations, the economy and local residents, so as to ensure the well-being of the community. Following this instruction, several public fora were organised for local residents at which the aims for action towards sustainable development in future were formulated and favoured.

The Lübeck list of indicators contains 22 single items all together covering the three areas of social economic and ecological aspects:

Table 5: The Lübeck List of Indicators

social	economy	ecology
• People on welfare (%) • Supply of space in day care centres (%) • Overweight children (%) • Pupils without leaving certificate (%) • Youth welfare (DM/E) • Women (%) in municipality • offences against the sexual right of self-determination (number) • visits of cultural facilities (number) • Turnout at elections (%)	• Qoute of unemployed (%) • Employees divided in branches of industry (number) • Energy consumption per gross income (kWh/TDM) • Companies with certified environmental management (%) • Women in leading positions in the municipality (%) • Independent use of funds in the community (DM/E)	• Housing- und traffic-space (%) • area under environmental- and- landscape protection (% of the protected area) • Parks, gardens, etc. (M^2/E) • Air Pollution by SO_2(µg/m³) • Water consumption in private households and business (m³/E) • Amount of household waste (kg/E) • Promotions in the ÖPNV (number/E)

Agenda 21 Office Lübeck, May 2001.

In the particular case of the implementation of Agenda 21 in the port of Lübeck, aims for action and the relevant indicators, with emphasis on economy and ecology, can give more information than social indicators. Thus of the 22 aims worked out, only a fraction can be realised in the port of Lübeck and to an even lesser degree the relevant indicators for the implementation of Agenda 21. For this reason the list of directives for concrete instructions in this project must be enlarged.

To the following three aims in the area economy favourised by local residents:

- Balanced economic structure
- Efficient use of resources
- The local advantage in being a precursor in the implementation of Agenda 21.

And to the five aims in the area of ecology it was added the following directives relevant to the port of Lübeck without having to enlarge the aims for action:

- The protection of nature
- The reduction of pollution
- A conscious use of the resource water
- The reduction of waste generated
- Promotion of environmentally friendly mobility.

Table 6: Indicators for judging the realisation of aims

Aim	Indicator
Balanced economic structure	• Economical development of the port
Efficient use of resources	• Fuel consumption (measurements, interview) • Water consumption (statistical, measurements,) • Electricity consumption (statistical, measurements)
The advantage by having a head start in the implementation of Agenda 21	• Development of tourism (statistical) • Development of risks (analysis)
The protection of nature	• The condition of the environment in the area influenced by the port (lichens indicators or other Bio-indicators)
The reduction of pollution	• Air quality NO_X, SO_X, soot (statistical, measurements) • Water quality, waste- and Bilge water, TBT- stress, (statistical, measurements) • Stress caused by noise (statistical, measurements, interview) • Stress caused by vibrations (statistical, measurements, interview) • Amount of waste (statistical) • Emission measurements and spread of the NO_X, SO_X and soot in percent – emissions by ships, machines, trucks and trains in the port area. • Number of port companies with emissions
A conscious use of the resource water	• Water quality, waste- and Bilge water, TBT- stress, (statistical, measurements)
The reduction of waste gener-	• Waste generated in port (statistical)

ated	
Promotion of environmentally friendly mobility	• Sea traffic, Short Sea Shipping etc. (statistical)

[30]: Hanseatic Town of Lübeck: Indicators within the scope of the Lübeck Agenda 21, Agenda 21 Office, Lübeck, in May 2001.

In the course of the project work - and following on from this - developments can thus be concluded when compared with the original situation. Close cooperation with the Agenda Office of the Town of Lübeck should allow results to be included in the local Agenda, in this way helping the town Lübeck-Travemünde to put Agenda 21 into action.

2.2 Implementation of Agenda 21 in German Ports.

An exchange between the Ministry for the Environment, the Stadtwerke Lübeck-Travemünde and GAUSS initiated the execution of the project. The background was the increasing concern about shipping emissions in parts of the town and the attempt to work out concrete suggestions for their reduction through an analysis of the situation.

2.2.1 Tasks to be dealt with

Ports serve as turnover-points for about 90% of the trade between EU-Countries and other parts of the world, and for c. 40% of internal EU trade, coming to a total volume of c. 3.5 billion tons of cargo turnover annually. In addition to this c. 350 million passengers are dealt with annually. However, ports serve not only as intersection-points for the transport of people and cargo, they are also centres for industrial estates and logistic businesses. Trades and industries in the fields of shipbuilding, construction work, repairs, finance and insurance, fishing and leisure, etc. are grouped here, so that many jobs in the town and the area are directly and indirectly dependent on the ports. They are therefore also important junctions for regional and transit traffic.
According to the EU guidelines on traffic planning, shipping, particularly over short distances (*short sea shipping*), shall be further developed in order to relieve shore-side traffic. In addition to this, when one considers the efficient use of energy, shipping is shown to be environmentally and economically positive in comparison with other forms of traffic. For this reason, there are increasing efforts to move the flow of goods away from the roads especially to ships.

Due to this, pollution caused by shipping is also rising. The increasing pollution in ports through the emission of pollutants can definitely be contributed to ships, because of the fuel used on board. The high figures for SOx in the air are concerning, and other pollutants are also generated in considerable quantities.

2.2.2 Aims of the project

Moving terminals away from urban areas in order to reduce pollution is generally not feasible, due to reasons of cost and infrastructure often also under environmental considerations. The project Agenda 21 shall therefore start with an analysis of the economic, environmental and social situation, shall describe the results of shipping while taking local conditions into special consideration, and offer suggestions for a solution. As far as possible, concrete measures towards an improvement of the situation shall be initiated. It must be taken into account here that at present international law does not allow ports to impose national regulations on ships sailing under foreign flag, because these are subject to their own laws in a foreign port as extraterritorial ground (see chapter 8). Moreover one must take into account that ports are in strong competition with each other and that they therefore cannot impose any more regulations over and above the internationally applicable regulations on their customers, i.e. shipping.

The results of the project to reduce conflict between users, in particular regarding the emission of pollutants can only be realised by means of regional cooperation even across borders between the competing ports. For this, the outline of a *Memorandum of Understanding for Sustainable Port Economy* shall be made available to the ports on the Baltic Sea. Following discussions among the Agenda-circles in the Baltic area this can offer a common basis for cooperative action to solve these conflicts.

Possible solutions to be considered will exist not only at sea (among other things the fuel used, equipment for the reduction of emissions) but also on land, e.g. by supplying ships with shore-side electricity. As a model for environmentally and socially compatible shipping, the realisation of a sustainable economy in the coastal regions shall be presented as an example later in cooperation with other ports.

2.2.3 Plan of Action

Statistical research on the basic economic data in the area of study shall show how the local economy functions. Investigation of the legal framework must first show what room for action there is, independently of any economic, social or other aspects. A comparison of the various binding international and national laws, regulations and voluntary engagement together with the relevant limitations of their effects and competence form the foundation for this.

Statistical research of the data, from which the development of traffic flows and, linked to this, the emission of pollutants can be derived, shall be carried out as a basis for the composition of a list of priorities as to any technical measures to be taken. In particular, to improve the environment, air emissions, wastewater – and drinking water – management, treatment of rubbish and recyclables, and pollution through noise and vibration must be examined. Data on the movements of ships entering and leaving Lübeck-Travemünde, combined with technical data of the individual ships, will help to determine air and water emissions. These theoretical results shall be verified by means of a program to measure SO_2 and NOx. The exchange of information as well as the preparation and identification of data, structures, information and results from other seaports and projects concerned with the realisation of ecologically sound shipping in the Baltic sea (e.g. Stockholm, Turku, Mariehamn) shall take place with the especial support and help of the *Union of the Baltic Cities,* in which nearly all larger ports are members. All the information gathered in this way should be used to achieve harmonious cooperation between the Baltic States. This information gained should be made available to other ports and the aim of enlarging the project to cover the whole of the Baltic Sea area under an international program must be continued.

Taking into account any civic action groups, non-profit making societies and other initiatives, the negative aspects arising from shipping for the health and quality of live of the population in the region must be summarised through an exchange of information. Any negative aspects named by the groups, whether subjective or measurable, shall be established and verified by means of measurements as well as by representative surveys, so that one is able to put them in order of priority. The suggestions for solutions which must be developed should first be discussed in the groups above, in order to define agreed courses of action.

Based upon this the administrative measures can be recommended or developed, e.g. the use of a system of bonuses to support environmentally sound ferry traffic. Furthermore, to show potential improvements, technical solutions available must be taken into consideration in order to describe the possibilities on board and on land of reducing the emission of pollutants and any other harmful effects on the environment.

For better cooperation, agreement and to make results public, the following partners / groups must be included:

- The local Agenda 21 groups of the Hanseatic Town of Lübeck, including the City Council
- German port management (in particular Baltic ports as well as Hamburg and Bremen)
- The organisation “Union of the Baltic Cities”
- The “Energietisch Lübeck”.

On a medium term basis, using a *Memorandum of Understanding for sustainable development of port and shipping companies in the Baltic* and applying progressive technology, the employment of environmentally sound ships in those ports cooperating must be promoted and balanced with other social and economic factors. In this way an integrated and sustainable economic use of the coast and the sea can be achieved. Possible social/economic effects on tourism must accordingly be taken into account when the title of being a spa could be deprived.

3 Situation around the ports of Lübeck

In Lübeck-Travemünde a series of very different economic activities come together, which interests are not always in harmony. An extract from the report made by the Office of Statistics of Lübeck gives a short survey of the different economic branches based here:

> "Although economic productivity is rising steadily in Segeberg and Stormarn on the outskirts of Hamburg, the Hanseatic Town of Lübeck with a population of 213.301, continues to be a powerful centre with high potential for development. But the density of industry in the town is sinking, and at the same time there is a great change in urban structure. Nowadays the tertiary sector (trade, traffic and services) is dominant in the town of Lübeck, with a gross production of around 70 %. At the same time industry in the town of Lübeck, with 109 larger companies and 13.639 employees achieved a turnover of 2463 million Euros in 2002. Well known firms in the food industries, engineering, medicine and electronics have brought this achievement. There exists between these firms and the expanding Universities close cooperation in the area of research regarding medicine, construction and electro technology and associated subjects.
>
> The construction of the "University quarter" of the town is progressing. By combining existing faculties with living areas and retail areas to create a campus for science and technology it is hoped to create a positive climate for new knowledge. The "media docks" – a multimedia park which also offers places for studies (ISNM-International School of New Media) – has opened in the centre of the old city. The Lübeck Centre of Technology (TCL) and the Lübeck Centre for Innovations (ICL) both support people from every sphere within the university and research with innovative ideas who hope to start up new businesses. In the city quarter of south Genen there are some larger vacant business areas.
>
> Closely connected to the development of industry, export trade and tourism are the ports of Lübeck and the traffic infrastructure dependant on these. The turnover of goods with the Scandinavian countries takes place through Lübeck, the largest German Baltic port with access to the network of inland waterways via the Elbe-Lübeck-Canal. Large investment in the expansion of the docks and other planned construction in this area will help to deal with the rise in traffic that has been prognosed large number of ferry lines link Lübeck to Scandinavia and north east Europe. The motorway A20 present under construction in the direction of Poland at will favour easy movement of all traffic. The expansion of the railway lines Hamburg-Lübeck-Puttgarden and Lübeck-Bad Kleinen/ Rostock and the expansion of the Lübeck railway station will also be of help here. Plans regarding traffic within the town, e.g. the construction of the "Nordtangente" and the "Herrentunnel" will count here too. Lübeck, as an UNESCO-World Cultural Heritage, attracts around 500.000 tourists every year and contains many hotels, restaurants, cafes, etc. The ancient city not only offers a wide range of service industries and many shops and stores in the well-developed pedestrian precinct it also supplies the needs of the c. 13.000 inhabitants of the old town. Retail trade in this hanseatic town realises around 950 million Euros. In the last few years the economy of the city has received positive impulses from the new music- and conference centre and from new shopping malls and service centres. Another new building project on the Lübeck market will shortly be completed. Lübeck airport at Blankensee has developed most satisfactorily. The introduction of regular flights to London, Stockholm and north Italy has greatly increased the number of passengers." [23].

Lübeck port is the port furthest to the south-west one Baltic Sea and is of special importance as the turntable in the traffic between the traditional economic centres of west and central Europe and the rapidly developing area of the Baltic. In 2003 there was a turnover totalling 25.4 million tons of goods. The Lübeck Port Company Ltd. (LHG) which runs the port of

Lübeck moved 23.1 million tons of this in total. In addition to this around 620.000 passengers used the port of Lübeck[6].

One of the most important factors for the success of the port, by far the largest port on the Baltic (share in the market of over 40%), is the exceptionally high frequency of liner services. The port of Lübeck offers on average around 150 sailings per week to 25 partner ports all around the Baltic. Thus it is offering the highest possible delivery capacity and security for the cargo flows of Europe. Nearly all transport returns loaded from its destination, so that the freight capacity not only of the ferries but also of carriage to the hinterland is always used to the full. For the transport companies this means decisive advantages in cost as opposed to alternative transport routes.

The port of Lübeck also offers the advantage of being a logistic centre with the highest standards of quality and know-how. This is particularly the case for forestry products, such as paper and cellulose. Lübeck is the largest centre for turnover and distribution in Europe for the Swedish and Finnish paper industry. This leading role has been recently made even stronger through long term contracts with the world wide leading paper producers from Sweden and Finland. About 4 million tons of forestry products went through Lübeck[7] in 2003.

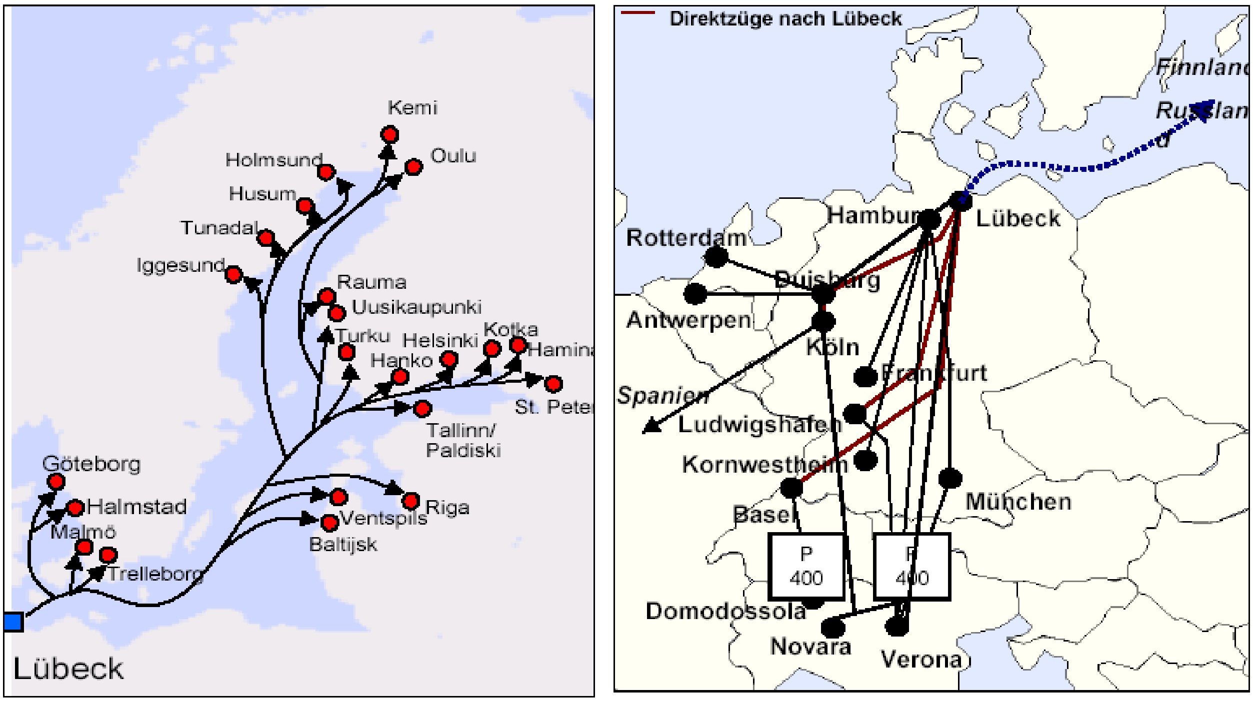
Lübeck ´s strongpoint is Roll-on-Roll-off-traffic (RoRo): fast freight, which is rolled on and off board by trucks, shipping company units or railway wagons. Individually retail made logistic systems guarantee the customer optimum service 365 days a year. With a turnover of more than 85.000 container units (TEU) per year, Lübeck is the largest German container port on the Baltic Sea.

The situation of the port of Lübeck gives it excellent hinterland connections. The three lane Motorway A1 towards Hamburg links Lübeck to the most important economic centres of Europe. The railway network excels because of particular efficiency as regards the wagonload traffic as well as in combined freight transport. Every week around 35 block trains operate to the main industrial centres of Europe. As well as this the Elbe-Lübeck canal provides a connection to the European network of inland waterways.

[6] http://www.lhg-online.de/

[7] http://www.lhg-online.de/

Picture 3: The most important ferry and inland connections from Lübeck-Travemünde



Source: Uta Stief, Port of Lübeck and Central HUB for the Baltic Sea: "Anforderungen für die Zukunft": Lübeck Port Company Ltd.

Among the ports run by the LHG there are five port areas with a total surface area of 120 hectares and 20 ships´ berths. The number of jobs in the port of Lübeck has been rising continuously over the last few years. More than 1100 persons were directly employed in the port in 2003. All together about 5500 jobs are dependant on the port. In this way the port makes a valuable contribution to economic profit and stability in the region. The number of jobs in the port of Lübeck in Toto has risen continuously over the last ten years. In comparison with 1993 there has been a growth of jobs to the extent of c. 55%. In the same way, the indirect on other jobs has developed in relation. By the year 2015 it has been prognosed that there will be an increase of around 50% in the turnover of goods in the port of Lübeck: correspondingly this will mean the creation of new jobs[8].

An increase in cruise liners is not seen as a priority in Lübeck-Travemünde. By 2006, a new bridge will have been built in Lübeck, so that ships longer than c. 100m will not be able to enter and berth. These ships will therefore mainly berth at the Ostpreussenkai, some possibly also at the Skandinavienkai. Smaller ships (< 100m) can perhaps also berth at Kohlenhof (Priwall). In 2003 just less than 30 passenger ships were documented as having entered the port, in 2004 c. 30 ships are also estimated. The aim for 2010 is to bring 50 ships into Lübeck-Travemünde.

[8] Source: Antwort der Bundesregierung auf die Grosse Anfrage der Abgeordneten..., - Dokument 15/2037 on „The Future potential of German Harbours", 28.05.2004

3.1 Information on the environmental situation in Lübeck-Travemünde

The Office for the Environment in Lübeck-Travemünde is to commission surveys on the air of the town and to make publish the results. Among other things lichens will be used for this as bio-indicators. After the `Rheinisch-Westfälische` TÜV had carried out their first surveys on lichen in 1989 and 1992, they undertook a new mapping of lichens in 1999. The aim of this survey was to find out the overall situation of air pollution in Lübeck, to identify any changes and to evaluate them. When evaluating the results it must be taken into account, that lichen do not react to one pollutant alone, they react to the total pollution. Nevertheless they are good indicators, especially for SOx, NOx and other pollutants.

When compared with the first survey 1989/1992 the position and form of the areas in Lübeck polluted up to now had changed only little. In some areas, in particular those that had been heavily polluted, the quality of the air had improved. Except for areas in the outskirts the quality of the air had almost generally improved by one degree on the scale. The exception here was South Genin. Here there had been no change in the quality of the air over the last ten years. The most positive influences on the quality of the air had been the reduction of pollutants in petrol an diesel fuels, the introduction of catalytic converters, the reduction of sulphur content in heating oil and stricter regulations regarding the filtering of exhaust and fumes in industry and power stations.

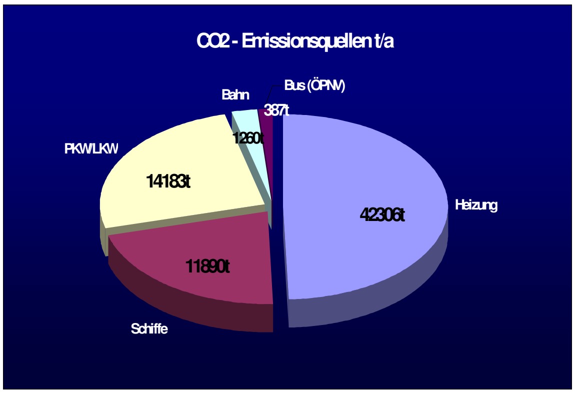
Heavy pollution of the air, on the scale 1.1 to 1.2[9], can be measured in the centre of the city where air movement is hampered by the density of the buildings. The same is also true for the port area, the industrial areas Genin and Dänischburg, Siems, Herrenwyk and that part of Travemünde influenced by shipping[10]. In a survey made by the German meteorological office in 1994 it is pointed out that there is “intolerably high sulphur pollution” in some parts of the town and that the permitted threshold is crossed time after time, in the case of nitrogen dioxide too. As a conclusion they stated “that Travemünde only fulfils the conditions necessary to be called a sea spa to a limited degree. Nevertheless it is agreed that the town may continue to bear this title, under the assumption that the necessary steps will be taken, measurably to reduce the high sulphur dioxide pollution in winter...” [28].

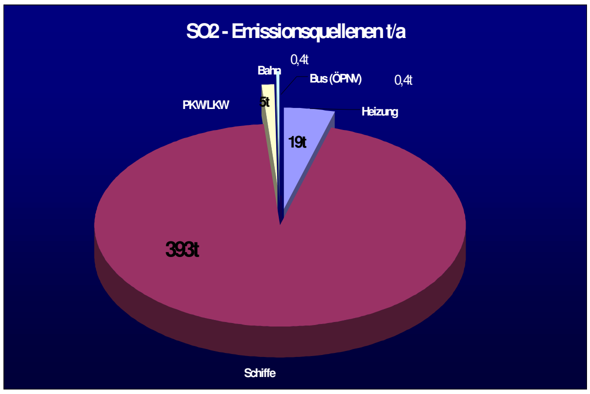
In 1995 a report on the quality of the air was presented to and discussed with the local residents of Lübeck-Travemünde. The following pollutants in the air have been quoted for Travemünde, although it must be pointed out that the amounts may partly be not accurate.

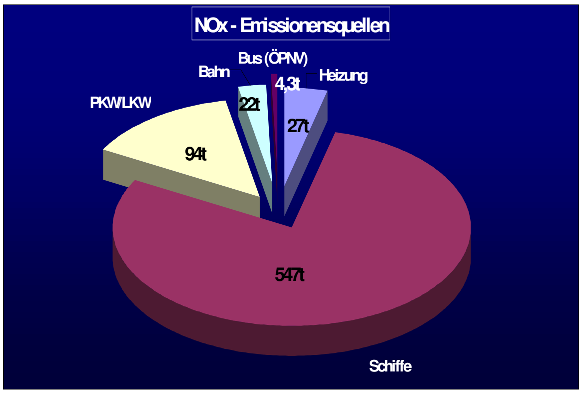
[9] Quality of the air is measured on a scale from < 0.7 (especially highly polluted) to >3.1 (pollutants not traceable). Zones with values from 1.1 to 1.2 are classified as critical pollution, from 1.3 to 1.5 as moderately high pollution and from 1.6 to 1.8 as medium high pollution.

[10] http://www.luebeck.de/aktuelles/pressedienstarchiv/view/2001/6/0104131/

Picture 4: Emission in Lübeck-Travemünde







[28]: German meteorological office in Schleswig: “Official evaluation of the quality of the air in Lübeck-Travemünde”, Schleswig, 23.November 1994

When one considers the causes of CO_2 emissions, it is clear that on land central heating produces the greater part. But for SO_2 and NOx emission shipping is mainly responsible. An analysis of the emissions causes by different forms of traffic shows the following situation:

Table 7: Pollutants caused by traffic in Travemünde[11]

Source of emission	CO_2 (t/a)	SO_2 (t/a)	NO_X (t/a)
Cars / trucks	14,183	4,67	93,5
German Railways co. Ltd.	1,260	0,40	19,5
Busses of the ÖPNV	387	0,22	5,5
Ships not in operation	7,910	281	228
Ships in operation	3,980	112	136
Total	27,720	398	482,5

[28]: German meteorological office in Schlesien: “Official evaluation of the quality of the air in Lübeck-Travemünde”, Schlesien, 23.November 1994

[11] These figures have been combined from two different tables and rounded off to the nearest number. The NOx emissions for shipping were mistakenly given as 464 t/a instead of the correct amount 364 t/a. (this has been corrected in this table).

As possible measures for the reduction of CO_2 emissions, it has been suggested that renovation of older buildings and changing heating energy to natural gas or some other regenerative source of energy is most important. This would also reduce SOx emissions. In order to reduce emissions from shipping, the following points have been suggested:

- Check whether ships at berth can be linked to shore-side electricity
- Check whether ships entering and leaving harbour should not proceed at reduced speed up to a distance of 4-5 nm from port
- Relocate the berths of small ferries on one-day-trips (so-called "Butterfahrten"). At the time of writing the shutting down of these services because of new customs regulations was already to be expected
- To give shipping an incentive to use low sulphur fuel by means of reduced port fees,

In the meantime in Los Angeles the first two options have already been realised. Gothenburg also has installed shore-side electricity to avoid having to relocate berth. In Sweden there are already incentives for ships using low sulphur fuels. German ports, however, have up to now refused to take part in the Swedish system. Some shipping companies operating between Travemünde and Swedish ports are already using low sulphur fuels and for this they receive discounts on shipping routes and for port fees in Sweden. The emissions caused by different forms of traffic were estimated for the year 2000, the results were as follows:

Table 8: Emissions caused by the various forms of traffic in the year 2000

	NO_X (t/a)	SO_2 (t/a)	NO_X (%)	SO_2 (%)
Public Road network	73,8	2,0	4,44	0,26
Railways (main lines)	31,7	0,6	1,91	0,08
Shipping (without Skandinavienkai)	966,0	536,9	58,16	69,48
Shipping (Skandinavienkai)	277,1	103,1	16,68	13,43
Times at berth (Skandinavienkai)	288,5	129,7	17,37	16,79
Rail transport within the port	8,0	0,1	0,48	0,01
Trucks and mobile units in port	15,9	0,3	0,96	0,04
Total	1661,0	772,7	100	100

Source [28]: German meteorological office in Schleswig: "Official evaluation of the quality of the air in Lübeck-Travemünde", Schleswig, 23.November 1994.

According to this in Travemünde c. 92% of NOx emissions and 99.7% of SOx emissions from the different forms of traffic can be attributed to shipping in total. Of this 37% of NOx emissions and 30.3% of SOx emissions are generated at the Skandinavienkai.

3.2 Potential conflict between competing economic interests

In former times the port activities, involving ships from all over the world, with foreigners and foreign goods, was an attraction for tourism on the coast. For many tourists shipping represented a different world with its own special charms, a world they could take part when on holiday in the coastal areas and ports.

This picture has changed completely. Because of stricter security measures, unauthorised persons are no longer allowed to enter the port area or board a ship. Work on board ship is carried out in areas that are inaccessible, often out of sight of the public and watched over by security personnel. In addition to this the romantic idea of shipping which in the past was clearly to be seen, nowadays has nearly disappeared. The anonymity has contributed to the negative public image of shipping, which imagines ships under foreign flags with little environmental and safety standards, sea birds covered with oil and environmental pollution in general. This point of view overlooks the fact that important work is done in the ports, keeping the economy running.

The total turnover of the port of Lübeck was 25.2 million tons in the year 1999 (1998: 24.9 million tons). Lübeck has good road and rail inland connections and regular ships´ routes to 16 ports of the Baltic Sea, with more than 110 sailings per week. At the five main terminals Skandinavienkai, Konstinkai, Nordlandkai, Schlutup and Lehman terminal mainly ferry traffic is dealt with. Here particularly paper and forestry products, packed goods, fruit and vegetables, bulk goods, cars, etc. are loaded and passengers services are offered.

Table 9: **Sea traffic in Lübeck**

Jahr	angekommen Schiffe	abgegangen Schiffe
1960	5 806	5 831
1970	7 556	7 567
1980	6 425	6 429
1990	5 896	5 894
1995	5 382	5 382
1996	5 471	5 468
1997	5 660	5 661
1998	6 088	6 075
1999	6 426	6 420
2000	6 003	6 002
2001	6 041	6 042
2002	5 913	6 041
Veränderung in v.H. gegenüber dem Vorjahr	- 2,11 %	- 0,02 %

[23]: Office of Statistics in the Town of Lübeck, as of 01.09.03

Although the number of ships handled in Lübeck-Travemünde in the period from 1960 to 2002 has remained relatively constant, the turnover of goods and the number of passengers has risen considerably.

Table 10: Turnover of goods entering and leaving Lübeck

Jahr	Umschlag in t insgesamt	davon Ausland	darunter Eingang in t insgesamt	davon Ausland	Ausgang in t insgesamt	davon Ausland
1960	3 037 630	2 770 768	2 261 110	2 040 892	776 520	729 876
1970	7 274 541	6 563 430	5 096 987	4 404 075	2 177 554	2 159 355
1980	9 962 481	9 314 234	5 856 264	5 212 266	4 106 217	4 101 968
1990	18 000 571	17 860 035	10 147 644	10 064 051	7 852 927	7 795 984
1993	18 577 423	18 204 925	10 902 327	10 547 879	7 675 096	7 657 046
1994	20 329 597	20 101 424	11 534 683	11 320 018	8 794 914	8 781 406
1995	20 835 004	20 132 980	11 619 788	11 365 185	9 215 216	8 767 795
1996	21 976 578	21 741 685	12 114 672	11 898 250	9 861 906	9 843 435
1997	24 372 718	24 143 988	13 494 998	13 288 734	10 877 720	10 855 254
1998	24 925 399	24 727 303	14 188 698	14 004 540	10 736 701	10 722 763
1999	25 262 869	25 118 920	14 449 152	14 336 595	10 813 717	10 782 325
2000	25 707 439	25 680 817	14 836 194	14 830 057	10 871 245	10 850 760
2001	24 523 215	24 496 621	14 206 510	14 202 422	10 316 900	10 294 199
2002	24 552 543	24 522 563	14 249 974	14 247 133	10 308 569	10 281 430
Veränderung in v.H. gegenüber dem Vorjahr	0,12	0,10	0,30	0,31	-0,08	-0,12

[23]: Office of statistics in the town of Lübeck, as of 01.05.03

Table 11: Turnover of goods and passenger transport in Lübeck-Travemünde

Category		1999	2000
Packed goods (Mio.t)	Paper	2.806.512	3.188.471
	Cellulose	275.784	312.6
Cargo (no of units)	Accompanied trucks	302.927	304.096
	Unaccompanied trucks	330.471	347.419
	Container	56.489	64.204
	Wagons (railcars)	26.848	18.931
	Cars	159.634	159.634
Travellers (number)	Passengers	573.373	484.189
	Passenger cars	117.413	110.758
LHG-Terminals (Mio.t)	Skandinavienkai	15.143.598	15.011.299
	Nordlandkai	5.249.705	5.481.341
	Konstinkai	1.818.194	1.783.341
	Schlutup	1.150.715	1.185.919

[I8]: Finnish Environment Institute: Statistical Analyses of the Baltic Maritime Traffic.

Even when compared to other Baltic ports the enormous potential for development of the port of Lübeck can be seen in the following prognosis of the ISL for the year 2015. A rise in operations of course will also necessarily mean more effects on the environment, unless these can be reduced by means of legislation or voluntarily.

Table 12: Prognosis for German Baltic ports and their capacity in 2015 (in mio. t)

Port	Throughput 1998	Throughput in 2015	Capacity in 2015 min	max
Kiel	4,13	5,44	6,48	7,55
Puttgarten	6,23	8,91	8,45	
Lubeck	24,69	38,67	39,28	39,87
Wismar	1,85	3,22	3,01	
Rostock	18,49	32,78	31,76	32,37
Stralsund	0,60	0,75	0,93	
Sassnitz	5,54	11,47	11,46	12,48
Total	61,90	101,24	101,36	104,56

Institute of Shipping Economics and Logistics 2000.

3.2.1 Shipping economy and tourism

As seen above, the shipping economy has developed enormously and further extensive growth is expected in the future. Tourism is also rising steadily on the German coast and income from tourism is one of the greatest sources of revenue here. Tourism on the Baltic coast of Schleswig-Holstein is a mixture of different forms. 60% of visitors are families and pensioners on holiday, 20% are taking part in health resort activities and the last two groups, each c. 10%, are business travellers (Lübeck, Kiel, and Flensburg) and people from Hamburg over the weekend or for short breaks. In spite of expecting a growth of tourism, it is still the city’s aim to achieve a good balance between economy and ecology, because tourism of course may not destroy its own basis, i.e. nature, the environment and the landscape must remain unharmed.

For the first time in Northern Europe the whole of the old medieval city in the centre of Lübeck has been recognised by UNESCO as a “World Cultural Heritage”. Because of its unique architecture including the perfectly preserved 13th century quarter of the town with the church of Jacob, the Hospital of the Holy Spirit and the rows of houses between the bell-foundry, the patrician houses of the 15th and 16th centuries and the salt warehouses on the left bank of the Trave, the Hanseatic Town was included as *The Hanseatic Queen* in the list of the *World Cultural Heritage for all People* in 1987.

This town, with its historic old city, over 800 years of culture, its Hanseatic and trading traditions, is one of the most important cultural towns of Germany. The town, already a national and international cultural monument is now competing with other German towns for the honour of being called a “Cultural Capital of Europe” in the year 2010. The link between the city of Lübeck and the Baltic resort of Lübeck-Travemünde offers all the advantages of holidays, meetings, and cultural events.

The marine resort of Travemünde developed very early to one of the traditionally most popular resorts of the Baltic Sea. Since 1957 it has been officially recognised as a health resort and attracts hundreds and thousands of tourists and weekend visitors with sun, beach, the spa, culture and casino. The hospital Priwall has a station for dialysis and also offers a variety of therapy methods including mineral baths, oxygenated baths, etc., Kneipp-therapy, fango-; moor-; ice-wet packs and special therapy for headaches and migraine.

In addition every year in the last week of July there is the *TravemünderWeek*, one of the greatest regattas in the world. Other sporting possibilities are: surfing, fishing/ marine fishing, diving, boat tours, sailing on vintage ships, riding, tennis, golf and many other activities. Due to the geographical situation with sheltered bays there are yacht harbours, sailing schools and surfing schools and other sporting activities together in many ferry ports,. In the past the differing interests of commercial and leisure shipping has often led to conflict, and the situation will probably become worse as ever faster and ever larger ferries are brought into use. The problems would be aggravated in particular by the use of increasingly fast ships, especially High Speed Craft. In high seas, small boats can only be made out by the officers on the bridge of such ships at the last moment: the amateur sailors for their part often underestimate the speed of these ships. This has already led to accidents.

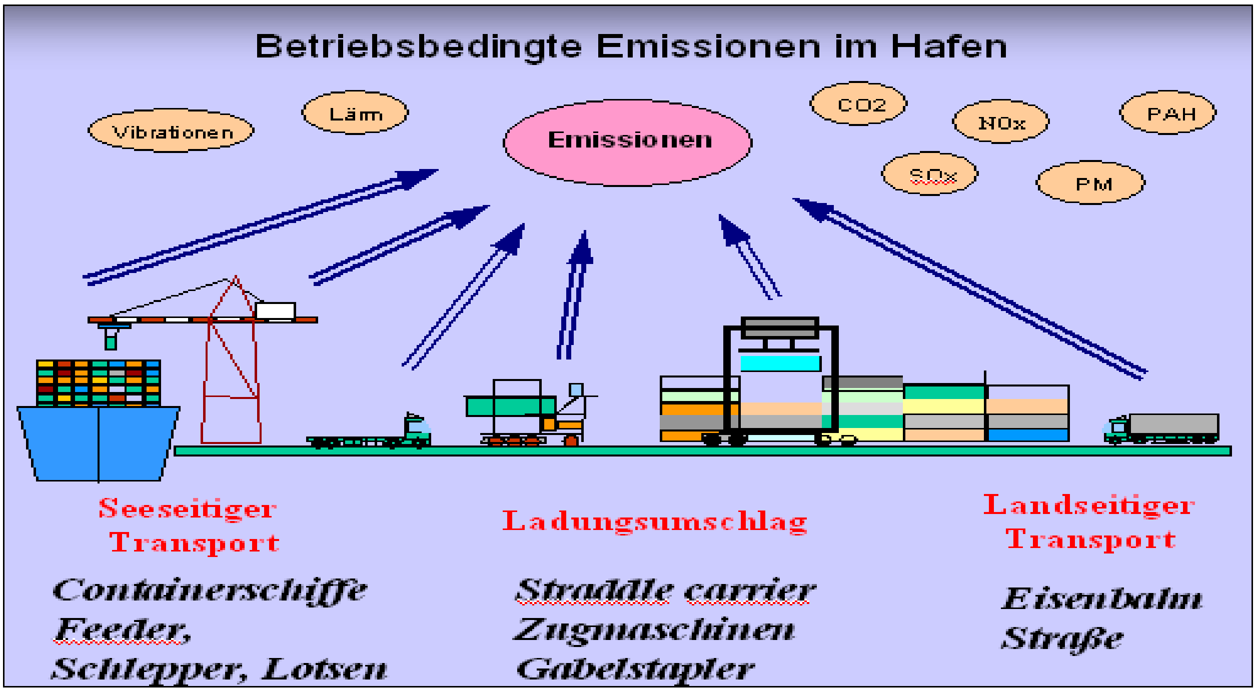
As the passenger / ferry terminals are situated in the town and at the mouth of the river, the infrastructure is often very strained because the city centre, tourist and spa attractions are in close proximity. One result is that because of continually increasing ferry traffic the inner cities and access roads are often congested by trucks and cars driving to and from the ferry terminals. This causes considerable clashes with residents and tourists.

The various effects given above have led to the founding of a group representing different interests, with members of the *Energietisch Lübeck, AG Schiffsverkehr* and local residents, in an attempt to find measures for reducing these negative effects.

4 Emission of pollutants by shipping and port-operations

As already described, emissions caused by shipping are becoming more and more a matter of public interest. Local measures for the reduction of particularly harmful pollutants must be expected in the near future. At present it seems obvious that little thought has been taken about ports and how to satisfy a demand for a sustainable development in balance with other parties with an interest in the marine environment. The main reason is that emissions here are already in part regulated. For example in port construction work compulsory environmental standards have been taken into consideration for quite a while now and where necessary, alternative biotopes must be offered. But for the working operation of a port there are generally no special preventive measures taken for a further reduction of environmental pollution.

Picture 5: Emissions during port operation



GAUSS 2004.

In some ports of the world such methods to reduce emissions of pollutants are being examined and put into practice. This shows that there is an increasing awareness of the need to minimize emissions in port. Here one must differentiate between port internal measures, i.e. measures against emissions in port caused by machines and operating units on land, and measures taken by ships to reduce their emissions in port. Important measures are:

- Measures to reduce pollutants from cranes, straddle carriers, mafis, fork-lift trucks, trucks, etc. Some of the methods taken here which are already in practise are described later.
- Measures to reduce emissions from ships, e.g. discounts for the “voluntary use” of low sulphur fuel or e.g. the supply of an external electricity supply.

Types of emissions and potentials for reduction will be described in detail in the following chapters.

4.1 Exhaust fumes

The most important emissions caused by the operation of ships and port are sulphur dioxide, nitrogen oxide, particle matter, volatile hydrocarbon and gases causing the greenhouse effect and those which are harmful to the ozone layer. Pollutants in ships´ exhaust, not described in detail in this study, include those causing the greenhouse effect, as does carbon dioxide[12]. The sources for the differing emissions are partly the same (e.g. main engine of the ship) but partly also different (e.g. fire fighting, cooling agents). While the main engines emit a whole range of different pollutants, VOC are largely emitted by the cargo. As well as the primary pollutants (e.g. CO_2 and SOx), secondary pollutants develop (e.g. ozone) from the ships´ exhaust through the influence of light.

Up to very recently, pollution of the air by shipping had little or no significance in the way of thinking and knowledge of international shipping. The much quoted and often misused "freedom of the seas" was therefore taken at face value and interpreted as though the apparent infinity of the oceans could take and stand every stress.

Picture 6: Gaseous emission of ships in port

Ver:di report on shipping, on the subject of traffic 2/2004.

In fact most ships burn a fuel which is a by-product of the refining process accompanied by insufficient technical treatment of fumes. It is only in the last few years that industrialised shipping nations have been concerned about the effects of air pollution caused by shipping. MARPAL annex VI was accepted by the IMO on 26th September 1997 and was ratified on 18.05.2004 by the necessary number of 15 countries, i.e. it came only into force on 19.05.2005.

The fact that the IMO has been giving more intensive attention to emissions caused by ships in the last few years has arisen on the one hand from the growth of greater environmental sensibility among many of the signing states, and on the other hand from increasing international public pressure. The LRTAP-Convention[13] in particular set the IMO under pressure to take rapid action, as it was planned for the end of 1997 to expand the NOx-report to cover mobile

[12] The most important gases causing the greenhouse effect are: carbon dioxide (CO_2), methane (CH_4), laughing gas (N_2O), fluorine hydrocarbons (FSKW) and sulphur-hexa-fluorides (SF6).

[13] Conventions on Long Range Trans-boundary Air Pollution

resources too, thus also affecting international shipping. The same can be expected to happen in the near future with the "Sulphur-Report" and also for the "VOC-Report".

4.1.1 Sulphur dioxide (SO_2)

The subject most under discussion at the moment in the field of shipping and protection of the environment is the emission of sulphur-dioxide. The fuel normally used on seagoing vessels is Heavy Fuel Oil (HFO), which unlike the one used on land has not been desulphurised. This fuel is a kind of waste product from the refining of mineral oil including the components which are no longer allowed on land. It is even sometimes a matter of fact that other pollutants which are normally expensive to get rid of are mixed with this "normal refinery waste" in order to get rid of them at sea. The advantage here for shipping lies in the fact that the robust ships´ diesel engines are able to use this fuel and that thus costs are low because of the poor fuel quality. While one ton HFO costs c. 160 US dollars, the price of MDO is c. 240 US dollars and the price the diesel used on land is about 440 US dollars per ton.

Whereas MARPOL Annex VI dictates the maximum allowable level of 4.5% sulphur content, worldwide the average content is already at c. 2.7%, i.e. the international binding regulations for shipping (with a few exceptions) concerning protection of the environment results in no improvement. The following table presents quite clearly the spectrum for different fuels containing sulphur.

Table 13: Sulphur content of various fuels

Summary of Sulfur Content in Various Fuels

SULFUR CONTENT percent	ppm	Example of Current Usage or Status
4.5	45,000	Maximum allowable level for marine fuels in the International Convention for the Prevention of Pollution From Ships (MARPOL)
2.7	27,000	Average for marine fuels (widely accepted global average)
1.5	15,000	Recently proposed by EU as its cap for marine vessels in the North Sea, English Channel, and Baltic Sea
0.5	5,000	Current U.S. EPA nonroad diesel fuel standard, which does not include marine vessels
0.1	1,000	Recently proposed by EU for marine vessels while berthed in EU ports beginning in 2010
0.05	500	Current U.S. EPA on-road diesel fuel standard
0.015	150	Current California on-road diesel fuel standard
0.0015	15	U.S. EPA on-road and California on-road and off-road diesel planned for mid-2006

[37]: D. Bailey, T. Plenys, G. Solomon, T. Campbell, G. Ruderman Feuer, J. Masters, B. Tonkonogy: HARBORING POLLUTION - Strategies to Clean Up U.S. Ports, August 2004.[14]

In the European regulations on fuels from 13th October 1998, the sulphur content of the petrol and diesel for vehicles on land was reduced as from the 1st January 2000: petrol from 500 to 150 ppm and diesel from 500 to 350 ppm. In 2005 it was aimed to make a maximum sulphur content of 50 ppm (= 0.005%) binding for all types of fuel. However representatives of the

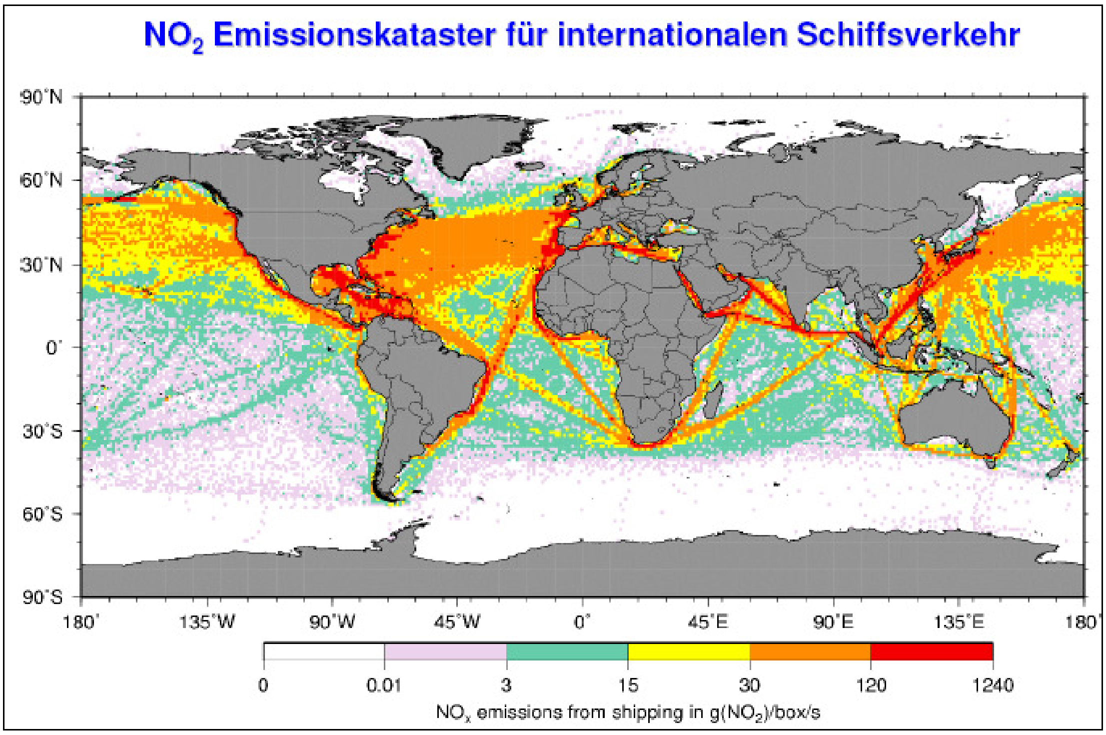
[14] http://www.coalitionforcleanair.org/pdf/reports/cca-reports-harboring-pollution-strategies-to-clean-up-US-ports.pdf

federal government, the automobile and the oil industry were already in discussion in mid 1999 about an earlier introduction of petrol and diesel with a max. sulphur content of 50 ppm, and even about a further reduction to only 10 ppm under the condition of tax bonuses. Agreement between these opposing factions could not be reached at once, but since 01.11.2002 refineries in Germany only offer sulphur-free fuel with less than 10 ppm sulphur which was under the traceable limit.

4.1.2 Nitrogen oxide (NOx)

NOx occurs during the burning process in the combustion chamber. Through the high pressure and high temperatures some of the nitrogen content is oxidised and so is converted to NOx. In the last 25 years pressure and temperature in marine diesel engines have risen continuously. This has had the positive effect that the efficient use of energy could be increased by up to 20%, but unfortunately at the same time the amount of NOx fumes has risen too ("Diesel Dilemma").

Picture 7: NOx emissions from shipping



Dr. Bovensmann, Universität Bremen: Presentation of the project SEAM by GAUSS, 12. April 2004.

Fundamentally one can say that with the stand of technology today NOx emissions can be reduced technically by 95% without problems [11]. This could best be achieved by the use of SCR-Catalysers (Selective Catalytic Reduction) [11]. An almost equally high reduction of NOx can be achieved by fitting out ships with gas turbines. Both catalysers and gas turbines, however mean considerable investment in technology and high expenses, so that alternative possibilities are sought for in the following pages.

4.1.3 Volatile Organic Compounds (VOC)

Even though there is little VOC content in the exhaust of the engines, for the most part VOC comes from tankers, respectively their cargo. These VOC emissions occur chiefly during loading, but also during the voyage, caused by the development of gas on the surface of the load in the tanks.

4.1.4 Green House Gases (GHG)

The natural greenhouse effect caused by the additional warming of the earth's atmosphere by solar energy reflected from a layer of gases in the troposphere is increased by the so-called "Green House Gases" (CO_2, CFC, methane, ozone etc.).

The most important greenhouse gas emitted by shipping is CO_2[15]. Even if the new MARPOL Annex makes no ruling on the reduction of CO_2, it is to be expected in the near future that similar regulations will be set for shipping as they were for land based sources of emissions in the *Berlin Mandate* of the *UN Framework Convention on Climate Changes.*

4.2 The importance of emission from auxiliary boilers

To determine emissions from ships entering and leaving ports as well as at berth, either the fuel consumption for the particular space of time is needed or the output data of the different engines and units used for propelling the ship, supplying electricity and the heating on board. As fuel consumption is not made public by the shipping companies, the output data must be referred to. Normally data is available on the main engines and the auxiliary diesels. In the case of the auxiliary boilers providing data is only available in some cases. As little information on this obtained from the shipping companies, the necessary data could only be found by comparison with other ships. The data needed for this regarding ferries and RoRo-ships are the number of persons on board (crew and passengers), and the space available for transporting vehicles. Most ships have three to four sources of energy which operate in three main operational conditions.

Table 14: Suppliers of energy and operating status

Operating status	Driving engine for prop. (+ shaft generator.)	Auxiliary engines (2-4) for e-supply	Exhaust boiler (if installed)	Auxiliary boiler
Form of energy	Mechanical energy	Electrical energy	Heat energy	Heat energy
On high sea	Constant operation, (creates partly also el. energy)	Not running, if there is shaft generator/ variable pitch propeller	Runs with exhaust of main - and auxiliary engines	Most times not in operation
Manoeuvring port entrance coastal shipping	Part time operation* irregular especially with the fixed pitch propeller	Running at low power* and full power, usually 2 motors	low power *	low power *
In port	Not running	Running alternately all the time	Most times not in operation	Total supply of heat

15 Other important gases are Methane (CH4), Laughing gas di-nitrogen oxide (N2O), fluorine hydrocarbons (FSKW) and sulphur-hexa-fluorides (SF6).

*Running at low power is favourable for high emission production, e.g. 3 times of the amount of normal soot usually emitted can be generated in this status.

[29] Isensee, J: Ship-auxiliary boiler: size – characteristics – pollution, Hanover 16.12.2003.

4.2.1. Capacity of auxiliary boilers

For many reasons it is often necessary to be able to estimate the capacity of auxiliary boilers easily. Therefore all available data on ships and their auxiliary boilers have been evaluated some of this data was available by wharfs. For the purpose of the study there were 28 sets of data for estimating the capacity of boilers on board available.

Working back from these the results are shown in the following table. The aim here is to find rules of thumb to determine the capacity of auxiliary boilers in relation to the most important parameters of the ship but it is not always certain, which parameters are decisive. Thus it is necessary to choose those parameters which are closest to the decisive parameters. The most important parameter when dealing with non-tankers and non-passenger ships seems to be the size of the tanks for fuel to be fore heated, i.e. as a rule those tanks containing fuel oil[16]. For some types of ship rules of thumb with two parameters can hardly be avoided – for example on RoRo-Passenger ships the auxiliary boilers depend on the number of passengers and the fuel tanks. As well as this, this type of ship falls into two sub-categories, namely RoRo-Passenger ships with and without cabins. Here cabin passengers use measurably more heating energy.

The following parameters were taken for this study. There are, however more parameters arising from the sets of ships data.

- Tonnes dead weight (tdw)
- Crew + Passengers (CP)

When the capacity of the auxiliary boilers is known from more vessels, it is planned to include into the list:

- (braking) power of the driving engines (PB)
- Space for transporting vehicles on RoRo cargo and RoRo passenger ships (SP).

Table 15: Types of ships and necessary performance of auxiliary boilers

Type of ship	Number of ships / size	Parameters	Rule of thumb for amount of steam DM* t/h saturated steam	Density of particles
Container	5 / 500<TEU<7500	tdw	$DM = 0,5 + 6 * 10^{-5} * tdw$	high
Tanker	6 / 16000<tdw<40000	tdw	$DM = 60 * 10^{-5} * tdw$	medium
RoRo Cargo	5 / 600<SP<2200	tdw	$DM = 1,2 + 26 * 10^{-5} * tdw$	high
RoRo-Pax	8 / 340<BP<2880	BP	$DM = 2,0 + 2,3 * 10^{-3} * BP$	high
Passengers	4 / 920<BP<4200	BP	$DM = 5,0 + 6,0 * 10^{-3} * BP$	low

* DM=mass of saturated steam per hour

[29]: Isensee, J: Schiffs-Hilfskessel: Größe – Eigenschaften – Umweltbelastung, Hannover 16.12.2003.

[16] U. Janssen, K.-H. Hochhaus: „Langzeitmessung des Hilfsdampfverbrauches“, HANSA 1985, No. 14 pp.1474 – 1483

Reliable data on the full capacity of auxiliary boilers was practically not obtainable. On a cool day in port a c. 25% capacity could be seen from the auxiliary boiler of a small coastal ship without pre-warming systems. Just less than 100% was determined in ship building regulation as the necessary capacity when cold crude oil (cargo) had to be heated up to pumping temperature for discharge. The performance of the auxiliary boilers here was almost as high as that of the main engines, and was about five times of the performance of the auxiliary engines.

The efficiency (saturated steam energy / fuel energy) is around 0.80 to 0.85 (approximately 2 t/h steam performance ~ 1.3 MW). The lower figures should be taken for smaller units the higher for larger units from 5 t/h.

4.1.5.2 Relevance of emissions from auxiliary boilers

At present there are no regulations on limiting emissions or on the fuels to be used for auxiliary boilers, in spite of their size and in spite of the fact that they are in use above all in port. Well-run auxiliary boilers can be expected to have fewer emissions than engines. However the combustion chamber and the main boiler are less efficiently constructed as shore-side facilities, as well as not being required to have filtering facilities, so that their emissions are higher compared to those of land based facilities. Apart from a measurement of NOx given orally and a similar estimate from Denmark[17], no data on NOx could be determined. Both the figures given are encouragingly low and amount to c. one g NOx / kWh. The Danish source gives a figure of c. 0.03 to 0.15 g PM / kWh without giving information on fuel, condition of boiler and size.

SO_2 is easily calculated from fuel figures, just as it is with engines. It must be remembered here that oil sludge is often burnt too. Almost nothing is known about the emission of soot containing particles, CO, CnHm, VOC, etc., but these components can be the most harmful of all in port. It is possible that auxiliary boilers cause a ¼ to ½ of all ships´ emissions in port and port entrance.

At the inspection of boilers on delivery and after installation there are generally measurements taken to check their functioning. These measurements are recorded in reports, but it was not possible to inspect these. They are not meant in the first instance to be for the checking of emissions. It costs great effort measure soot in g/kWh, so soot is generally not measured at all: there are after all no regulations as to permissible limits. Whether the figures measured at the time of installation are at all reliable regarding emissions in normal operation is doubtable anyway.

The special "thermal boiler" is so similar to the steam boiler in all aspects important for the study that it need not be separately dealt with here. Its emissions and efficiency are comparable with those of the steam boiler. Regulating the thermal-oil pre-heating system is however more difficult, because thermal-oil cools down when giving off heat, while steam condenses and this condensation takes place at the same temperature.

4.2.3 Oil sludge and used oil as fuel for the auxiliary boilers

At least since the *Port state control* (PSC) has been checking the tanks for used oil and oil sludge and insisting on the legally correct disposal of waste, ships are attempting to use these

[17] 380 ppm NOx was given for one boiler corresponding to around 10.7 g NOx per kg oil when NOx = NO2 or 7.2 g NOx per kg oil when NO: NO2: N2O = 94:5:1. For particles the Danish source gives 0.3 – 1.5 g per kg oil

on board. Waste disposal, which was subsidised for only a short time, is expensive. The Directive on Port Reception Facilities is not yet universally applied. Today the simple assurance on board that oil sludge is burnt is accepted. The fact that no one really knows how much and which pollutants (soot with among other things PM and VOC) are coming out of the boilers when sludge and is burnt must be viewed critically from the point of view of the environment.

These waste products can therefore be burnt in the auxiliary boilers although it is sometimes difficult to keep the process constant. The fact that this possibility today is generally formulated when asking for tenders should be seen as proof of this. Sometimes oil sludge is first past through a homogeniser, but nevertheless the boilers are soon encrusted and have to be washed out. This causes a great problem with waste water but this seems not to be a point of issue at present. It is hoped to organise a special research project to examine the problem.

4.2.4 Conclusion

It is most unsatisfactory, that it is not possible to calculate the emissions of most of the ships in port. It is also not understandable why in port a boiler on land operates under strict regulations but directly next to it on board a ship an auxiliary boiler is allowed to generate several MW of heat without a single regulation. In a project outline, data on the operation and emissions of typical auxiliary boilers of different sizes and construction operating similarly to Cooper's auxiliary engines[18] must be measured. It is important to take into special consideration their capacities in various operating conditions, weather conditions, seasonal conditions and conditions of the day. Based on these recommendations for the construction, operating and cleaning of auxiliary boilers with low emissions should be proposed. The permissible limits for the emissions from auxiliary boilers on board, e.g. for the IMO and clear statements on the fuels permitted must also be worked out.

4.3 Emissions caused by port operations

Researches from the United States [22] show that port operations and deliveries play a considerable role in the total of emissions. These data cannot be transferred 1:1 to ports in the Baltic Sea and to Lübeck-Travemünde, because of different parameters, but they can serve as guidelines (see picture 8).

4.2 Waste water

Letting waste water drain into the marine environment must be viewed with criticism because of the nutrients and pollutants it contains. Most nutrients in the Oceans of the world come from sources on land. The nutrients (above all phosphate and nitrate) are carried into the sea via rivers and the atmosphere. Under certain conditions, these nutrients can lead to a over saturation of the marine area involved [65]. Shipping alone can hardly be the only source of nutrients leading to over saturation, but it may considerably increase the influx and saturation in areas already highly saturated. An ecosystem counts as oversaturated when the organic regulators no longer have enough oxygen to survive, and an-aerobic decomposition begins.

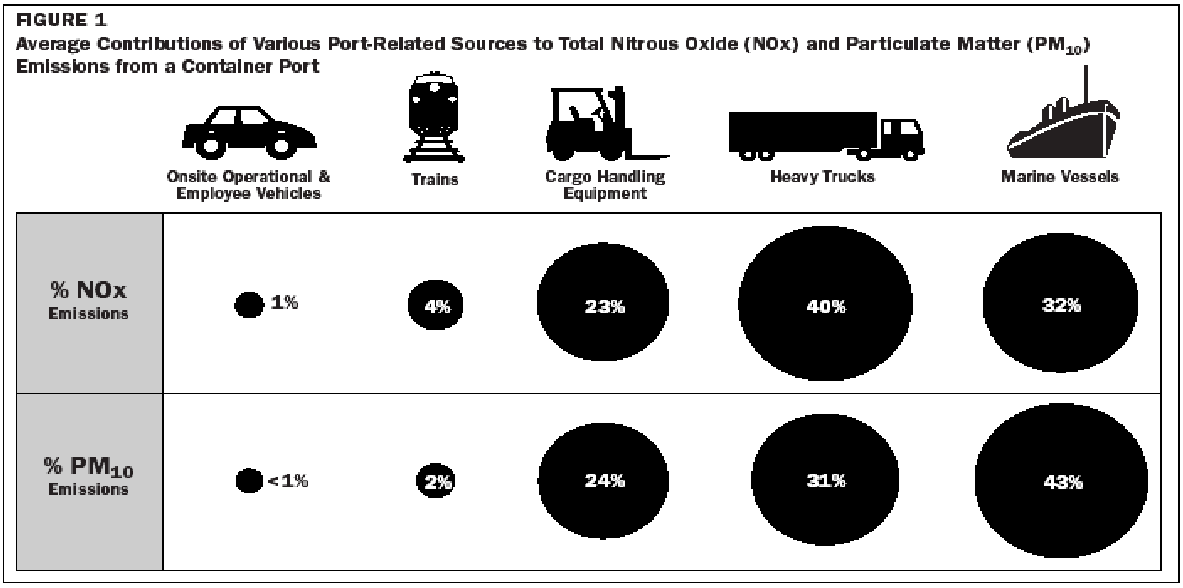
The problem of the amount of waste water that accumulates on board must be seen in conjunction with the sensitivity of the marine area involved. This concerns mainly the large

[18] Cooper: „Exhaust emissions from ships at berth", ATMOSPHERIC ENVIRONMENT 37 (2003) 3817 - 3830

cruise ships and ferries, whose passenger capacity has increased continuously over the last few years and which operate in highly frequented areas of the sea that are often very sensitive to the influx of waste water, for example the Caribbean, the Mediterranean, the Arctic and Antarctic, the Baltic, Fiords, large reef areas, etc.

Where sewage is not or only insufficiently treated, coli-bacilli and germs may be discharged into the water. This can lead to health problems particularly in marine and port areas with little movement of the water. The treatment of waste water with chlorine to eliminate germs has led to another increasingly serious problem, as chlorine not only kills the germs but also has a harmful influence on a whole range of marine organisms [17]. It is obvious that chlorine has already damaged some reefs (Great Barrier Reef, Caribbean). Definite proof that such damage has been caused primarily by the influx of chlorine from ships has not yet been established. Through the increase of passengers on ferries and cruise ships in the last few years, the influx of chlorine in their special route areas has also risen. A thorough study of the ecological balance and the effects of waste water treated with chlorine is still to be carried out. There are however clear indications that the damage caused in ecologically sensitive areas by waste water treated with chlorine is greater than the advantages.

Picture 8: Average contributions of various forms of traffic to CO_2 and PM emissions



[22]: Bailey, D., Plenys, T., Solomon, G., Campbell, T., Ruderman, G., Masters, J., Tonkonogy, B.: HARBORING POLLUTION, The Dirty Truth about U.S. Ports.

4.2.1 Sewage

Annex IV of the MARPOL concerning the disposal of sewage in the sea came into force internationally on 27.09.2003. Sewage is waste water deriving from toilets, from sanitary facilities and from rooms in which living animals are kept. All waste water that mixed with sewage is also sewage.

Table 16: MARPOL Annex IV and discharge of waste water into the environment

Sea Area	Discharge Area
Within 3 nautical miles from land	No discharge except from approved sewage treatment plant

	certified to meet regulations 3(1)(a)(i) and 8(1)(b)
Between 3 and 12 nautical miles from land	No discharge except from: (1) approved sewage treatment plant certified to meet regulations 3(1)(a)(i) and 8(1)(b); or (2) an approved system für comminuting and disinfecting sewage meeting regulations 3(1)(a)(ii) and 8(1)(a)
More than 12 nautical miles from land	Discharge from either (1) or (2) above; or sewage which is not comminuted or disinfected when the ship is proceeding at not less than 4 knots and the rate of discharge is approved by the Administration

[10]: Kaps, H.: Development of a catalogue of criteria for the title of "Environmentally friendly ship", UBA F+E-Project 102 04 416, GAUSS, February 1998.

Further important entries are MARPOL Annex IV:

- Obligation for countries party to the contract to build the necessary sewage disposal plants in ports
- MARPOL Annex IV recognises no special areas
- MARPOL Annex IV contains the draft of an *international sewage pollution prevention certificate*
- MARPOL Annex IV gives regulations on the capacity of sewage plants [16].

Today almost all ships are fitted with waste water tanks and treatment units. This means that they can hold waste water on board in port and dispose it of after treatment at sea.

According to HELCOM ships of neighbouring states may dispose of waste water[19] only twelve nm from land. The same goes for ships under foreign flags in the territorial waters of the countries on the Baltic Sea. If solid matter in the waste has been minimized and disinfected it may be disposed of at a distance of 4 nm. It must not be discharged *in excessive quantities* and ships must maintain a speed of at least 4 knots. When there is an *approved sewage treatment plant* on board, there are no regulations regarding the distance from the coast. Ships under the flag of a neighbouring state which are certified to transport more than 50 persons internationally must have a *Sewage Pollution Prevention Certificate.* The ships are checked regularly.

4.2.2 Grey water

Grey water is outflow and waste from the galleys, pantries, laundry rooms, baths and showers as long as they have not been mixed with sewage. Grey water is defined in MARPOL Annex IV, but without any further rulings.

The waste water collected on board varies considerably in composition and amount depending on the type of ship, the route, etc. A review of the types and amounts of waste water is given in the following table:

Table 17: Type and amount of waste water generated on board

Type	Amount (per person /day)
Sewage- , grey- and waste water from galleys (conventional)	250 ltr.

[19] Waste water here means ´sewage`, i.e. sewage and grey water (no bilge water)

Sewage - , grey- and waste water from galleys (vacuum)	195 ltr.
Sewage - and waste water from galleys(conventional)	130 ltr.
Sewage - , grey - and waste water from galleys (vacuum)	75 ltr.
Sewage water (conventional)	70 ltr.
Sewage (vacuum)	15 ltr.

http://www.marinfloc.se/Marinfloc%20Neptumatic%20System.pdf

According to MARPOL Annex IV, grey water may be disposed of into the environment without prior treatment. This ruling is limited locally by port regulations, so the grey water is collected in port in tanks and disposed of at sea. This water is often mixed with sewage on board and then treated in the sewage plant on board.

The initiative for small biological sewage plants for use on board came from plants used on land. These plants work on the principle of living sludge in which waste water is purified by a circulating mass of bacteria which in the ideal case convert the biological contents of the water into Carbon-dioxide (CO_2), water (H_2O) and nitrogen oxide (N_2). More modern biological sewage plants on board work fully automatically, including monitoring and addition of disinfectants (chlorine) [14].

In biological sewage plants functioning on these principle germs can be reduced by 90 to 98%. The reduction BSB5[20] can be up to 90%. Such plants when inspected on land under the required conditions can fulfil the limits set in MARPOL Annex IV and those set by HELCOM and different national laws.

Table 18: Limits set by MARPOL and HELCOM for the disposal of waste water

Waste Water Parameter	**Limit**
BSB_5	50 mg/l
Faecal colibacilly germs	250 to 100 ml MPN-Method
Swimming- and floating items as geometric agent, when testing the type on Board	100 mg/l

[16]: International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78), [I3]: http://www.HELCOM.fi/HELCOM/convention.html

To reduce the amount of sewage on board vacuum WCs have been installed in ships, in particular passenger and ferry ships, reducing sewage per day and per person by up to 80% [13].

In spite of this even the modern biological sewage plants on board are not, or only to a limited degree, able to cope with the demands put on them. In particular on cruise ships and ferries the enormous amount of sewage and the biomaterial in it to be dealt with lead to considerable problems under typical conditions on board [13].

Movements of the ship in heavy seas often influence the necessary sedimentation of the living sludge in these sewage plants. Several experiments have already been made to add another bed to the operation which shall serve as a growing-bed for bacteria, thus increasing the efficiency of the plant, and also to reduce the effect of movement and to make fat separators superfluous, which are inefficient and need high maintenance.

[20] BSB5: Biologischer Sauerstoffbedarf innerhalb von 5 Tagen. (biologically necessary oxygen in five days)

4.2.2.1 Chlorination of waste water

In all modern biological sewage plants on ships, chlorine or chlorates are added as disinfectants automatically. Dependent on the amounts of waste water and the number of harmful germs in it the large ferries and cruise ships cause considerable amounts of chlorine and chlorates in the marine environment. For example, a ferry with a passenger capacity of 1500 persons discharges on average 10 tonnes of chlorine and chlorates into the marine environment annually [17].

Even the most modern biological sewage plants, fulfilling the highest IMO criteria and so allowed to discharge treated waste water within the permitted zone continue to discharge considerable amounts of chlorine and chlorates automatically into the marine environment. As passengers and crew use toiletries which are harmful for the biological treatment of waste water, it has been proved that there is often a negative effect on the purification process in the biological plant on board [17]. In these plants the whole purification and discharge functions are fully automatic and work constantly, which means that in some cases port areas too can be affected by waste water. In cruise shipping and in the highly frequented ferry ports this can lead to considerable ecological problems, especially if these areas are already struggling with sewage inflow from land.

4.2.3 Bilge water

Waste water from the engine room is not included in MARPOL Annex IV because as a rule it contains oil. Cooling, feed and wash water belong to this waste category. Especially in cooling water there are a lot of additives which are for the prevention of corrosion, preservation of the installations, external passivation, and protection against acids and / or as a ph-buffer. These various, often synthetic, compounds, which are usually mixed with emulsion oils, are usually clarified with the separators generally found on board before they are disposed of. The separators use different methods to separate the oil–water-mixture but cannot get rid of other contamination, e.g. additives so that these generally are discharged into the sea [10].

Chemicals of various kinds, such as hydrazine, caustic soda and others are often added to the feed water. This water is left over after blowing through the boilers as well as after elutriation. It is let out into the bilges and passes then through the separators, which however cannot remove the chemicals mentioned above, so that these too end up in the sea [10].

Generally all washing water in the engine room contains sometimes high concentration of cleaning agents and solvents as well as considerable, generally oily, residues of dirt [14]. The waste water coming from the separators on board also contains a variety of problematic substances, among others dissolved hydrocarbon, magnesium sulphate, emulgators and additives [14].

4.2.4 Waste water from decks and cargo holds

The waste water left after the ship and the holds have been cleaned after discharge can lead to considerable problems in the environment because, in particular regarding bulk shipping they are contaminated or contain a great deal of residue from the cargo. This waste water which often arises in port or near the coast is also not included in MARPOL Annex IV as stated above.

4.2.5 Reception of waste water in port

Discharging waste water into the environment not only impairs the quality of the water and leads to over fertilization in local water, endangering the environmental balance, but it can also mean that in areas on the coast the limits on the quality of water for swimming are exceeded, leading to problems with other branches of the economy. This is particularly the case for local tourism. As a measure to avoid this, memoranda have already been composed to motivate cruise companies to keep to certain standards for the discharge of waste water. According to the *Baltic Sea environment proceedings no. 86* [17] reception facilities in port must be installed to receive waste water[21].

In the Baltic sea environment proceedings no. 50 (seminar on reception facilities in ports) [16] it says that twenty ports on the Baltic Sea are equipped with mobile units to receive sewage. In twelve of the ports stationary installations are available. As this report is from the year 1992, the situation has probably improved since then. Spot checks have shown however that in German ports, stationary installations are definitely not a matter of course. In some areas in Scandinavia this is however obviously already the case (at least for passenger and ferry shipping).

4.3 Solid waste

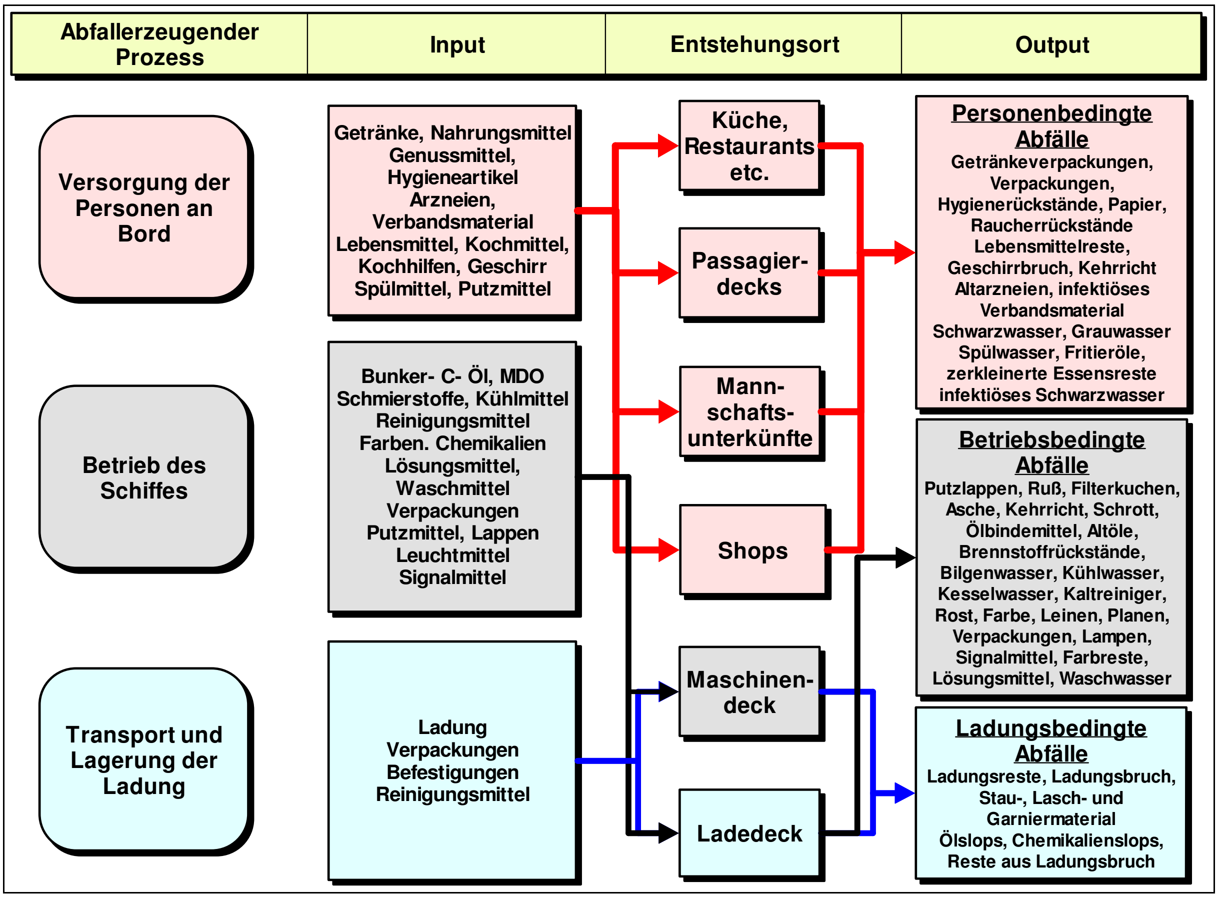
Pollution of the sea with waste is a threat to the marine environment and endangers people on the beach and in the water. This pollution is easily avoidable without causing too much expenditure. On the German coast a considerable amount of waste is caused by shipping and fishing vessels. There is a multiplicity of negative effects from this pollution of the sea with waste; the costs of repairing the resulting damages are immense. The problems caused by waste pollution range from blocked ships´ propellers, damaged fishing equipment and blocked water filters at power stations to polluted beaches which have to be cleaned. It is estimated that the sum total of these effects costs the coastal communities of Europe several billion Euros per year all together. In addition, the negative effects of waste on marine organisms, animals and birds have been well documented, especially for the German North sea coast. The waste on the German North sea coast examined in a study made by the Ministry for the Environment [24] consisted mainly of floating objects. The waste washed up on the beach consisted for the greater part of things that neither disintegrate in water, nor are dissolved or broken down. There is less metal or glass as these sink, in contrast to waste made of plastic, foam, styropore or wood. Paper partly disintegrates in water, some edible waste is eaten by marine animals and birds, and some sinks or disintegrates.

Results of studies in the last ten years show that plastic rubbish is by far the predominant form of waste pollution when considering the number of objects: wood is the most frequent form of pollution when measured by weight. This overall pattern has not changed in the last few years. The results of similar surveys in other parts of the world confirm that worldwide plastic is the main form of marine waste pollution [24].

The production of waste on board ship can be assigned to three different processes. These processes and the types of waste produced hereby are shown in picture nine.

[21] Quotation: „Port reception facilities are equipped to deal with sewage“.

Picture 9: Waste producing processes



Stadtwerke Lübeck-Travemünde / GAUSS

Operational waste is produced solely by the operation of the ship. This means the maintenance as well as keeping up all ship’s operations. Cargo waste is caused directly or indirectly by the goods transported. Here it is a question of cargo rendered useless or inedible, or defect and useless material needed for the stowage, separation, securing of the cargo. Personal waste is caused by the crew and passengers on board a ship. This last is mainly leftover food and food packaging of all kinds. According to Hartung[22] on ferries and freighters the following breakdown of operational waste can be expected:

Table 19: Operational waste, cargo waste, personal waste

Group	Ferries	Freighters	
	per Person [kg/(d x pc)]		
	Operational	Operational	Cargo
Food leftovers	-	-	2,41
Paper/ Cardboard	0,01	0,02	1,72
Wood	0,01	< 0,005	7,98
Glass	< 0,005	< 0,005	-
Metal	0,28	0,09	1,49
Plastic	0,01	0,02	0,08

[22] Dipl. Ing. Olaf Hartung, Bremen, 1997, Average occurrence of solid waste matter on ferries - evaluation of questionnaire “Schiff“ for the analysis of weak points in ships´ disposal of waste

Oily- and greasy waste	0,31	0,22	-
Chemicals/ Paints	0,12	0,05	0,08
Rest	0,04	0,03	0,91
Total	**0,78**	**0,43**	**14,79**

Source: Municipal Works Lübeck-Travemünde / GAUSS

4.3.1 Summary of legal conditions

MARPOL Annex V dictates the division of waste into 6 categories. Since the first of July 1988 all ships bigger than 400 registered tonnes and / or transporting more than 12 persons are obliged to separate their waste into these categories.

Disposal of plastic matter into the sea is generally forbidden. There are regulations on the disposal of other ships´ waste in coastal waters and special zones. In the guidelines to the introduction of MARPOL V the use of already existing recycling possibilities in the region is recommended. As well as separating according to material, a difference must be made between materials that sink or float and between those that have been minimized or remain entire. Possibilities for disposal at sea of the different waste categories are shown in the following table.

Table 20: Waste categories according to MARPOL Annex V

Category 1	Man made / plastic waste
Category 2	Floating material e.g. stowage wood, form boards, packaging (from the cargo holds)
Category 3	Non floating, minimized materials, e.g. glas, metal, ceramics, paper/cardboard, rags, etc.
Category 4	Non floating, non minimized materials as in category 3
Category 5	Food waste
Category 6	Ash from the waste incinerator

[16]: International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78).

MARPOL Annex V regulation 7 on port reception facilities says that all member states are obliged to offer in their ports an adequate number of suitable reception facilities for waste, cargo residue and for various dangerous materials. It must be made possible for ships to dispose of waste with no loss of time. In special zones, of which one is the Baltic Sea, special regulations apply.

Table 21: Conditions for waste disposal inside special zones

Waste category	Disposal within the Baltic sea
Man made materials, e.g. synthetic ropes, nets, plastic bags, etc.	Forbidden
Floating material, e.g. stowage wood and form boards and packaging	Forbidden
Metal, paper / cardboard, rags, ceramic, glass, etc.	Forbidden
Other waste including metal, paper/cardboard, rags, ceramics, glass, etc. Minimized / ground to size less than 25mm	Forbidden
Food waste, non minimized	Allowed at a distance > 12 nm from the coast
Food waste, minimized	Allowed at a distance > 12 nm from the coast

Mixed waste	According to the stricter ruling
Ash from the waste incinerator	Disposal on land because of possible pollutants (plastic waste), if plastic is also burnt, disposal at sea forbidden

[16]: International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78.

As well as separating waste according to the categories named, ships of over 400 GRT and those transporting 12 or more persons are obliged to have “waste management”. There must be provided a “waste treatment plan” to describe how solid waste has to be dealt with. Crew and passengers must be informed on procedures resulting from this. In addition, a “waste handbook” must be kept, in which there is exact documentation on which categories and amounts of waste have been disposed of where.

The “council guidelines on port reception facilities for ships´ waste and cargo residue” (2000/59/EG), worked out by the EU, came into force on 27.11.2000. Following MARPOL Annex V regulation 7, they cover ships´ general obligations in waste disposal, the provision of port reception facilities (hereafter PRF), and preparation of waste management plans (WMP) by ports and also the question of fees for waste disposal.

The aims of these guidelines also include the reduction of marine pollution, marine environment protection across borders, the ratification of MARPOL 73/78 in the whole EU, the improvement of use, availability and inspection of PRF s and the avoidance of competition between different waste disposal regimes. The guidelines on PRF are binding for all ships, including fishing vessels and sport vessels, entering the port of a member state or operating therein, regardless of their nationality. As regards ships that do not come under this ruling, the member states must ensure that their waste is disposed of according to the guidelines as far as possible. These guidelines are valid for all ports normally frequented by the ships mentioned above. The member states ensure the availability of sufficient port reception facilities, corresponding to the needs of the ships normally frequenting the port, without delaying ships unreasonably long.

Waste management plans are the main key of these guidelines. Each port must provide a WMP made up with the participating parties, in particular those using the port or their representatives.

Summing up, it can be said, that the laws on shipboard waste disposal is compiled from various different legal components. Different regulations specific to each port arise from the combination of international, national and regional regulations on the environment. For example in German ports there are no generally valid laws on waste disposal because of the mixture of regulations given above, which are sometimes even contradictory. Ships must cope with continually changing laws. One problem here, on board and on land, is among other things variations in classification of waste.

The classification of waste according to MARPOL Annex V and the guidelines for port reception facilities still vary greatly at present. “A generally binding and recognised definition to describe all solid wastes arising from ship’s operations, making it possible to assign these directly and unmistakeably to a particular class, does not yet exist”[23.] In other words, the crite-

[23] Hartung, Olaf: Knoob, Hans Gerd et al. (1997), GAUSS: “Entwicklung Umweltverträglicher Entsorgungskonzepte für die Seeschifffahrt”, preliminary study for research project F+E 102 04 417 commissioned by Federal Environmental Agency, Bremen.

ria of MARPOL Annex V may be adhered to on board but later treatment on land must follow EU regulations on port reception facilities, using the waste index given in these. It is therefore suggested for regular ferries that waste on board should be separated accordingly.

4.3.2 Waste treatment in ports

Several attempts are being made to achieve comparable or very similar waste disposal structures in ports. An initiative by ECOPORT, for example, is concerned with conformity of all the different waste managing facilities in ports. Some of the ports engaged in this (Antwerp, Gothenburg, Barcelona, Amsterdam, Genoa, Piraeus and others) have combined for a cooperative project to work out common strategies for dealing with waste, to make easier not only its treatment in port but also disposal on board.

Their task has been firstly to find out the types of waste produced, its volume and its transport, and to develop a summary of laws on the subject and based on this to produce a Green book for Waste in Ports. The contents are to be:

- Definition of the best and worst methods in practise
- Methods of exchanging data
- Definition of recommendations for port policy
- Preparation of a suggestion for common action.

Efforts to bring port activities into conformity mean also methods of dealing with waste, containments, pictograms, etc. In addition a manual for port workers is to be prepared. Information on the trials carried out in the different ports will be made available to all partners via data processors.

Apart from the waste generated on board ship or discharged on land at port, the ports themselves of course generate waste. This comes mainly from

- Vehicle workshops for repairs and inspection
- Repair of buoys etc.
- Storage operations
- Offices and catering
- Left behind in port by the ships (separation, lines, dunnage, etc.) [15].

All this waste must be treated and disposed of according to the regulations valid on land.

4.4 Emissions of noise

The part played by noise cannot be underestimated when judging the stress of the place of work. Noise is therefore the subject of particular laws and regulations. In shipping, too, stress on the crew caused by noise has been known to be a problem for a long time and has often been examined. Therefore, as far as economically viable expenses go, accommodation on board ship, with the exception of stores and sanitary facilities, must be positioned and of such a nature that they are insulated against noise and vibration, particularly from the engine room, the ship´ s screw, winches, ventilators, heating, air conditioning and other machines and installations causing noise.

Sound is a combination of pitch (frequency in hertz (Hz)) and volume (sound pressure in Pascal (Pa)). The sound pressure level is measured in decibel (db). The human ear perceives high and low tones of the same sound pressure as of different volume. In order to have viable data the sound pressure level is evaluated. The unit of measurement db (A) has been universally accepted. As a means of categorising levels of sound pressure the following can be accepted:

- Ca. 0 db(A): Lower level aural perception
- Ca. 40 db(A): Whispering
- Ca. 70 db(A): Traffic noise
- Ca. 90 db(A): Machines, presses
- Ca. 100 db(A): Compressors
- Ca. 110 db(A): Pneumatic drills in mining
- Ca. 130 db(A): Plane engines

The effects of noise can be classified as following:

- Troublesome: well-being is impaired, anger and annoyance, headache.
- Impairment of performance: attention and concentration disturbed, leading to higher risk of accidents.
- Acoustic perception blocked out: inability to communicate impairs well-being and also works safety (e.g. signals are not heard).
- Nervous reactions: harm to the nervous system with physiological consequences, vascular disease, rise in blood pressure, neurosis.
- Shock reactions at sudden noise impulses and the danger of increased mistakes. The central nervous system cannot get used to this continuous stress.
- Loss of hearing: a continuous noise level of more than 85 db (A) can lead to lasting loss of hearing.
- The pain threshold for the human ear lies at c. 135 db (A).

It is to be remembered that the higher the existing noise level is, the shorter must be the length of time in which a person is exposed to it without danger. “Regulations for the prevention of accidents at sea” gives an example.

[...]: The following noise levels and lengths of time means that the critical level of 85 db(A) has been reached.

- 88 dB(A) - 4 Hours
- 91 dB(A) - 2 Hours
- 94 dB(A) - 1 Hour
- 97 dB(A) - 30 Minutes
- 100 dB(A) - 15 Minutes
- 105 dB(A) - 4,8 Minutes.

4.4.1 Noise caused by ships´ operations

It can be a problem for work on board ships that the seaman does not go home after his work, but lives in the direct proximity of his place of work. He can hardly avoid the normal operational sounds on board. The predominant stress factor at sea comes from the noise of the engines. But even when the main engines are not running in port, a continual and perhaps annoying background noise e.g. from the auxiliary diesels will exist. In addition there is the noise of loading operations, with e.g. the lowering of containers, lashing material thrown on deck, the sounds of straddle carriers, cranes, tug masters, trucks etc. in operation. Noise from other ships can also be a nuisance. Port operations (turnover of cargo) also cause noise, for example with trucks or port railways. There are often industrial and manufacturing estates situated near the ports.

As well as the danger of damage to hearing, which is especially great for those employed in the engine rooms, risky situations can arise when warning signals and other acoustic signals are overheard. The level of noise can disturb concentration, e.g. when observing radar and other nautical instruments or cause stress symptoms.

Noise caused by ships´ operations at berth (especially ventilators and the movement of ramps) and noise from loading and discharge is present around the clock, depending on the ships´ schedule. The hull of the ship works as a steel sounding board and increases the emission of noise.

4.4.2 Noise caused by port operations

Generally shipping takes place 24 hours a day and 7 days a week. This arises from the need on land to transport goods and to convey passengers on the ferries and RoRo-ships. In addition the high investment cost in ships does not allow a ship to lie “inactive” at berth or to wait for “normal” business hours. Although shipping companies generally try to have their ship in port in the daytime (mainly because it helps the passengers coming on board or leaving but also because the night shift of port staff is more expensive than the day shift), in larger ports work at night cannot be avoided. Depending on the port (ferry port or container port), the kinds and amount of noise are different. Whereas it is more the noises of dealing with containers in container ports (which as a rule are further away from city centres), in RoRo-ports it is noise caused by the movement of ramps, the driving of tug masters and the operation of ventilators on board.

The permissible level of noise in residential areas, mixed areas, industrial estates, manufacturing estates, is regulated in the “technical directives for protection against noise” (TD noise) of which a revised version appeared only last year. This TD noise however explicitly excludes places of work on ships and port loading facilities.

4.5 Vibrations caused by ships´ operations

Vibrations during ships´ operations occur through the oscillation of the main engines and auxiliary diesels when running slowly and causing low frequencies.

The main problem thus generally comes from the main engines. The exhaust turbo charger is a particular source of noise (high frequency vibrations). If there are people living directly next to the berths or e.g. restaurants and pubs, etc. (as is the case in Lübeck) the vibrations can certainly be felt as a nuisance, and retailers in the neighbourhood (restaurants, pubs, shops) are disturbed. In Lübeck-Travemünde this has led to a complaint to the town council by those concerned[24].

[24] cf.: residents´ letter of complaint in appendix

5 Quantitative review of pollutant emissions in Lübeck-Travemünde

When preparing the data from shipping routes and individual ships´ data, different types of emissions must be seen in relation to geographical positions. All this data serves to find out the main points of emission along the river Trave and at the individual berths respectively. When working with MARION total emission results from the time at sea from (to) berth to (from) the entrance buoy and the time the ship is at berth. As the movement of a ship is defined for the shipping traffic service by it reaching a report point, its movement when changing berth or turning and manoeuvring ´behind´ this point and the emissions it makes here are not included. In a further step these data shall be used to estimate the efficiency of various measures and to prepare a list of priorities for important action. Further it can serve in finding out possible less expensive ways by using these various measures.

The area under observation for working with MARION is defined by the course of the river Trave and by the extent of the *Lübecker Bucht*, as described in the chart in the appendix.

The position of the entrance buoy is 53° 59,9' N 10°56,2 E and it lies 2.8nm in front of the port entrance. Ships arrive in Lübeck-Travemünde coming from the NNE and berth at the following most important berths:

- Skandinavienkai (LPC)
- Nordlandkai (LPC)
- Konstinkai (LPC)
- Schlutup (LPC)
- Container Terminal Lübeck
- Lehmann Kaianlagen (private)

As c. 150 ships enter and leave the Trave every week, there are often situations that make manoeuvring within the set routes necessary. As well as there are yacht harbours on the Trave and the Priwall ferry crosses it. Emissions are particularly high while manoeuvring, especially when reversing the machines (unless the ship has variable pitch propeller). In other words the “theoretically possible” time of passage, on the basis of a speed of eight knots from the entrance buoy Trave to the place of berth gives only limited proof of the emissions caused in this zone. Therefore, when describing the times of passage to the berths, numbers are rounded up to the nearest half hour from / until the moment when the main engines of the ship are started / stopped.

The Wallhafen, the Hansahafen and the Burgtorhafen are part of the port of Lübeck, together with others described below. The turnover of bulk goods (grain and grain products, wood and wood chippings) is carried out here. The Hansekai is also landing place for naval vessels, cruising ships and leisure craft.

The results of LAIRM and MARION cannot be compared with each other because their parameters at the start were different. One reason for this lies in the different basis of the ships data, as the calculations were made in different phases of the project. In addition, they worked with different emission factors and different estimates of pollution. Even if the data were compatible, the fact that there is no generally accepted standard regarding e.g. emission factors makes it clear how difficult it is to achieve dependable, valid results. In order to achieve comparability in the results from different ports or in the results of different operational years of a port, generally accepted standards must be developed.

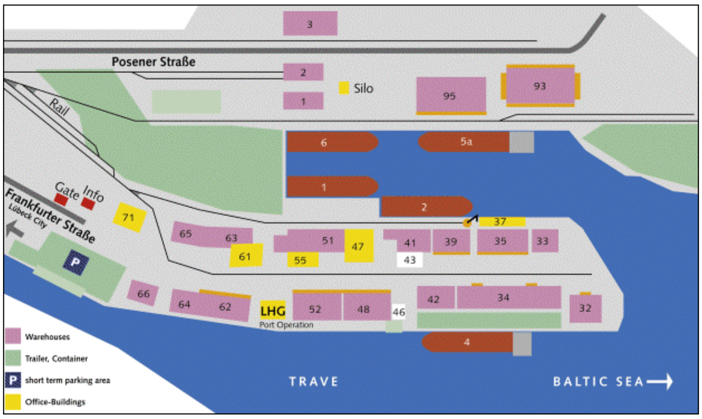
5.1 Examination of emissions at different quays in Lübeck-Travemünde

The following chapters are to briefly describe the different port areas of Lübeck-Travemünde before the description of results obtained of the examination of the respective emissions.

5.1.1 The terminal "Nordlandkai"

This, the largest of the town ports of Lübeck, is the junction for all traffic to and from Finland and Russia. It includes the Vorwerker port. The main activity in this area is the turnover of paper and cellulose, the transport of trucks/trailers, mixed cargo and the export of new vehicles.

Picture 10: The terminal Nordlandkai



http://www.lhg-online.de/german/terminal/nk.

The heavy goods traffic from the north makes additional sailings with paper and forestry products possible to the south, so that there is the advantage of two-way traffic for Lübeck and the Nordlandkai. Daily sailings to Rauma, Helsinki, Kotka and other Finnish ports mean that the transport firms have excellent possibilities for making shipments to and from Finland. Since the beginning of 2003 there are sailings to the ports of St.Petersburg and Baltjisk/Kaliningrad, too.

The Nordlandkai is an important place of turnover for combined cargo traffic and containers. There is now a shuttle-connection between Lübeck and Hamburg with several trains running daily. Its high storage capacity and rail connections to west and south-west Germany, to Switzerland and Italy, increase the port's status as the main distributor for the Finnish paper industry.

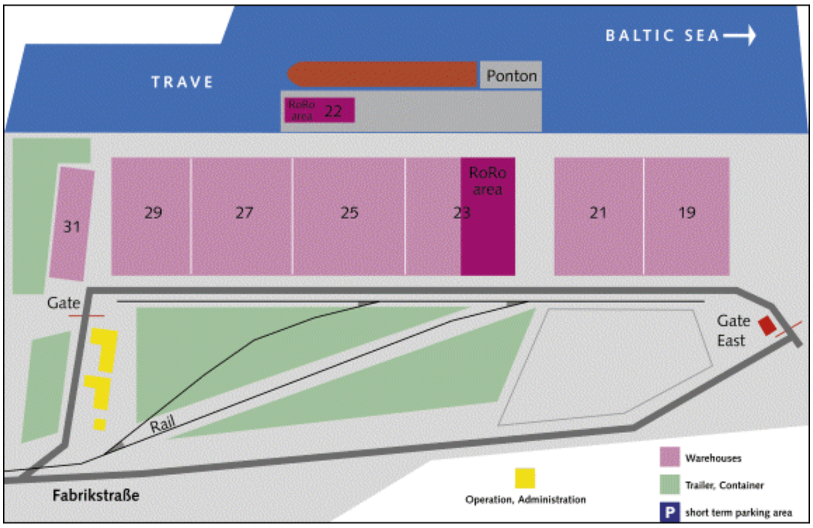
The Nordlandkai has a total area of 446000m², the quays are 1550 m long, and there are five RoRo berths. 320 persons are employed here. The main goods handled here are paper, trucks, trailers, containers, packaged goods of all kinds, combinations of these and new vehicles. The turnover was 3.4 million tonnes in the year 2003.

Generally ships turn before docking, meaning relatively high manoeuvring. When leaving berth however the ships can sail without much manoeuvring.

5.1.2 The terminal "Schlutup"

This terminal represents a new generation of docks, developed and expanded in cooperation with Swedish paper manufacturers. Following their logistic concept, wood products from Sweden are brought on land in Lübeck-Schlutup and distributed from there throughout Europe. The installations have been developed according to these needs, i.e. the provision of vast warehouse space and the equipment necessary for the turnover from the ship directly or indirectly into wagons, trucks and containers.

Picture 11: The terminal Schlutup



http://www.lhg-online.de/german/terminal/nk.

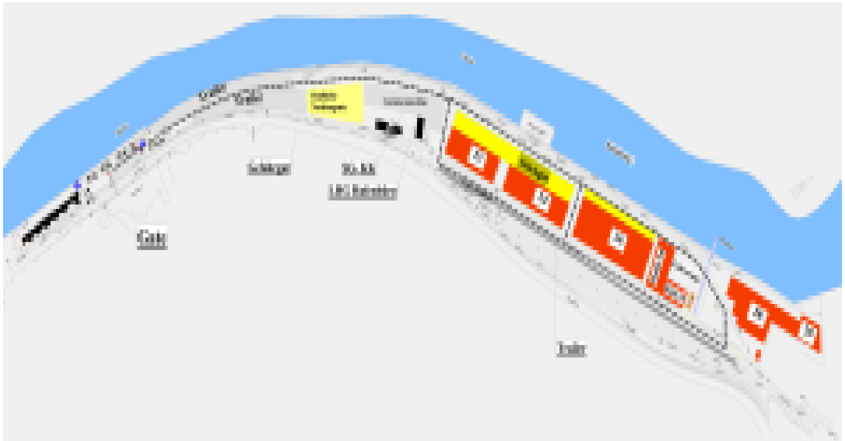
Schlutup has a total area of 259.627 m². The warehouse capacity is 64.000 m², the quays are 230 m long, and there is one RoRo berth. There are 80 people employed here. The goods mainly handled here are forestry products (paper, cellulose), trucks, trailers, containers, combined goods and bulk goods. The turnover was c. 1.1 million tonnes in 2003.

5.1.3 The terminal "Konstinkai"

The focus for shipping from this terminal, with RoRo traffic, forestry traffic and heavy cargo is Finland. There are ships daily to the port of Hanko, thus offering a further RoRo service to and from Finland. At this terminal the balance of mixed cargo moving north and south ensures the optimum use of ships, wagons and trucks/trailers. The second most important cargo is the transport of vehicles. Work goes on at the Konstinkai seven days a week, meaning that work on loading and discharge is done on Sundays and bank holidays whenever necessary.

The Konstinkai has a total area of 131.707 m², with a warehouse capacity of 23.500 m². The quays are 1.108 m long with two RoRo berths. 75 people are employed here. The main goods dealt with are forestry products, trailers and trucks on the RoRo ferries, new vehicles, combined cargoes and heavy cargoes. The turnover was c. 1.8 million tonnes in the year 2003.

Picture 12: The terminal Konstinkai



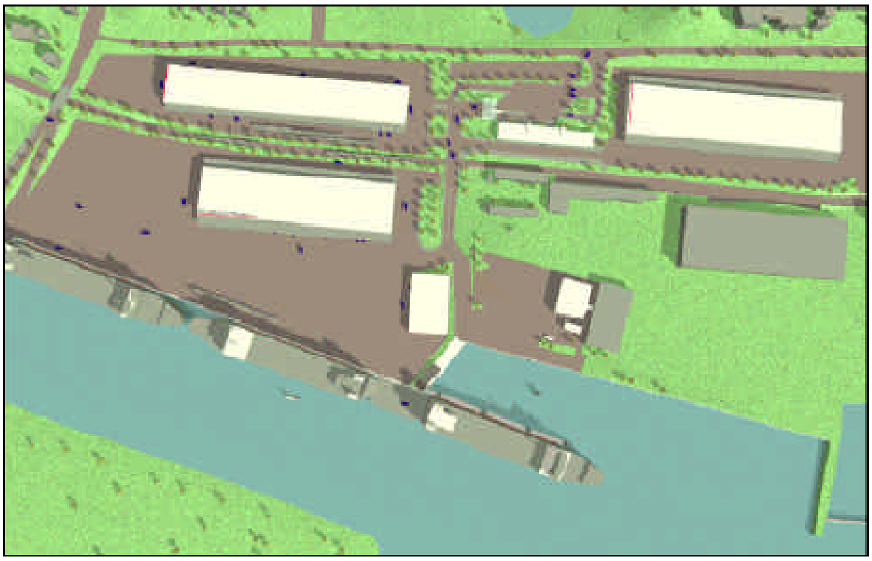
http://www.lhg-online.de/german/terminal/kk-karte.htm

5.1.4 The terminal “Seelandkai”

Some time ago the town of Lübeck bought up more land in the grounds of the former Flender Werft AG on the streets “Unter der Herrenbrücke/Seelandstrasse”, in order to increase the capacity of the ports. By the year 2005, four berths and three warehouses will be built on a port area of c. 20 hectares[25]. Here mixed traffic with Finland, Sweden, the GUS and Baltic states can be dealt with, as well as to a more limited extent bulk cargo. The terminal has good connections via the main road B75 to the motorway A226. Ships must turn in front of the terminal Schlutupkai. As this turning place may not meet the requirements of future shipping traffic, however, it may be extended to a diameter of 300m.

[25] http://www.ihkluebeck.de/HLIHK24/HLIHK24/produktmarken/standortpolitik/Anlagen/Positionspapier_LHG.pdf

Picture 13: The terminal Seelandkai



http://www.kmting.de/pdf/103099.PDF.

5.1.5 The terminal "Skandinavienkai"

The terminal Skandinavienkai lies at the mouth of the river Trave. It is the largest of the ports of Lübeck and one of the largest RoRo and ferry ports of Europe. Frequent sailings with more than 80 departures per week ensure a firm connection in the chain of transport between the industrial centres of Europe with Sweden, Finland, Russia and the Baltic states. There are regular and frequent services to ports such as Gothenburg, Trelleborg, Malmö, Helsinki, Turku, Hanko, and Ventspils. For some of these services there are up to five sailings daily, and a 24 hour service on 365 days in the year is available.

The terminal is a turning point for all kinds of cargo which can be transported by means of trucks, trailers or containers. Three of the eight berths have special equipment for train ferries. As well as loading new and used vehicles of all kinds, c. 350.000 passengers make the Skandinavienkai the starting or end point of their journey over the Baltic Sea yearly.

In the year 2003 the turnover of cargo was c. 16.8 million tonnes. The two-way traffic north and south was well balanced.

In the last few years there has been a continuous rise at the Skandinavienkai in the volume of cargo as well as in the expansion of regular services. It is expected that this positive trend will continue over the next few years not only because of the positive economic development in Russia and the Baltic states, but also because of the geographically well-situated terminal.

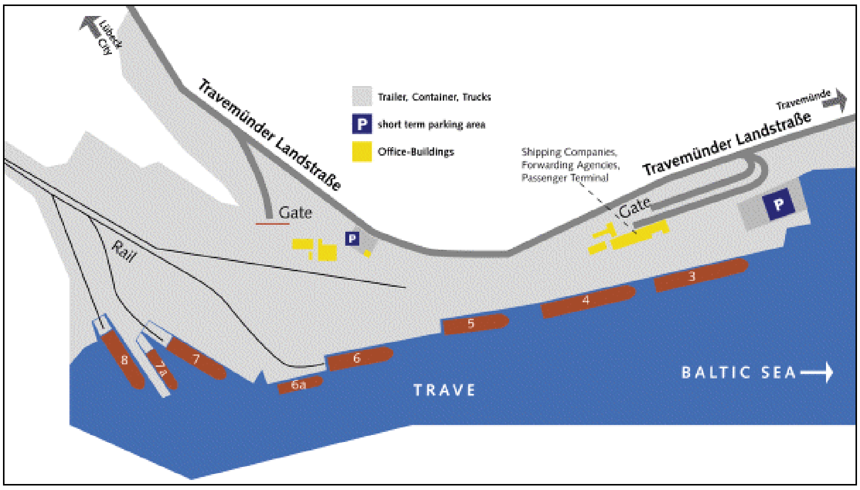
Building construction and development is taking place at present at the terminal Skandinavienkai. These building developments were started with high investment in order to fit future demands on berthing capacities and land facilities. In the year 2003 a rail terminus for another form of transport came into action: this has doubled the capacity of the Skandinavienkai to 140.000 units per year.

The Skandinavienkai has a total area of 658.129 m². The quays are 1689 m long; there are eight RoRo berths (3 for rail ferries, 3 with upper deck ramps, 3 pontoons). 120 people are employed here. Cargoes handled here are mainly on wheels (trailers, trucks, combined cargoes and trajectory wagons) and new and used vehicles. The turnover was 16.8 million tonnes in the year 2003.

Generally ships turn before docking, meaning relatively many manoeuvres. On the other hand when leaving berth the ships can sail without having to manoeuvre.

The Skandinavienkai has 8 berths of which not all can be used by different types of ships. Most of these ships are typical RoRo-combi-ferries, which are among the largest and most modern in the Baltic Sea. By the year 2010 the Skandinavienkai is to be extended by a further 2 berths.

Picture 14: The terminal Skandinavienkai

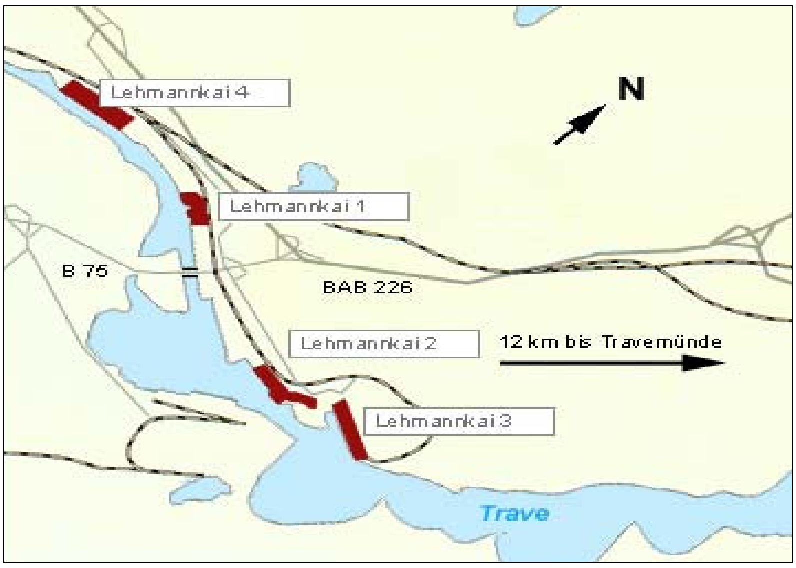


http://www.lhg-online.de/german/terminal/nk

5.1.6 The Lehmann Quays

The firm Lehmann in Lübeck, which does not belong to the LPC group, has its own four docking facilities. The quays all together are over 1.6 km long and offer facilities for RoRo, LoLo, packaged goods, bulk goods, heavy cargoes and valuable goods such as paper and cellulose. Its distribution centres are conveniently situated for the follow-on transport or delivery via road, inland shipping and rail. It has railway connections, modern warehouses and machinery, and its docks are suitable for future generations of ships.

Picture 15: Docking facilities at Lehmann



http://www.hans-lehmann.de/hafenbetrieb.html.

5.1.6.1 Lehmannkai 1

The terminal Lehmannkai 1 combines the loading of RoRo, LoLo, packaged goods, heavy goods, and valuable cargoes such as paper, cellulose, trailers and trucks with the loading and discharge of forestry products on to trains at the firms own rail terminal or for transhipment on inland shipping.

The Lehmannkai 1 has a total area of 62.500 m², with a warehouse capacity of 8.000 m². The quays are 300 m long in toto with one RoRo berth.

5.1.6.2 Lehmannkai 2

These docking facilities for RoRo and LoLo traffic were designed in 1996/97 for the turnover of forestry products. As well as for paper and cellulose these facilities are used for the turn-over of packaged goods, heavy cargoes and valuable goods and for container transport. The shipping company DFDS Torline offers a ferry connection to Riga transporting rolling goods and passengers, with 6 departures a week.

The "Flender Werft" has been bought in order to extend the quays. It is planned to build three more RoRo docks for additional traffic. The Lehmannkai 2 has a total area of 300.000 m², with a warehouse capacity of 25.000 m². The quay is 670 m long.

5.1.6.3 Lehmannkai 3 und 4

As special terminals for bulk goods, the facilities at Lehmannkai 3 offer all the conditions necessary for a rapid turnover in sea- to-land traffic. Quay 3 and quay 4 are together 800 m long. Both quays have a total area of c. 70.000 m², with one RoRo berth.

5.2. Movement of traffic

Record of the movement of traffic was made on the basis of the reports of the shipping traffic service for January and July 2003. The data given was compared with the timetables of the services. After comparing both months and after consultation with the employees of the shipping traffic service, it became clear that any seasonal differences in the ferry service were not of great significance. In spite relatively fixed timetables for the ferries of different companies had to change the timetables relatively often. The reasons for such changes were e.g. that ships had to be exchanged spontaneously to cover technical difficulties or to cope with special needs at short notice. New routes were opened, initially as a test, to find out if they would be popular and a paying venture. Representatives of the relevant shipping companies, some personally, were consulted to clear up any problems arising. Although there were no great differences between the different months it was confirmed that of course more journeys were booked in the holiday season and on bank holidays. The increasing demand could be covered by additional departures. This was more the case with passenger ships: as a general rule they did not need extra ships, they altered the timetables so that one ship could make an extra departure. Because of the higher use of ships in the summer months, for the statistical evaluation of traffic and for working out the emissions a “conservative estimate” was taken as a basis, i.e. the June traffic was taken as the average for all twelve months, levelling out any possible peaking in other months. In addition the calculation of emissions is not “over-generous”: quite the opposite, the results show more in “the worst case”.

5.3 Technical analysis of ships

After the ships´ movements had been recorded, the technical data of the ships were compiled to calculate the emissions. The IMO number of the ships and the ship owners could be ascertained from the ships´ names given by the shipping traffic service. On the first run through, it was often possible to find information on the type of ship, BRZ, tdw, year of construction, the wharf, in published material less often the number of engines, their individual and total performance, auxiliary diesels, auxiliary boilers and the fuel which was used. The number of crew members and the possible number of passengers on board also had to be identified, being factors that could possibly influence the results. In addition information was gathered on the size of the funnel (the height of the funnel), the temperature of the exhaust, its speed and volume. This latter information was needed for calculating how far emissions spread out in the surrounding area. The last question was whether and how long the auxiliary diesels were running before berthing and after leaving port.

As a first step official publications (Lloyds register, Hansa, Schiff&Hafen, etc.) and then special periodicals were consulted for the necessary data. Only after this representatives of the shipping companies were consulted. This approach was taken to avoid additional work for them and also because it was known that they are sometimes reluctant to make such information known. Some of this information is really not “on hand” in the company office. First a questionnaire was sent to the shipping companies from whom information on the ships was needed, asking them to fill it out and send it back. In some cases, it was possible to complete the basic data needed. In other cases however the person involved “didn’t have the time” to look for the required information. Sometimes the request was made to call back, but this was generally without success. In one case, cooperation was definitely refused.

Certain basic conditions must be met in order to calculate results of emissions, but for some ships not all the necessary data could be found out. The position is particularly bad as regards information on the height of the funnel, the exhaust temperature, its speed and volume. A sensible guess had to be made here. The lack of information regarding “the fuel used” (for main engines, auxiliary generators and boilers) and regarding the number, age and efficiency of the auxiliary boilers was more difficult to deal with.

If there was no data concerning the fuel used on board, it was as a rule taken for granted that heavy fuel oil with a sulphur content of 2.7 % was used. It is clear to the authors that ferry ships in the Baltic Sea often use fuel with low sulphur content, but the calculations had to be made using a conservative estimate. Thus low sulphur fuels could not be assumed even when it was “suspected” that this might be correct. Another difficulty was that different units on board can use the same fuel, but needn’t necessarily. Whereas in former times shipping in coastal waters generally changed for safety reasons from high sulphur content HFO to low sulphur content MDO, today this is no longer necessary. Some ferries only use MDO anyway, as for example the ships of the TT-Line on which the sulphur content of fuel is 0.2 %. Such data, especially as regards the use of different fuels in different units on board, was sometimes not available and therefore 2.7 % was taken as the norm.

It was even more difficult to find out which proportion of the emissions was caused by the operation of auxiliary boilers on board. Officially published information on the number and efficiency of the auxiliary boilers was as a rule not available. And if it was possible to get this data, it remained generally unclear which fuel had been used. The answer often was that it was “the fuel normally used on board”. While on some ships MDO was used, even if only for the auxiliary generators, on others the fuel from the main engines is used to save money. In some cases it may be that sludge is also burnt, to save the costs of disposing it. According to the boiler manufacturers this is technically possible. The fact that a boiler, differently from the main engines, is in operation mainly in port, (apart from diesel electric drive, where the main engines functions as the auxiliary diesel), leads to the assumption that the proportion of emissions must be significant. Apart from this, on the ships used in traffic around Lübeck-Travemünde, generally ferry ships, a relatively high boiler efficiency is necessary in order to heat passenger cabins and if necessary to supply large quantities of warm water.

Another point of un-clarity is that, depending on the type of (main) engines, age of the engines, the length of time at berth, the time of year, etc., the main engines are started before leaving port with a varying length of the warming-up phase. During short periods at berth the engines are not even turned off because of the factors mentioned above.

5.4 Calculation of emissions and prognosis

The calculation of emissions serves to define the situation as regards pollutants emitted by shipping. Based upon the results it would be possible to play different scenarios and to create a prognosis for any change of emissions. The most important change to be taken into consideration here was the projected new regulations for emissions in shipping. These regulations are in the main an implementation of MARPOL Annex VI from 19th may 2005, in which the Baltic Sea is named as a specified area, which means that only fuels with a max. sulphur content of 1.5 is allowed to operate here. Another premise was taken into account: that the EU is planning ships regulations saying that during time at berth the max. sulphur content of 0.1 % may not be exceeded (adequate time is allowed for the switch-over). This law has not yet been passed but should come into force in 2010. In a third scenario it was supposed that the ships at Skandinavienkai receive their electricity supply from land, so that main engines and auxiliary generators (not auxiliary boilers) can be turned off. The results of the different scenarios are presented below.

5.5 Calculation of emissions and prognosis (LAIRM-Consult)[26]

Within the framework of the project ships´ emissions for shipping traffic in the year 2002 was quantified by the company LAIRM, in order to calculate potential improvements of the quality of the air in different scenarios on the basis of the results. The following chapters are taken from the summing up of the calculation and include the most important suppositions and results. The full report including tables, illustrations, etc. is here in the appendix.

5.5.1 Motives and tasks (extract from the LAIRM report)

Tension is rising around the ports where the interests of increasing shipping traffic and the economic factor “tourism on the coast”, which is also increasing, come into conflict. Under criticism are in particular the internationally and nationally valid standards for the environment set for shipping, which are much less stringent compared with the regulations for emissions on land (road traffic, industry, power stations, workshops, etc.). Pollution levels of the air in European ports can generally therefore be traced back to shipping. Here emissions while at berth are just as important as when under way.

Within the scope of an F+E-project for the Implementation of Agenda 21 in German ports, an analysis on the example of Lübeck-Travemünde of air pollution shall be carried out and possibilities for their reduction examined. A distinguishing factor for Lübeck-Travemünde is that the sea resort of Travemünde, the narrow entrance on the river Trave to the ports of Lübeck and port operations at the Skandinavienkai have developed close together but without planning over the years. The continuous increase in marine goods traffic in the last few years and the project to expand the Skandinavienkai mean that a further increase in shipping can be expected. This will cause a further rise in pollution, too, and plans for new tourist attractions on the Priwall (e.g. health farm) will be effected. By reducing the emission of pollutants by shipping, improvement of the quality of the air shall be achieved in order to bring the differing interests into balance over the long term.

Possible solutions for the reduction of emissions by shipping could be e.g. the setting of permissible norms for ships´ exhaust and/or limiting the sulphur content of fuels. Such measures can probably only be enforced through international agreements. As another idea, port fees in ratio to the amount of emission are feasible. This last however, bearing in mind the competitive situation with other German and European ports, would only be possible to a limited extent unless such regulations are introduced in all ports. Another effective possibility for reduction on land is the supply of shore-side electricity to ships while at berth.

In this survey the imission of pollutants in the area of Travemünde has been prognosed by means of calculating simulation using the TA-Air model AUSTAL2000. For this time spans of one year divided into hourly intervals were taken as the basis, so that as well as yearly averages, peak values and daily averages can be calculated.

The survey-report contains the results of the analysis for today (without the expansion of the Skandinavienkai) and the prognosis for 2010 after the expansion of the Skandinavienkai. In order to find measures for reducing the emissions from shipping, examples of three ideal concepts are examined to find potential reduction methods (concept 1: provision of shore-side electricity for all ships berthing at the Skandinavienkai. Concept 2: limitation of the sulphur content of fuels to a maximum of 1 %. Concept 3: limitation of the sulphur content of fuel during times at berth to a maximum of 0.1 % (use of marine gas oil)).

[26] The full text, including tables and illustrations, are in the appendix

5.5.2 Research concept

5.5.2.1 Summary of previous work

During planning commissions for the expansion of the Skandinavienkai the pollutant imissions within an extensive study area were measured for the situation of the time of analysis (year 2000) and for the forecasted situation (year 2010). All changes were noted and evaluated [L 47[27]]. As well as areas of housing nearby where protection is needed the study area included the region of Travemünde, the river banks at Priwall and the FFH-area "Dummersdorfer Ufer".

All planned construction work at the Skandinavienkai (redeploying the rail tracks, extension of the port area, new KV-Terminal, new industrial estates) was taken into consideration during the evaluation. As well as this, effects of construction work in Lübeck-Siems, whether already approved or still in the planning phase, were also considered (Lehmannkai, Seelandkai, Container terminal Herrenhafen). All this will directly affect the amount of shipping on the Trave in the future. As regards the sources of pollution, all important influences were considered (road traffic, rail traffic, shipping, times at berth, the operation of trucks and port units both in the ports and in the industrial estates). Other outside factors as for example private households (fires) or small businesses and background pollution from sources further away were combined to a lump sum estimated from the readings taken.

In order to ascertain the background pollution in the region of Travemünde sample readings were taken in the year 2000 during planning for the expansion of the Skandinavienkai. Pollution levels from nitrogen oxide, soot and particle matter were taken as suitable guidelines. The measurements were agreed on with the federal office for the environment at Itzehoe and carried out by the ERGO research company (Hamburg), which has also been commissioned by the federal office for the environment Itzehoe to take part in the supervision of air quality in Schleswig-Holstein.

Readings were taken at three measurement-points, at which different environmental influences could be expected:

- Measuring point 1: in the port area at the Skandinavienkai near heavily used traffic lanes, mainly at times of high operational activity, in order to record maximum pollution.
- Measuring point 2: on the esplanade to the west of the Priwall ferry, in order to record imissions arising from shipping on the Trave.
- Measuring point 3: in the spa park, a relatively pollution-free area, to record the general background pollution values in the research area.

Readings were taken over 6 months between May and November 2000. NOx pollution was measured by taking samples every half hour on one day a week. Times of high operational activity at the Skandinavienkai were chosen in preference for this. Measurements of particle matter and soot were carried out over 24 hours with stationary collectors.

From the readings, it could be seen that there was only slight pollution in the region of Travemünde. Air pollution detected in the spa park in Travemünde is the same as that measured at the provincial research station in Bornhöved and can registered therefore as low. The measuring point stationed at the Priwall ferry, although it is in a spot influenced by road and shipping traffic, also shows relatively low pollution levels. On the other hand, the measuring point at the Skandinavienkai is directly influenced by the emissions from shipping and load-

[27] The sources, pictures, etc. marked with an "L" are not part of this report but part of the complete LAIRM-survey in the appendix

ing activities. The readings here however are less than at points exposed to road traffic, e.g. at Lindenplatz in Lübeck.
The investigation of the amount of air pollution for this survey meant the calculation of the spread under present conditions (analysis) and the prognosis for the future. At each point relevant factors causing emission were taken into consideration and to be on the safe side always under assumption of the worst, in particular as regards emissions from ships´ units. In order to check the reliability of the calculation modus, levels of pollution at measuring points for the analysis were first calculated and then compared with the actual readings.

It was shown that the calculation modus led to higher values than the data of the readings. In other words, the calculation modus overestimates the actual situation and therefore remains for those interested on the safe side.

The same calculation modus was used for the prognosis, so that the pollution calculated for the time after the planned expansion is clearly made on the safe side.

Present EU-Regulations on the quality of the air include maximum imission levels for some pollutants, sulphur dioxide et al., for annual average values and also for daily and hourly values. A certain number of infringements above these levels are permissible. These limits have also been included in the revised version of 22.BImSchV and the TA Luft. In order to calculate the spread of pollutants, the revised version of TA Luft includes the model of spread AUSTAL2000, with which it is possible to calculate time spans and to identify the frequency of infringements in daily and hourly average values.

Altogether in the prognosis for the time after expansion it turned out that the limitation levels and test values for the protection of people, both those binding today and those planned for the future, were kept to at all important points of imission in the area closest to the nearest housing. Increases caused by the expansion of the Skandinavienkai and other construction are very slight. A measurable depreciation in the quality of the air around the spa park is not expected.

The greatest pollution can be expected in the area near the banks in Priwall, which are near to ships´ berthing places and where the prevailing wind is from the south-west.

5.5.3 Plan of survey

In preparation for the survey on air pollution for the “F+E-project”, there was consultation with the authorities, public offices, companies and experts involved. Participants were as following:

- The Federal Environmental Agency (UBA)
- Stadtwerke Lübeck, which commissioned and coordinated the F+E-project
- The Hanseatic town of Lübeck
- Ministry of the Environment in Schleswig-Holstein (MUNL)
- Provincial Office of the Environment Itzehoe (StUA)
- The Lübeck port company Ltd. (LPC)
- The Institute for Environmental Protection and Safety in Shipping (GAUSS), Bremen
- German Lloyd (GL), Hamburg
- Mister Jürgen Isensee, Dipl. Ing. (shipbuilding), Hanover
- LAIRM Consult co. Ltd, to the end of 2003: Masuch + Olbrisch co. Ltd.

Within the framework of the projected research, an analysis of individual sources of pollution is necessary in order to check the possibilities of reducing emissions by suitable measures at the individual sources (reducing emissions at berth by the provision of shoreside electricity or use of low sulphur fuels). This can only be quantified with the calculation modus. The calculation of time spans with TA Luft-model AUSTAL2000 makes exact hourly statements possible, so that even short peaking of pollution levels can be recorded.

The basis for the prognosis of imissions is made up of possible stress factors (number of ships, times at berth, routes, engine capacity, daily, weekly and annual operations, etc.) and the emission factors of the individual sources.

In the area of Travemünde, the emissions caused by shipping on the Trave and during times at berth at the Skandinavienkai are decisive. In order to gain more detailed results than in research up to now, it is extremely important to get ships´ emissions up to date. The following sources et al. must be considered:

- Emissions from auxiliary diesels and auxiliary boilers during times at berth at the Skandinavienkai
- Emissions of ships while docking at and leaving the Skandinavienkai and also on the river Trave, including turning:
- Emissions while moving on the Trave to the other ports in Lübeck.

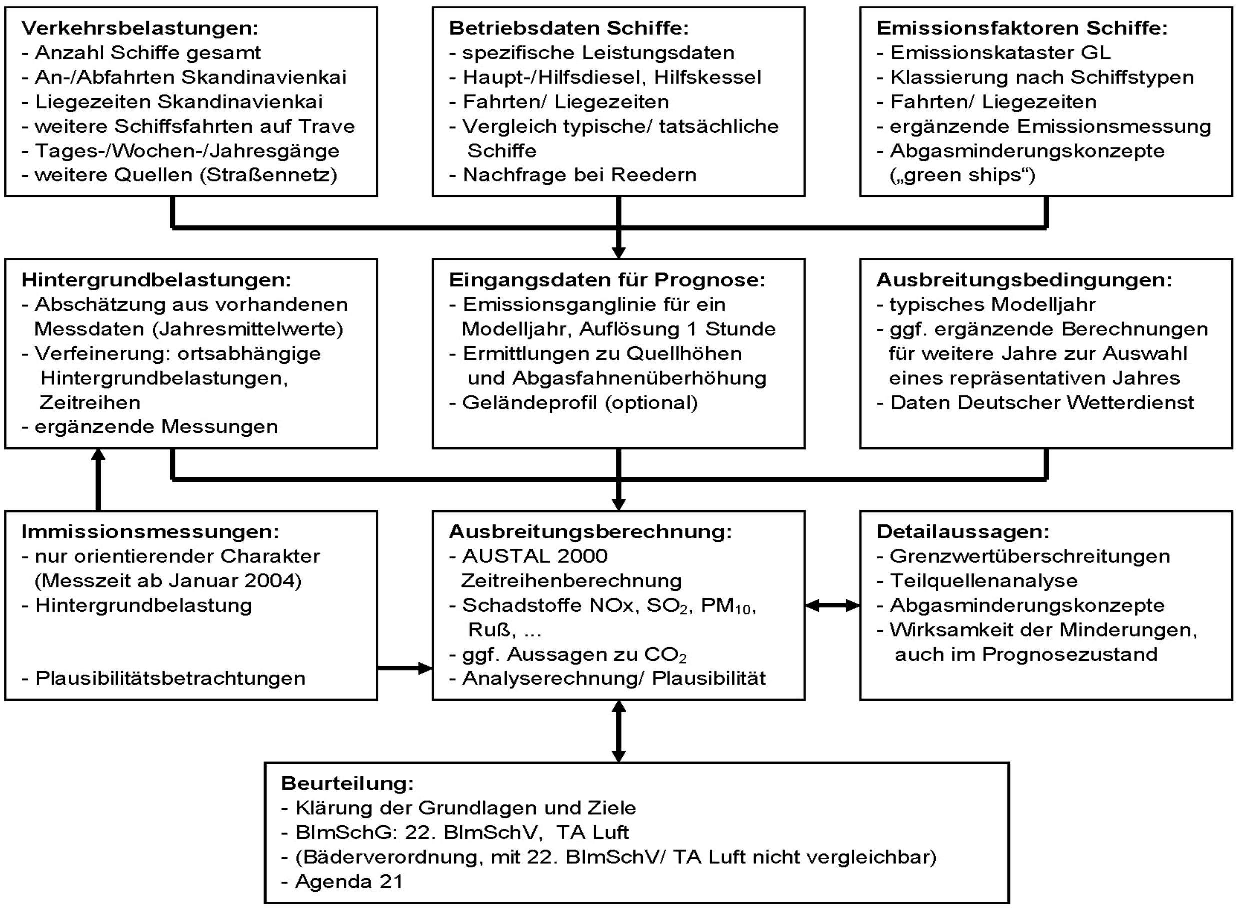
In order to obtain a detailed time span calculation of the spread of pollutants, exact hourly, daily and weekly readings of the emissions for every individual source are needed (i.e. for each ship berthing and its routes). The relevant data can be obtained by the port authorities of the town of Lübeck. The emissions can be calculated to the hour for a simulated year using the emission factors and the engine numbers for each particular case of pollution.

It was agreed on the following plan of the survey. Then the individual steps were worked out – sometimes different from those in the original plans, in cooperation with the following participants. Some points could not however be fully resolved.

1. Definition of hourly pollution data (arrival/departure, time at berth), with the cooperation of the LHG, the shipping companies and the port authorities: compilation by GAUSS
2. Definition of specific efficiency data for main and auxiliary units and boilers: shipping companies to be asked, following data already available from German Lloyd and other specialists, carried out by GAUSS and Mr. Isensee
3. Additional measurements of emissions to complete the emissions register from German Lloyd: new measurements of ships´ exhaust emissions, in particular those of the auxiliary boilers could not be carried out as the shipping companies and / or the boiler manufacturers were not interested in cooperating. Further investigations were started by Mr. Isensee and GAUSS but could not completed
4. Compilation of the emissions of the pollutants CO_2, NOx, SO_2, benzole, particles and soot for the area of Travemünde (ships movements from / to the Skandinavienkai, times at berth at the Skandinavienkai, movements to other ports in Lübeck)
5. Examination of the emissions was carried out under consideration of the present scale according to ENTEC by LAIRM Consult in cooperation with UBA and GAUSS
6. Drawing up hourly emission lines for individual sources during a simulated year to have input data for the calculation of spread. Inclusion of different scenarios taking measures for the reduction of emissions into consideration: LAIRM Consult

7. Additional consideration of emissions from the wide scale traffic network to assess imissions caused by road traffic, definition of pollution caused by traffic in cooperation with the traffic office of the town of Lübeck: LAIRM Consult
8. Coordination with the provincial office for the environment Itzehoe on existing background pollution: LAIRM Consult
9. Prognosis of imissions by calculations of spread using AUSTAL2000: LAIRM Consult
10. Evaluation of the situation as regards pollution and assessment of individual measures for reduction: LAIRM Consult
11. Additional measurements of imissions to establish present levels of pollution and to examine the plausibility of the calculation model, in particular SO_2 pollution. For this at the end of 2003 the Office for the Environment Itzehoe carried out a program of measurements at five points around the Skandinavienkai and in Travemünde, in which pollution from nitrogen dioxide and sulphur dioxide were measured over one year.

Picture 16: Diagram of the plan of the survey



5.5.4 Framework of the survey

5.5.4.1 Survey scenarios

The following cases were included in the survey:

1. **Analysis of the present state:** the present state of development at the Skandinavienkai, the pollution caused by shipping on the basis of an analysis for the year 2003:
2. **Analysis of the present state together with concept for reduction 1:** exemplary concept for reduction to find out the max. possible potential reduction by supplying shore-side electricity for all ships at berth at the Skandinavienkai (100%), pollution levels and other input data as in the present state:
3. **Present state of analysis together with concept for reduction 2:** in a second exemplary concept for reduction a limitation of the sulphur dioxide content to max. 1% in the fuels used by all ships in the area of research is assumed, pollution levels and other input data as in the present state:
4. **Prognosed state (2010):** the future expanded state of the Skandinavienkai after realisation of all extensions planned at present, prognosis of the increase of shipping on the basis of the examination to the project approval procedure for the extension of the Skandinavienkai as well as data already available, taking into consideration the max. permitted sulphur content in HFO of 1.5% in the Baltic area as from 2006:
5. **Prognosed state (2010) together with concept for reduction 1:** exemplary concept for reduction to find out the max. possible potential reduction by supplying shore-side electricity for all ships at berth at the Skandinavienkai (100%), pollution levels and other input data as in the prognosed state:
6. **Prognosed state (2010) together with concept for reduction 3:** as a further exemplary concept for reduction a limitation of the sulphur dioxide content to max. 0.1% in the fuels used by all ships in the area of research is assumed (use of marine gas oil), pollution levels and other input data as in the prognosed state:
7. **Prognosed state (2010) together with concepts for reduction 1+3:** in this case the concepts 1 and 3 are combined.

5.5.4.2 Area of survey

For the calculations a wide scale survey area was chosen, including all important sources of pollution and affected areas in the vicinity of the Skandinavienkai and in Travemünde. An illustration of the survey area can be found in the site plans in appendix LA1.

Calculation of the imissions of air pollutants was carried out all over the survey area, 5000x7000m². Important individual points were taken into consideration. The positions of the points of emission can be found in appendix LA1.

5.5.5 Sources of air pollutants

5.5.5.1 Internal combustion engines

Exhaust is caused by the burning of fuel in combustion engines leading to pollution of the air. The primary pollutants, components of exhaust are:

- Nitrogen oxides (as a rule given as NOx: made up of nitrogen monoxide NO and nitrogen dioxide NO_2)
- Carbon monoxide (CO),
- Sulphur dioxide (SO_2),

- Hydrocarbon (HC, including benzole, (C_6H_6), Toluole (C_7H_8), and xylole (C_8H_{10})),
- Particles (PM, including diesel soot and particle matter) and
- Lead (Pb).

The nitrogen oxides in exhaust are generally composed of more than 90% nitrogen monoxide (NO) and less than 10% nitrogen dioxide (NO_2). When expanding in the atmosphere, nitrogen monoxide oxidises to nitrogen dioxide, and a whole range of chemical reactions is possible (cf. e.g. [L1]). The most important change of NO in the atmosphere is oxidation by ozone (O_3). This reaction happens relatively quickly, so that near roads most of the natural traces of ozone in the air is used up. In sunlight NO_2 can change back to NO and O_3 by photolysis.

Extensive research on carbon monoxide and its effects has provided levels as limitations and precautionary values. These levels are so high when compared with the actual readings that CO presents no problems in the open.

In hydrocarbons there is a variety of components which have a wide range of effects. At present up to 200 organic components in exhaust are known. Among these are benzole and the volatile hydrocarbon compounds (VOC). Because of the wide range of effects an evaluation of the total hydrocarbons is not available. Instead therefore an evaluation was made on the benzole in hydrocarbon.

Lead is loosing its significance on shore as a pollutant, with unleaded fuels coming more and more into use. It can therefore be omitted from the evaluation.

Particles (dust) form a further component in engine exhaust. In 1998 three discussions with experts took place in the office for the environment on the subject of dust/particle matter [L26].

In motor exhaust, the particles are all fine particle matter PM_{10} (diameter of particles less than ten µm), in fact mainly fine particle matter $PM_{2.5}$ (particle diameter less than 2.5 µm).

Particles in exhaust also include diesel soot emissions. As modern diesel motors have been producing less and less emissions in the last few years there has been a consequent reduction in total emissions (measured in g per km). This reduction however is at least in part balanced out by a continual increase in the number of diesel vehicles on the road. As regards the size of the particles in diesel soot, research has shown a considerable amount of small and very small particles even in modern exhaust systems. More systematic research is needed here, in particular on the use of filters. As regards ships´ exhaust, diesel soot is a clearly visible pollutant component, especially when docking and leaving port.

Carbon dioxide, an end result of the burning of fossil fuels, is a further component of exhaust. As it is already present in the air it cannot exactly be called a “pollutant”. Carbon dioxide however affect the climate and is said to be one of the factors responsible for the greenhouse effect, and is therefore of interest here. In the survey, therefore, a balance of the emission of carbon dioxide is given.

5.5.6 Other sources of emissions

Vehicles on the roads stir up dust, and this is another important source of particle emission. A distinction must be made here between made-up roads and dirt roads.

In addition dust is caused by tyres wearing down. The proportion of PM_{10} is estimated in the relevant publications as c. 10%. The material from tyres is included in the general dust stirred up on roads, and further examination here is not necessary, bearing in mind too the very slight proportion of particle matter.

5.5.7 Basis for evaluation

An assessment of air pollution is achieved using the imission values given in the valid regulations (22nd. BImSchV, 23rd BImSchV, TA Luft, the EU guidelines and sub-guidelines, precautionary levels of the commission for protection against imissions (LAI)).

The regulations on the quality of the air [L7] of the European union and its sub-regulations [L8]/ [L9] have in the mean time come into force with the revision of the 22nd BImSchV [L4]. The TA luft has been thoroughly revised, and the present limitations of the EU regulations above have been included. The revised version of the TA Luft [L5] came into force on the first of October 2002.

The present limits, guidelines and the precautionary values for the protection of people, of vegetation and ecosystems are shown in table 22. (Note: The 98-percentile serves in the assessment of short term pollution and shows the amount of concentration which is kept to in 98% of the hours in a year.).

Table 22: Imission data for the protection of people [µg/m³] relevant to the assessment (if not otherwise indicated)

Luftschadstoff		Immissionswerte		
		Wert [µg/m³]	Quelle	Charakter
NOx	Jahresmittel	30	22. BImSchV	Schutz der Vegetation abseits von Ballungszentren
		30	TA Luft	
NO_2	Jahresmittel	40	22. BImSchV	Grenzwert (ab 2010)
		40	TA Luft	Immissionswert
	98-Perzentil	200	22. BImSchV	Grenzwert (ab 2010)
		135	EG-Richtlinie 85/203/EWG	Leitwert (Vorsorge)
	1 Stunde	200	22. BImSchV	Grenzwert (ab 2010), max. 18 Überschreitungen im Jahr
		200	TA Luft	Immissionswert, max. 18 Überschreitungen im Jahr
SO_2	Jahresmittel	50	TA Luft	Immissionswert
	Jahr und Winter	20	22. BImSchV	Schutz von Ökosystemen abseits von Ballungszentren
		20	TA Luft	
	24 Stunden	125	22. BImSchV	Grenzwert (ab 2005), max. 3 Überschreitungen im Jahr
			TA Luft	Immissionswert, max. 3 Überschreitungen im Jahr
	1 Stunde	350	22. BImSchV	Grenzwert (ab 2005), max. 24 Überschreitungen im Jahr
			TA Luft	Immissionswert, max. 24 Überschreitungen im Jahr
Benzol	Jahresmittel	5	22. BImSchV	Prüfwert
		5	TA Luft	Immissionswert
		2,5	LAI	Vorsorgewert
Ruß	Jahresmittel	1,1	LAI	Vorsorgewert
Feinstaub (PM_{10})	Jahresmittel	40	22. BImSchV	Grenzwert (ab 2005)
		40	TA Luft	Immissionswert
	24 Stunden	50	22. BImSchV	Grenzwert (ab 2005), max. 35 Überschreitungen im Jahr
		50	TA Luft	Immissionswert, max. 35 Überschreitungen im Jahr

As regards pollution with particle matter, recent research has shown that the normal concentration of particle matter that usually occurs in the open air can be harmful to health. Here particles with an aerodynamic diameter of 10µm and less are relevant (the term PM_{10} = Particulate Matter 10µm).

These findings have also led to decisions at EU-level for further limitations of the PM Imissions. Within the scope of the EU regulations 1999/30/EG [L8] as from 2005, limits were set for the yearly mean values for PM_{10} imissions (step 1) of 40 µg/m³ and from 2010 (step 2) a limitation of 20 µg/m³. The twenty-four-hour mean value of PM_{10} imissions may not exceed a limit of 50 µg/m³ more often than 35 times per year (step 1) or seven times per year (step 2).

5.5.8 Emissions (shipping traffic at the present state)

5.5.8.1 Ships´ movements and times at berth

The amounts of ships´ traffic on the Trave and their times at berth at the Skandinavienkai were identified by GAUSS [L48]. An analysis of the lists with ships´ entries and departures at the port authorities of Lübeck was made. This data has not yet been digitalised and so the evaluation had to be done personally. The month of July 2003 was taken as the mean month for regular shipping traffic to and from Lübeck. For the times at berth, the timetables were considered and enquiries made at the LHG and the shipping companies. A separate examination of the cruise ships entering at irregular intervals was carried out by GAUSS, taking the whole year 2003 into consideration.

With the data collected by GAUSS a model of regular ships´ movements was developed showing a period of four weeks. From this four-week-model a year's model was developed as the basis for calculation in simulation. The cruise ships were added to the model according to their real data. Smaller ships, ships seldom visiting Lübeck, day-trip boats and the Priwall ferries are of less importance in the whole and in agreement with GAUSS were not included. The model year was designed in hourly readings, meaning that at each measuring point 8760 hourly readings have to be considered. For shipping on the Trave, the times of arrival and departure given in the timetables were rounded up to the nearest hour emissions were calculated according to their actual times of influence, resulting from their route and their speed. For movements on the Baltic Sea near to the port entrance and on the Trave, ship's movements of 15km/h (c. 8 knots) were presupposed as an example. The following routes and times of influence were considered:

- Movements to Ostpreussenkai: route 2.2 km, time of influence 10 minutes:
- Movements to Skandinavienkai: route 4.6 km, time of influence 20 minutes:
- Movements to other ports in Lübeck (southern Skandinavienkai): route 6.8 km, time of influence 30 minutes.

Times at berth were also included to the exact hour. Where a ship was not at the quay for the full hour, in the model the full hour was as a rule taken. In this way the facts in the model remain on the safe side, to cover possible additional ships emissions when turning, docking and departing.

The input data are in appendix LA2. A diagram of ships´ movements in the four week model is given in appendix LA2.1. Times at berth at the Ostpreussenkai are given for each quarter in appendix LA2.2. (Note: there was no shipping at Ostpreussenkai in the first quarter). The four week model with exact information on the ships is shown in appendix LA2.3 (model month July): ships´ codes are to be found in appendix LA 2.6.1.

5.5.8.2 Emission factors

Emissions from shipping arise on the one hand from their movements on the Trave, including manoeuvres for turning and docking, and on the other hand from the continuous running of auxiliary generators and auxiliary boilers during times at berth in port. As a rule, three to four different types of motors provide energy for the ship:

- Main engine(s) (drive for propeller and shaft generator): in constant operation at sea, sometimes operating when manoeuvring, when entering harbour and in coastal waters, in port generally not in operation

- Auxiliary diesels (two to four, for supply of electricity): auxiliary generators are not in operation at sea if the ship has a shaft generator/variable pitch propeller: partly or fully in operation when manoeuvring, when entering port and in local waters: in port in full operation alternately
- Exhaust boiler (not always installed, for heating): at sea operates on the exhaust from main and auxiliary engines: partly in operation when manoeuvring, when entering port and in local waters: in port generally not in operation
- Auxiliary boilers (for heating): at sea generally not in operation, partly in operation when manoeuvring, when entering port and in local waters: in port total supply of heating.

Some more modern ships are equipped with diesel electric generators which generate electricity both for the drive and for the supply of electricity on board. From the point of view from consumption and emission these are favourable as among other things they use low sulphur fuel ("green ships"). Auxiliary diesels are not installed on these ships.

The amount of exhaust emitted can be specified from the emission data of the engines, usually given regarding the capacity of the motors or the consumption of fuel. In order to calculate the emissions, therefore, it is necessary to have data on the operational condition of the driving motors as well as emission factors. As the emission factors and the degree of capacity vary according to the operational condition, the design of the motor and/or the type of ship, deviations from the average are possible for ships´ emissions in some cases. The following sources of information are available on the factors influencing emissions from ships´ motors:

- German Lloyd (GL) has published information on the operations of auxiliary units and main engines, this information is taken from 1980 and 1985 [L14]. In addition GL has cadastral survey of emissions which however is not freely available. The data gained from measurements from emissions commissioned by the manufacturers of ships´ motors often relate to single projects and are only available to the commissioners. As performance and accordingly fuel consumption depend to a great degree to the load, global assumption of emission factors is only possible to a limited extent, and in some cases exact information on the operational conditions are necessary as well as the relevant emission factors.
- In commission from the Ministry of Environment, the port authorities of Bremen developed the emissions model MARION for finding and assessing shipping emissions. By means of this the total emissions from ports can be calculated to the last ship. The emission factors and degrees of performance, however, in this are global figures and the same for all classes of ships.
- Information on the emission of pollutants is also to be found in publications by Isensee et al. [L15]. These include existing factors (information from the office for the environment Hamburg, stand 1980 (source: Ministry of Health and Environmental Protection, Holland)) and also factors from the project *CLEAN* (joint project "low emission ships´ engines", German Lloyd).
- For the award of the environmental badge the *Blue Angel*, Isensee was commissioned by the Ministry of Environment to compose the computer programme *EMISS* [L17] for the calculation of ships´ emissions. In this reasonable average emission factors and degrees of performance were surmised, which are comparable with values given in modern publications.

- The most up-to-date compilation of the factors affecting ships´ emissions and of other important influences can be found in the final report "quantification of ships´ emissions caused by ships´ movements between ports in the European union", composed by ENTEC UK Limited from the year 2002 [L16] as well as average emission factors for particular classes of ships, it also gives detailed information on the main engines and the auxiliary generators according to types of motor and fuel. In addition there is information on the units, fuels and degrees of performance. Emission factors for auxiliary boilers, however, are not available in the *ENTEC* study.
- For the estimation of emissions from the auxiliary boilers, Isensee has created a prototype model which however is still in the process of development [L18]. The amount of heat needed and the size of the auxiliary boilers necessary for this can be estimated using standard parameters (containerships, tankers, RoRo cargo ships: tonnage tdw, RoRo Pax and passenger ships, number of crew and passengers). In addition Isensee gives values for performance, efficiency and emission factors. It must be noted that up to now only a small amount of data was available to work on, but nevertheless the model is suitable for the calculation of the amount of emissions from auxiliary boilers.
- As regards possible plans for the reduction of emissions from ships´ engines the following must be said:
  - For new ships a considerable reduction of NOx emissions by more than 90% is in principle possible by the inclusion of a catalytic converter. In a few cases such a concept has already been realized [L19].
  - SO_2 emissions can be reduced to a half or to one third by using fuel with a low sulphur content of 1%, in contrast with normal fuel with a sulphur content of 2-3%.
  - Emission of soot can be reduced by the introduction of soot filters.

These measures however cause considerably increased costs not only in purchase price but also in ships´ operations. A realisation of these measures for reduction is probably only to be achieved through legislation (as is already the case in Sweden).

In this research the emission factors of the *ENTEC* study, differentiated according to class of engine/fuel, were taken as premises. These represent the most up-to-date data available and are suitable for reckoning the emissions for every ship, as long as the types of motor and fuel are known. A list of the emission factors is included in appendix LA2.4.

As well as the values given in *ENTEC*, the emission factors arising from use of the formulae in the programme *EMISS* (Isensee) can be found in appendix LA2.4.6.

When the data for SO_2 and CO_2 are compared (premises: consumption of fuel according to ENTEC) the emission factors show equal values or slight differences between 10-15% (see appendix LA2.4.7). For auxiliary boilers the values given by Isensee are taken. A list is given in appendix LA2.4.5.

The emission factors available are limited to the pollution components NOx, SO_2, CO_2, HC and fine particle matter PM_{10}. The emission factors of more pollutants were estimated on the analogy of lorry diesel motors. Benzole emissions can be reckoned in the same way from the proportion (c. 1.9%) of the total HC emissions, and diesel soot emissions as a proportion (c. 40%) of the particle emissions.

5.5.8.3 Types of fuel

Types of fuel for ships units are residual oil (RO), marine diesel oil (MDO) and marine gas oil (MGO). As regards exhaust emissions, the main difference lies in the sulphur content, as practically all the sulphur in the fuel is converted into SO_2 when burnt. The average sulphur contents given in the ENTEC study, also representative for the Baltic Sea, are used in this survey:

- Residual oil (RO): sulphur content 2.7%
- Marine diesel oil (MDO): sulphur content 1.0%:
- Marine gas oil (MGO): sulphur content 0.5%.

Where in particular cases detailed information on the sulphur content of the fuels used was available from the shipping companies, this was used instead of the *ENTEC* values.

5.5.8.4 Degrees of performance of the units

Furthermore, the degrees of performance of the engines are important for the calculation of the emissions during different manoeuvres. Here again the values given by ENTEC were taken which premise e.g. for the main engines an average performance of 1% during times at berth. This is realistic in order to cover the emissions during the phases of starting up and shutting down the engines. A list can be found in appendix LA2.5.

If the figures for motor performance given in the *EMISS*-program by Isensee are taken, the resulting total emissions are c. 5-10% less in the study area than those resulting from the *ENTEC*-program. The differences are slight and therefore to be on the safe side in the following survey *ENTEC* values are used.

Isensee recommends values of 30% (local waters) and 25% (in port) for the performance of auxiliary boilers. However as the premise is based on relatively little data, in the following survey values of 10% less have been taken so as not to give too much weight to the influence of the auxiliary boilers. A test of plausibility between the model estimates and first rough results of up-to-date readings show that this approach is pointing in the right direction.

Where in particular cases detailed information on the performance of units was available, this has been used instead of the *ENTEC*-values. In some particular cases (e.g. diesel electric motors) reasonable suppositions were made.

5.5.8.5 Input data of specific ships

For regular shipping traffic and for cruise ships, the necessary input data of specific ships was collected by GAUSS [L48], including the number and the efficiency of main engines, auxiliary diesels and auxiliary boilers, types of fuel used and sulphur content, volume and temperature of exhaust, tonnage, numbers of crew and passengers. All together 54 ships were considered. Supplementing this, data calculated using the model *MARION* was used [L49]. A list of the data is in appendix LA 2.6.

Where no detailed information was available, reasonable suppositions were made. The values given by GAUSS or data from the shipping companies were used for sulphur content; where information was missing the *ENTEC* values were used. The size of the auxiliary boilers was estimated by Isensee, where no exact data was available.

5.5.8.6 Emission model

Taking emission factors, types of fuel, degrees of performance and the other input data for specific ships into account, the emissions from each ship were determined for the tree cases “at sea”, “in coastal waters” and “at berth in port”. A list can be found in appendix LA2.6.

In this case movements in the Baltic Sea area at the mouth of the Trave and on the Trave are seen as “coastal waters”.

After this the total emissions from each ship as the sum-total of all ships´ motors was taken as the basis and related to the hourly scale of the model year for ships´ movements (appendices LA2.6.21 to LA2.6.23). With these values an annual curve was made for each pollution component. This serves as the emission time span in the calculation of spread. The total annual emissions caused by shipping are listed in appendix LA2.

5.5.9 Shipping traffic (analysis), concept for reduction 1

In this concept for reduction it is premised that all ships at berth at the Skandinavienkai are equipped for and use an electricity supply from land. Thus the main and auxiliary engines are no longer in operation during times at berth. To be on the safe side, however, the *ENTEC* values with a low mean performance of 1% are taken for the main engines, so that emissions when the machines are started up or shut down are also taken into consideration. In the same way a residual performance of 1% is also taken for the auxiliary engines. As regards the performance of the auxiliary boilers, a division is made into two cases:

- Concept for reduction 1a: degree of performance of auxiliary boilers as in analysis 10%:
- Concept for reduction 1b: auxiliary boilers not in operation, i.e. degree of performance 1% (to be on the safe side, as above).

The resulting emission values for each case and hour of operation are listed in appendices LA2.7 and LA2.8. The annual balance of emissions is given in the appendices LA2.11.2 and LA2.11.3.

5.5.10 Shipping traffic (analysis), concept for reduction 2

In the concept for reduction 2 it is premised that all ships within the area of survey only use fuel with a sulphur content of max.1%, for the main and auxiliary engines and also for the auxiliary boilers. This concept for reduction mainly affects the emission of sulphur dioxide, in direct proportion to the sulphur content. The reduction of other pollution components is only slight and is not examined further.

The resulting emission values for each case and hour of operation are listed in appendix LA2.9. The annual balance of emissions is given in the appendix LA2.11.4.

5.5.11 Shipping traffic in prognosis

5.5.11.1 Ships´ movements and times at berth

The forecasted conditions in this survey refer to the year 2010, after the expansion of the Skandinavienkai has been completed. This will include among other things an extra ships berth.

An analysis of the increase in shipping was made in cooperation with GAUSS on the basis of the investigations made during the planning stage for the expansion of the Skandinavienkai [L47]. According to this around 28 ships are expected additionally per week. In the model two ships per day at the new berth 5a and one ship per day at each of the berths 7 and 8 are assumed. An average of ten hours is taken for the time at berth.

For movements on the Trave to the other ports of Lübeck (container terminal Lübeck-Siems, Seelandkai, Lehmann), and also to those at present in the planning stage, an increase of around 28 ships per week, i.e. 56 movements, was estimated. In other words, 8 additional ships´ movements are premised per day. A meantime of twelve hours is allowed between arrival and departure (10 hours berthing time and 1 hour for each movement).

Regarding operations at the Ostpreussenkai an aim of around 50 cruise ships per year can be assumed. Berthing times are given on average as 16 hours. The pollution from this shipping is listed in appendices LA3.1 to LA3.3.

5.5.11.2 Emission factors

As from 2006 the sulphur content of residual oil may only reach max. 1.5% in the Baltic Sea area. This reduction must be taken into consideration for the prognosis 2010.

As regards emission factors, the detailed values from the *ENTEC* study [L16] were taken as in the analysis. The reduction in sulphur content mentioned above corresponds to the scenario 2 (2006) of the *ENTEC* study, meaning that the relevant emission factors and reductions are considered. The emission factors are listed in appendix LA3.4.

5.5.11.3 Input data of specific ships

For the additional ships prognosed at the Skandinavienkai and at other Lübeck ports, the following parameters were taken to be on the safe side for RoRo/C ships (ENTEC-type A35):

- Capacity main engines together 2500kW
- Auxiliary generators together 6000kW
- Auxiliary boilers 3000kW.

It is assumed that ships docking at the Skandinavienkai and at other ports will show no changes from the analysis state of the present. According to GAUSS, it is hardly possible to make prognoses on the time when existing ships will be replaced. Some of the ships regularly docking at the Skandinavienkai have already been replaced recently and are already in the analysis of the present state. The prognosis 2010 regarding the typical length of a ships operational life can be considered as up-to-date, so that only a few shipping lines will be affected, if any. As many average assumptions have to be made, projections as to other ships or sizes of ships make little sense because of the lack of concrete data. An improvement in the precision of the statement cannot therefore be expected.

5.5.11.4 Emission model

The emission model was determined using the emission factors, types of fuel, degrees of performance and other input data of individual ships, as in the state of analysis. A list of these is given in appendix LA3.6. The total annual emission caused by shipping is listed in appendix LA3.13.

5.5.12 Shipping traffic (prognosis), concept for reduction 1

In this concept for reduction it is premised, as in the analysis, that all ships at berth at the Skandinavienkai are equipped for and use an electricity supply from land. Thus the main and auxiliary engines are no longer in operation during times at berth. To be on the safe side, however, the *ENTEC* values with a low mean performance of 1% are taken for the main engines, so that emissions when the machines are started up or shut down are also taken into consideration. In the same way a residual performance of 1% is also taken for the auxiliary engines. As regards the performance of the auxiliary boilers, a division is made into two cases:

- Concept for reduction 1a: degree of performance of auxiliary boilers as in analysis 10%
- Concept for reduction 1b: auxiliary boilers not in operation, i.e. degree of performance 1% (to be on the safe side, as above).

The resulting emission values for each case and hour of operation are listed in appendices LA3.7 and LA3.8. The annual balance of emissions is given in the appendices LA3.13.2 and LA3.13.3.

5.5.13 Shipping traffic (prognosis), concept for reduction 3

In the concept for reduction 3 it is premised that during times at berth in ports only fuel with sulphur content of max.0.1% (MGO) may be used. Negotiations are being carried out at EU level on this at the present.

This concept for reduction mainly affects the emission of sulphur dioxide, in direct proportion to the sulphur content. In contrast with the emission factors for SO_2 in scenario 2 (2006) with a sulphur content of 0.5% for MGO, the emission factors are reduced to 20% accordingly. Reduction of other pollutant components is also achieved by the increased use of marine gas oil (MGO), but the reductions here are much less. In the present case it is assumed that all ships´ units, including the auxiliary boilers, run on low sulphur MGO during times at berth.

The resulting emission values for each case and hour of operation are listed in appendix LA3.9. The annual balance of emissions is given in the appendix LA3.13.4.

5.5.14 Shipping traffic (prognosis), concept for reduction 1+3

In addition a potential reduction using a combination of concept 1 (electricity supply) and concept 3 (reduction of sulphur content while at berth) was examined.

At the Skandinavienkai, in comparison with concept 1, reductions are mainly achieved by the operation of the auxiliary boilers, because the main and auxiliary engines need not be in operation because of the shore-side electricity supply.

The resulting emission values for each case and hour of operation are listed in appendices LA3.10 and LA3.11. The annual balance of emissions is given in the appendices LA3.13.5 and LA3.13.6.

5.5.15 Road traffic (pollution caused by road traffic)

5.5.15.1 State of analysis

Within this survey, emissions caused by road traffic were also taken into consideration when estimating the total amount of pollution. For this, all major road segments within the survey area were included as relevant sources. Road segments not explicitly included here show much lower pollution and/or are far enough away from the relevant imission areas. Thus they hardly contribute to pollution and in the following they are ignored.

The amount of traffic (DTV-Durchschnittliche Täglicher Verkehrsstärke an allen Tagen des Jahres i.e. average daily amount of traffic on all days of the year) and the important proportion of trucks (vehicles of more than 2.8t total weight) on public roads in the survey area were estimated using existing traffic counts in the town of Lübeck [L13] or were taken from previous surveys [L14]. As emissions from the roads are not being assessed here and serve only for estimating total emissions, a detailed survey of road traffic was not carried out. The figures given for road traffic in the following are to be understood as estimates.

When no data was available on the proportion of trucks, reasonable assumptions were made following the numbers given in the traffic counts. The distribution of cars, vans and heavy vehicles is derived in the following text from data taken from [L21]. A detailed list of the pollution can be found in appendix LA4.1.2.

The results of traffic counts were made available by the Traffic Office of Lübeck. These were counts (censuses) of varying compass made between 1995 and 2002, on workdays and also on sundays. To project the figures of the single hours up to the total amount of traffic for the day, average projection factors were derived from the figures given in the available censuses for 24 hours. The following factors were used:

- count from zero to 24 o'clock (24 hours: factor 1),
- count from 6 to 20 o'clock (14 hours: factor 1,2)
- count from 15 to 18 o'clock (3 hours: factor 4)
- count from 15 to 19 o'clock (4 hours: factor 3)

No other hourly groupings were analysed. In the evaluation it could be seen that the daily traffic on single days sometimes showed considerable variation, not only between sundays and workdays but also on the same workdays at different seasons of the year. These results point to clear differences in the course of the year and the week. In a second step to identify the DTV, suitable yearly / weekly sequences were considered. For this, up-to-date sequences from the "Bundesanstalt für Straßenwesen" (BAST-federal office for roads) were used [L12]. In comparison with the figures of the counts, sequences mainly with leisure and holiday traffic led to the best results (annual sequence type F, weekly sequence average from type E and type F).

(Note: the sequences of the BAST are given for each week. Because of the great peaking in particular weeks (Easter, Whitsun, etc.) comparison with the numbers of the counts was very indecisive if the census had been taken at these times. A better conformity with less mean mistakes was achieved by using a monthly sequence from which the weekly values could be derived.)

5.5.15.2 Prognosis

With the expansion of the Skandinavienkai and the abolishment of the main Travemünder road, changes in traffic flow can be expected. In the above surveys [L47] investigation of this had been carried out, so that this data could be used. Increases due to changes in traffic flow and additional traffic to/from the Skandinavienkai are included in this.

For the road segments not taken into account in the investigation above, reasonable assessments were made. Here it was agreed with the Traffic Office of Lübeck that no increases worth mentioning were to be expected in the town area of Travemünde. The prognosis of pollution caused by traffic is summarised in appendix LA4.1.3.

5.5.15.3 Emission factors (vehicle exhaust)

The up-to-date version of the "manual of emission factors" [L20] was used for the identification of emission factors. The emission factors depend among other things from the following parameters:

- Vehicle categories and vehicle distribution
- Traffic situation (traffic pattern, type of road)
- Temperature of the surroundings, gradient, vehicle performance, etc.
- Year of reference

The computer program "manual of emission factors" calculates emissions for different types of roads and different traffic situations. Included here, according to the year of reference, is the corresponding distribution of important performance (numbers and types of vehicles on the road), typical temperature sequences and frequency of cold starts, which can be used where figures from a traffic census are not available.

Emission factors often depend to a great extent from the year of reference chosen as the basis for the calculation, because the composition of the vehicle fleet on the road changes according to age, motor design and exhaust norm. The "manual of emission factors" gives a prognosis according to the year of reference on the composition of the vehicle "fleet". Improvements in the quality of fuel, whether planned or already legally binding, are also taken into consideration (reduction of benzole and sulphur contents).

(Note: a reduction of the sulphur content leads automatically to a reduction of other pollution components (particle matter, HC, CO, NOx)).

In this survey, the year of reference for the analysis to identify emission factors is 2004. For the prognosis the year of reference is 2010. Information on emission of diesel soot is not included in the "manual of emission factors". As a first approach, however, it can be assumed from present knowledge that the proportion of diesel soot in the total particle emission is 60% in car exhaust (and vans) and 40% in the exhaust from trucks (information from the ministry of the environment).

In 1998 there were 3 rounds of discussion with experts at the Ministry of Environment on the subject of dust/particle matter [26]. According to them, the particles emitted in vehicle exhaust are all fine particle matter PM_{10}. In this survey therefore it is taken for granted that the particle emissions in exhaust are 100% PM_{10}.

The basic emission factors from the manual of emission factors can be found in the appendices LA4.4.1 and LA4.4.2. The relevant input data for the determination of emissions from the traffic situation and the particle matter model are listed in appendix LA4.2. The emissions from the roads which were considered are listed in appendix LA4.5. They are given as mean emission factors per vehicle and kilometre for the respective part of the road.

5.5.15.4 Dust raised by road traffic

The stirring up of dust by vehicles using the roads is a further source of particles. While detailed emission factors for the particle emissions in the exhaust of vehicles are available, the prognosis of the dust stirred up on roads is far more difficult. In the guidelines 3790, paper 3 [L23] a respective calculation approach is available based however upon data from the U.S. Environmental Protection Agency (EPA, 4 Edition [L24]) which overestimates the actually measured pollution level on German roads considerably.

Another method is the use of the up-to-date calculation method of the EPA (5th edition [L25]), which has been used in the USA as official calculation method for PM-emissions for some years. For this information on the amount of dust on different roads is needed as well as information on the mean weight of the vehicles. Extensive measures on the amount of dust on roads is available, however they can hardly be drafted to the situation in German. In Germany only measures for a few points are available so far, but extensive measurements have begun. The results are to be published this year.

As long as no systematic results are available which can be used for the development of a suitable emission model, the present EPA-model can be taken as a substitute. To be able to transfer these data to the German situation for the scope of a research project on the basis of the existing publications and present measurement results the engineering office Lohmeyer made an adjustment of the EPA-formula was done and according tips were given for the application [L28]. More recent imission measures of the air observation in Schleswig-Holstein and Hamburg suggest that at least in Schleswig-Holstein even the approach of Lohmeyer exaggerates the dust emissions. In the following this approach is used anyway, as no other appropriate approaches are available. The determination of the emission factors is listed in appendix LA4.4.2.

5.5.15.5 The emission model

Taking the emission factors and the daily- , weekly- and annual sequences into consideration, a time-scale to the hour was made for the whole road network. As the maximal number of sources is limited in AUSTAL2000, the entire road network was divided into 5 sectors each with one source (5 calculation runs). The sequences of BAST [L12] were used for the daily-, annual and weekly calculations. Corresponding to the census results, for cars sequences showing a high amount of traffic at weekends and in the holiday were taken.

For industrial traffic sequences were taken that mainly remained even or showed only slight increases in summer. A diagram of the sequences used can be found in appendix LA4.3. An exact monthly distribution was taken into consideration in the annual sequences. The total emissions for each road sector are shown in the tables in appendix LA4.6. The total yearly emissions from the whole road network can be seen in appendix LA4.7.

5.5.16 Total emissions in the survey area (analysis)

The total emissions resulting for the model year in the area of survey are listed in table 3 and the illustrations 2.2.7. For this an analysis was carried out for each of the single sources. Emissions from road traffic are given as well as emissions caused by shipping.

The following results must be noted:

- The emissions in the survey area were mainly influenced by the Skandinavienkai. The proportions of the total emissions lie at around 80 to 85% for nitrogen oxides, sulphur dioxide and diesel soot: 70% for CO_2 and benzole: 60% for particle matter (PM_{10}). Emissions caused during times at berth are most important with 60 to 80%, as opposed to emissions during movements to/from the Skandinavienkai with 20 to 40%. With reference to the total emissions within the survey area, the proportion of emissions during time at berth at the Skandinavienkai is c. 50 to 65%, for particle matter around 40%.
- Emissions at the Ostpreussenkai are insignificant for the total balance. However since important development is taking place nearby an increase in the imissions of pollutants may result.
- Ships´ movements on the Trave to other ports in Lübeck contribute about 18% sulphur dioxide, 16% diesel soot and 12% particle matter (PM_{10}) to total emissions. For other pollutant components, their proportion of the total lies under 10%.
- The proportions from the road network in the survey area contributed to the annual total are c. 18% for benzole and 25% for particle matter (PM_{10}). The proportions for NOx and diesel soot are lower, with fewer than 7%. The proportion CO_2 is around 22%. Sulphur dioxide emissions from road traffic can be ignored.

According to these results, the greatest potential for reduction can clearly be seen as the limitation of the emission of pollutants during times at berth at the Skandinavienkai.

Table 23: Total emissions from shipping and road traffic in the survey area (tonnes per year), analysis

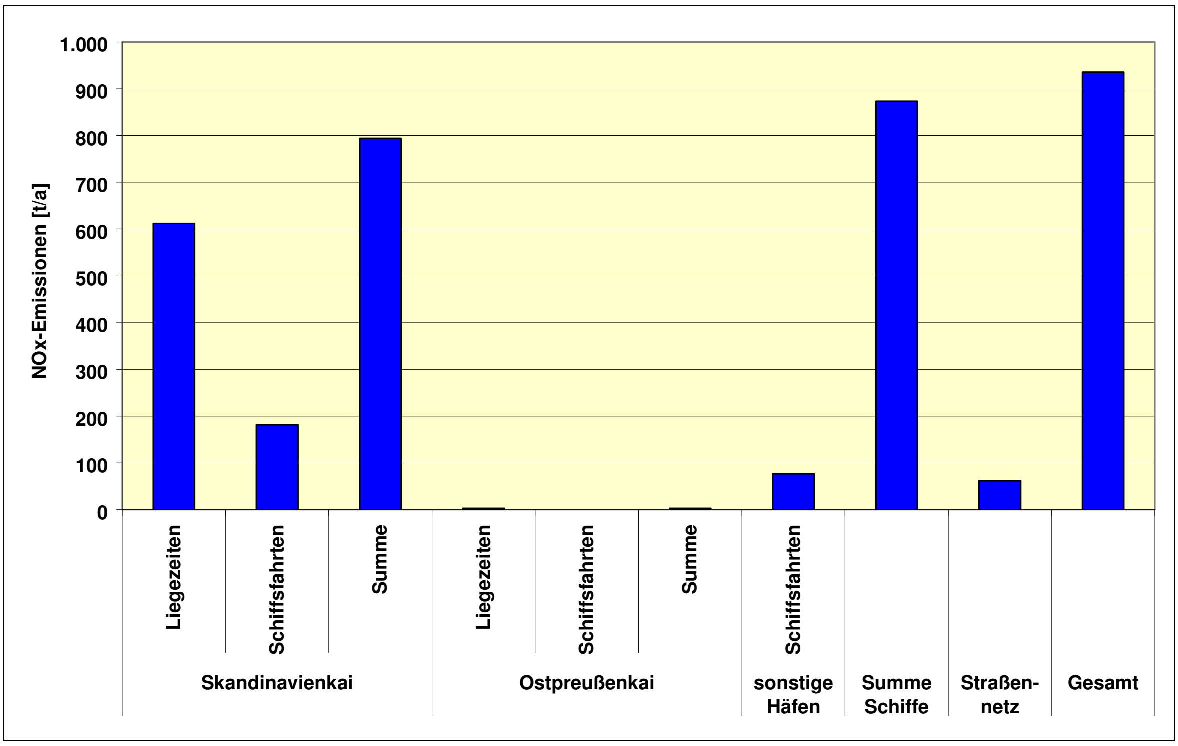
Hafen	Gesamtemissionen im Untersuchungsgebiet pro Jahr [t/a]					
	CO_2	NOx	SO_2	Benzol	PM_{10}	Ruß
Skandinavienkai						
Liegezeiten	35.745	612,2	185,4	0,818	32,42	12,97
Schiffsfahrten	10.748	181,5	91,2	0,368	21,69	8,68
Summe	46.493	793,7	276,6	1,186	54,12	21,65
Ostpreußenkai						
Liegezeiten	194	2,8	1,5	0,006	0,24	0,09
Schiffsfahrten	7	0,1	0,1	0,000	0,01	0,00
Summe	201	2,9	1,6	0,006	0,25	0,10
sonstige Häfen						
Schiffsfahrten	4.667	76,9	59,4	0,133	10,39	4,16
Summe Schiffsverkehr	**51.360**	**873,5**	**337,6**	**1,325**	**64,75**	**25,90**
Straßenverkehr	14.683	61,9	0,07	0,293	21,51	0,84
Gesamt	**66.043**	**935,5**	**337,6**	**1,619**	**86,26**	**26,74**

Table 24: Total emissions from shipping and road traffic in the survey area (tonnes per year), prognosis

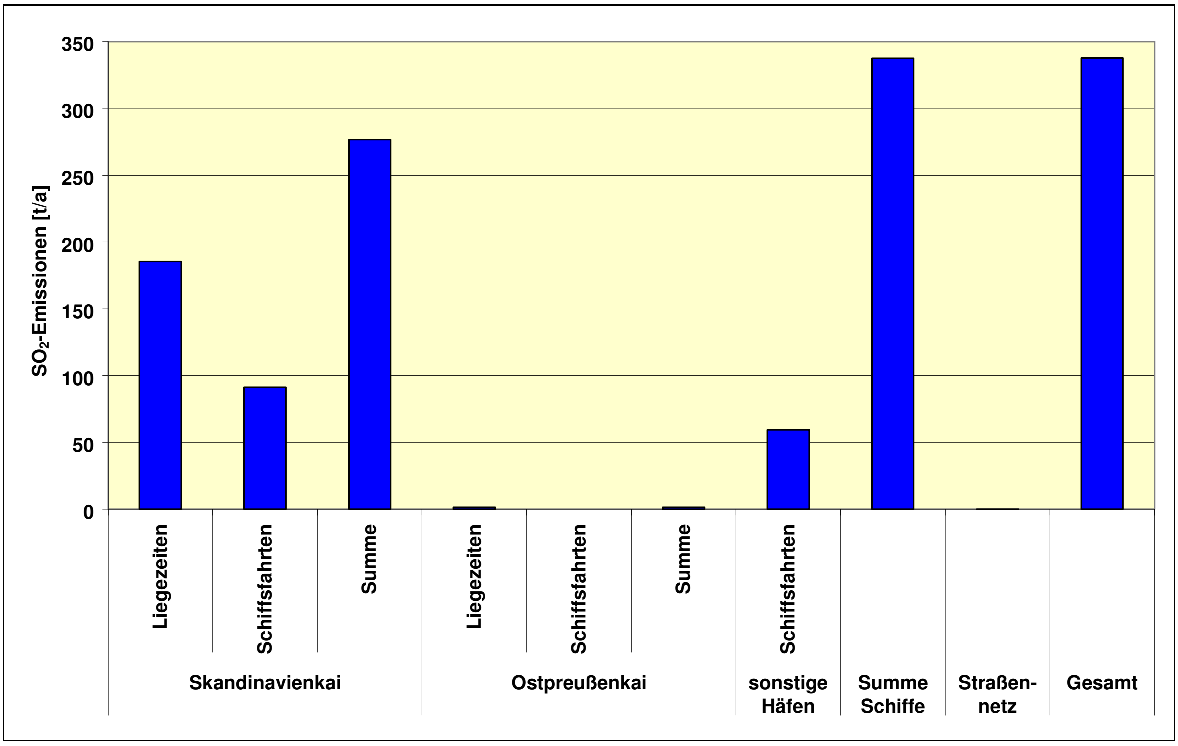
Hafen	Gesamtemissionen im Untersuchungsgebiet pro Jahr [t/a]					
	CO_2	NOx	SO_2	Benzol	PM_{10}	Ruß
Skandinavienkai						
Liegezeiten	64.027	1144,3	350,7	1,205	46,59	18,61
Schiffsfahrten	16.480	276,8	111,5	0,530	24,43	9,73
Summe	80.506	1421,2	462,1	1,735	71,02	28,33
Ostpreußenkai						
Liegezeiten	421	6,2	2,9	0,013	0,46	0,19
Schiffsfahrten	16	0,2	0,1	0,001	0,02	0,01
Summe	437	6,4	3,0	0,013	0,49	0,19
sonstige Häfen						
Schiffsfahrten	13.267	220,0	108,8	0,376	19,78	7,87
Summe Schiffsverkehr	**94.211**	**1647,6**	**574,0**	**2,124**	**91,28**	**36,39**
Straßenverkehr	16.312	47,4	0,08	0,137	24,94	0,65
Gesamt	**110.522**	**1695,0**	**574,0**	**2,261**	**116,22**	**37,05**

In the following, of the six estimated emissions given above only the illustrations for NOx, SO_2 and PM_{10} are cited. The illustrations for the other emission paths can be found in the appendix.

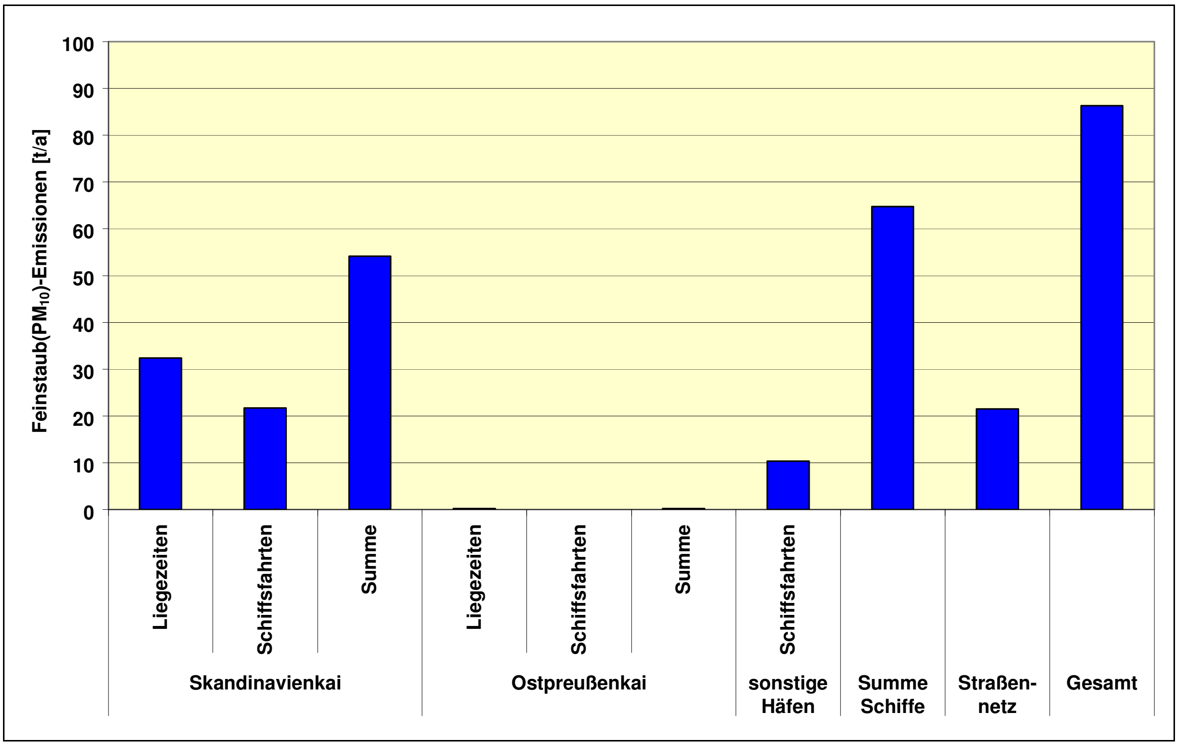
Picture 17: Total emissions of nitrogen oxide caused by shipping and road traffic in the survey area [t/a], analysis



Picture 18: Total emissions of sulphur dioxide caused by shipping and road traffic in the survey area [t/a], analysis



Picture 19: Total emissions of particle matter (PM_{10}) caused by shipping and road traffic in the survey area [t/a], analysis



5.5.16.1 Analysis together with concepts for reduction

The total emissions measured in the analysis and those expected when the concept for reduction 1a/1b (electricity supply) and 2 (limitation of sulphur content) are carried out, are listed in table 4. Detailed lists can be found in appendix LA2.7. Illustrations can be seen in pictures 8 to 13. The following results must be noted:

- **Concept for reduction 1 (electricity supply):** when the concepts 1a/1b are taken into consideration, reductions of 40 to 45% can be expected in the annual emissions of carbon dioxide, sulphur dioxide and benzole. Slightly higher reductions of just less than 60% are expected for nitrogen oxides. Particle matter (PM_{10}) and diesel soot will be reduced by around 25 to 35%. When the concepts 1a/1b are compared (auxiliary boilers in operation during times at berth with 10% / 1% performance), it can be seen that any reductions worth mentioning during minimal boiler operation can only be expected for sulphur dioxide (around 10% less emission). For all other pollution components, possible reductions lie at 5% and below. Higher reductions can be clearly seen for emissions in the area of the Skandinavienkai, in particular at the berths. Reductions of 40 up to 70% can be expected in emissions caused by operations at the Skandinavienkai (ships´ movements and times at berth together). When one considers only berthing times, considerable reductions between 70 and 90% can be expected.
- **Concept of reduction 2:** limitation of the sulphur content in fuels to max. 1% leads to reductions worth mentioning only for emissions of sulphur dioxide. Here a reduction of the total annual emissions in the survey area of about one third can be expected.

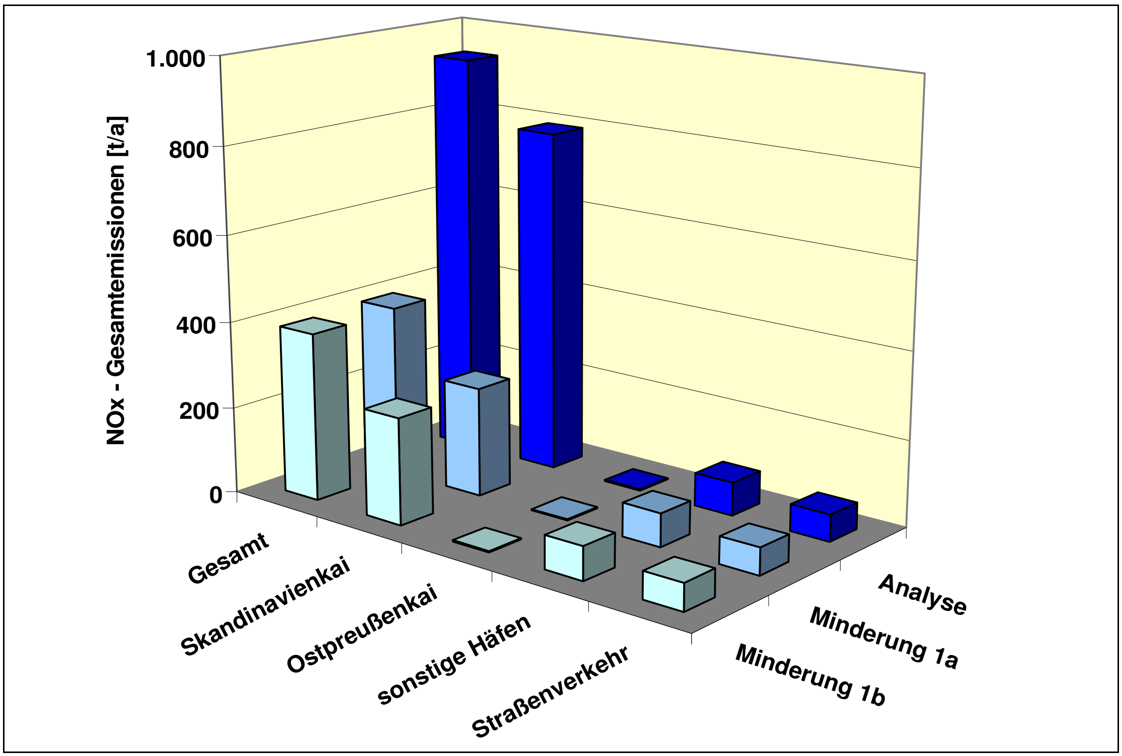
To sum up, the installation of an electricity supply proves to be an effective means of reducing the emission of pollutants into the air, especially as these improvements are in the immediate neighbourhood of the areas which are most affected by air pollutants. The limitation of the sulphur content to a maximum of 1% would further reduce sulphur dioxide emissions considerably.

Table 25: Total emissions in the survey area under consideration of concepts for reduction 1a/b and 2 (tonnes per year)

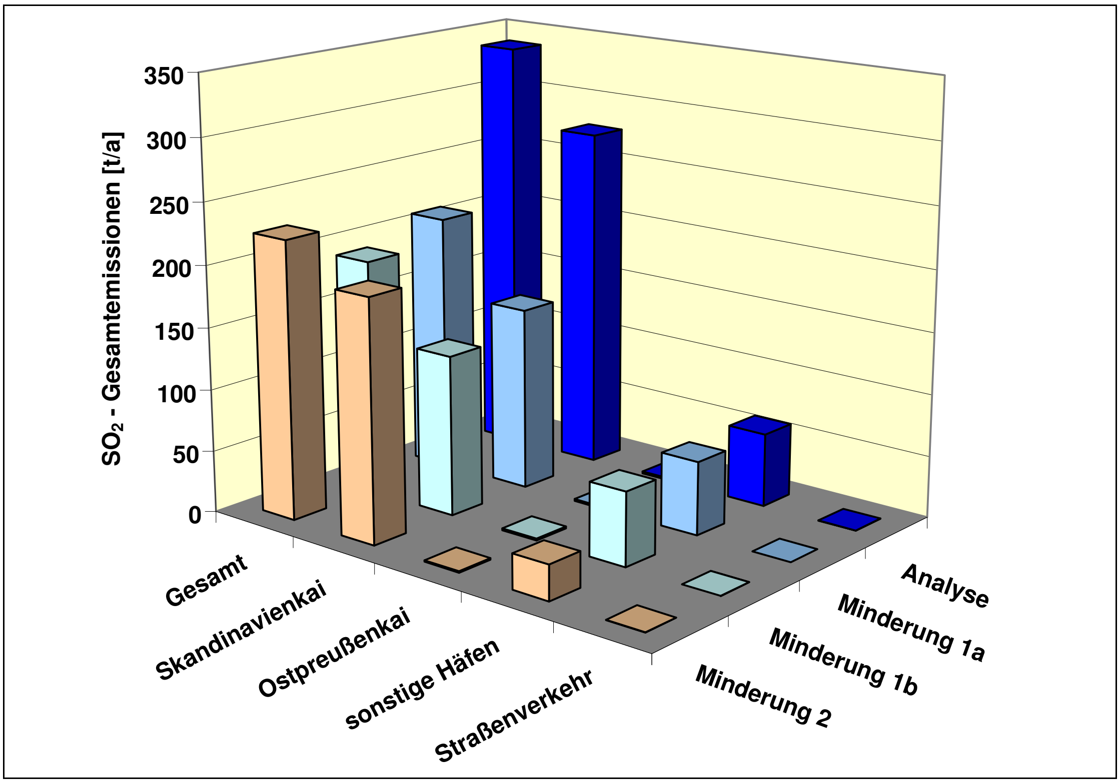
Port	Total emissions in the survey area per year [t/a]					
	CO_2	NOx	SO_2	Benzole	PM_{10}	soot
Analysis						
Skandinavienkai	46.493	793,7	276,6	1,186	54,12	21,65
Ostpreußenkai	201	2,9	1,6	0,006	0,25	0,10
Other ports	4.667	76,9	59,4	0,133	10,39	4,16
Road traffic	14.683	61,9	0,07	0,293	21,51	0,84
total	66.043	935,5	337,6	1,619	86,26	26,74
Concept for reduction 1a						
Skandinavienkai	16.774	252,4	148,0	0,538	31,94	12,78
Ostpreußenkai	201	2,9	1,6	0,006	0,25	0,10
Other ports	4.667	76,9	59,4	0,133	10,39	4,16
Road traffic	14.683	61,9	0,07	0,293	21,51	0,84
Total	36.324	394,2	209,1	0,971	64,09	17,87
Reduction vs. Analysis	-45 %	-58 %	-38 %	-40 %	-26 %	-33 %
Concept for reduction 1b						
Skandinavienkai	14.956	246,6	129,7	0,516	31,08	12,43
Ostpreußenkai	201	2,9	1,6	0,006	0,25	0,10
Other ports	4.667	76,9	59,4	0,133	10,39	4,16
Road traffic	14.683	61,9	0,07	0,293	21,51	0,84
Total	34.507	388,4	190,7	0,949	63,22	17,52
Reduction vs. Analysis	-48 %	-58 %	-44 %	-41 %	-27 %	-34 %
Concept for reduction 2						
Skandinavienkai	46.493	793,7	195,1	1,186	54,12	21,65
Ostpreußenkai	201	2,9	1,3	0,006	0,25	0,10
Other ports	4.667	76,9	28,4	0,133	10,39	4,16
Road traffic	14.683	61,9	0,07	0,293	21,51	0,84
total	66.043	935,5	224,8	1,619	86,26	26,74
Reduction vs. Analysis	0 %	0 %	-33 %	0 %	0 %	0 %

In the following, of the six estimated emissions mentioned above given above only the illustrations for NOx, SO_2 and PM_{10} are cited. The illustrations for the other emission paths can be found in the appendix.

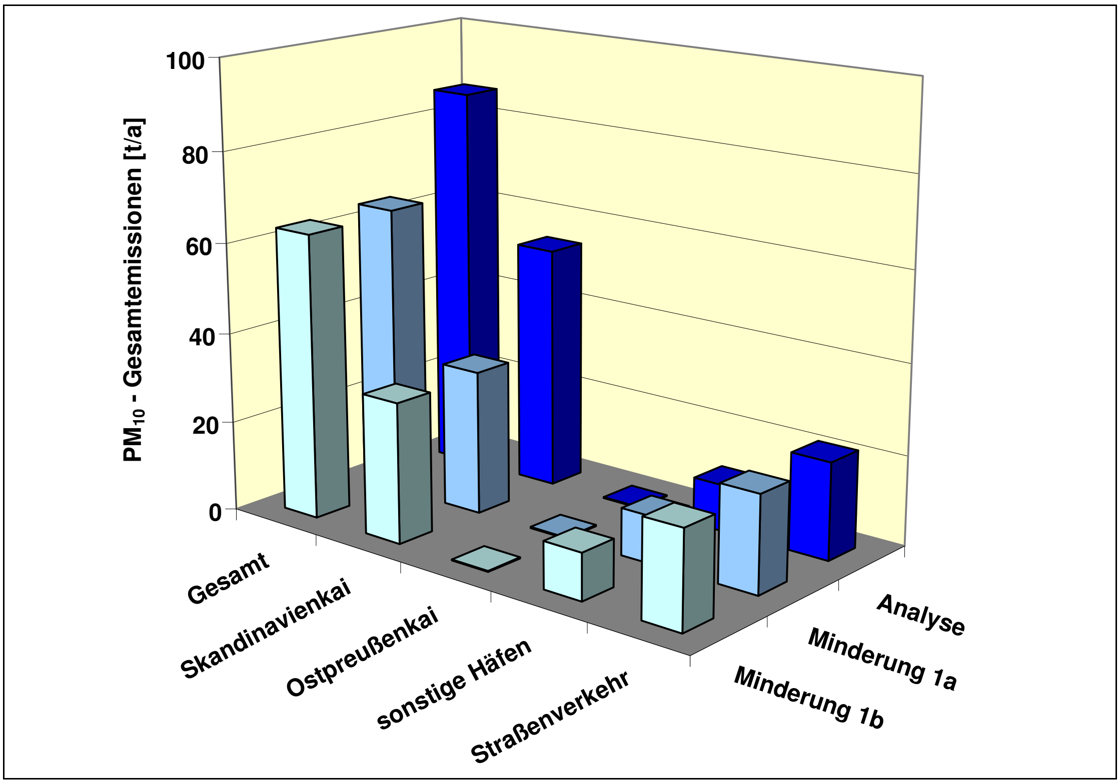
Picture 20: Total emissions of nitrogen oxide caused by shipping and road traffic in the survey area (t/a), taking the concepts of reduction into consideration



Picture 21: Total emissions of sulphur dioxide caused by shipping and road traffic in the survey area (t/a), taking the concepts of reduction into consideration



Picture 22: Total emissions of particle matter (PM_{10}) caused by shipping and road traffic in the survey area (t/a), taking the concepts of reduction into consideration



5.5.16.2 Prognosis

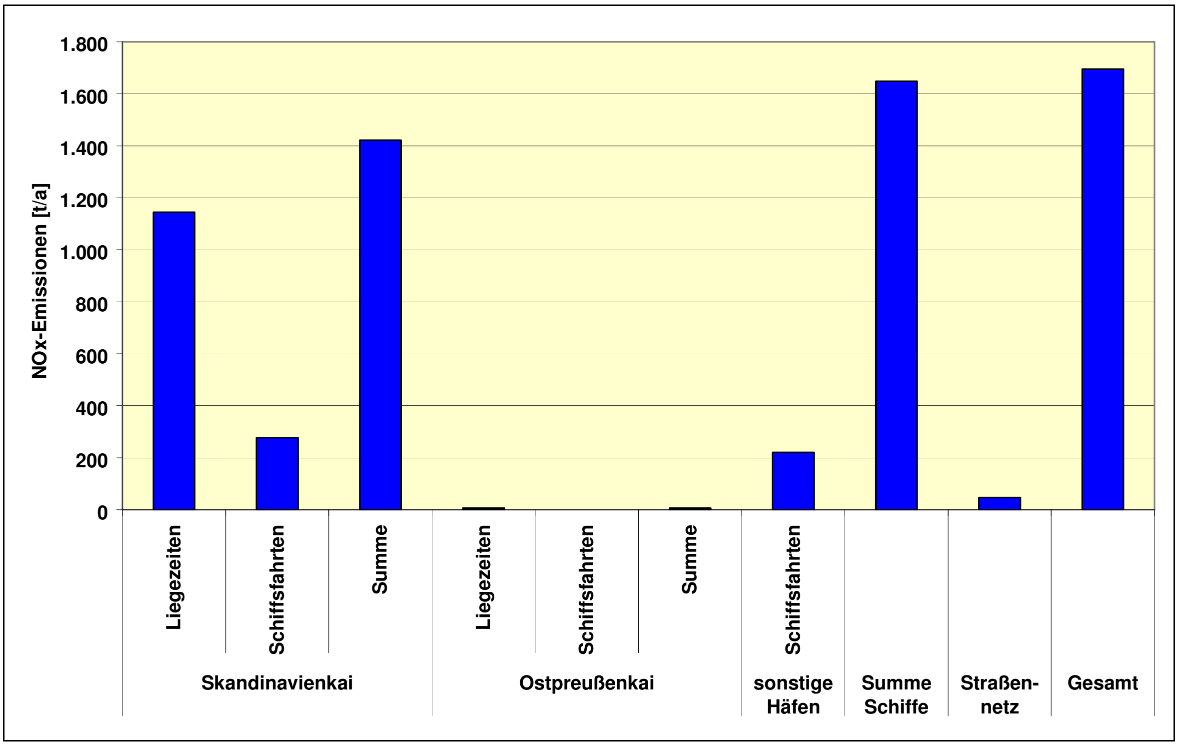
The total of emissions for the year of prognosis 2010 in the survey area is given in table 5 and in the pictures 14 to 19. A differentiation was made here, as in the analysis, according to the separate source sectors. The following results are to be noted:

- Considerable increases in the total emissions in the survey area are prognosed, in contrast with the state of analysis. This is caused by additional ships´ movements and times at berth. The increases are within a scale of 70 to 80% for carbon dioxide, nitrogen oxide and sulphur dioxide and of 35 to 40% for benzole, particle matter (PM_{10}) and diesel soot emissions.
- As in the analysis, emissions in the area of survey are determined mainly by the Skandinavienkai. For nitrogen oxide and sulphur dioxide, the proportion of the total sum of emissions is around 80 to 85%, for CO_2, benzole and diesel soot at about 75% and for particle matter (PM_{10}) at about 60%. The emissions during times at berth are decisive with about 65 to 80%, in contrast with ships´ movements from/to the Skandinavienkai with 20 to 35%. With reference to the total emissions within the survey area, the proportion of emissions during time at berth at the Skandinavienkai is c. 50 to 65%, for particle matter around 40%.
- Emissions at the Ostpreussenkai are insignificant for the total balance, but are however of interest locally.
- Ships´ movements on the Trave to other ports in Lübeck contribute between 10 to 20%, depending on which pollutant, to total emissions.
- The proportions from the road network in the survey area contributed to the annual total are highest for particle emissions (PM_{10}), with about 22%. The proportions for ben-

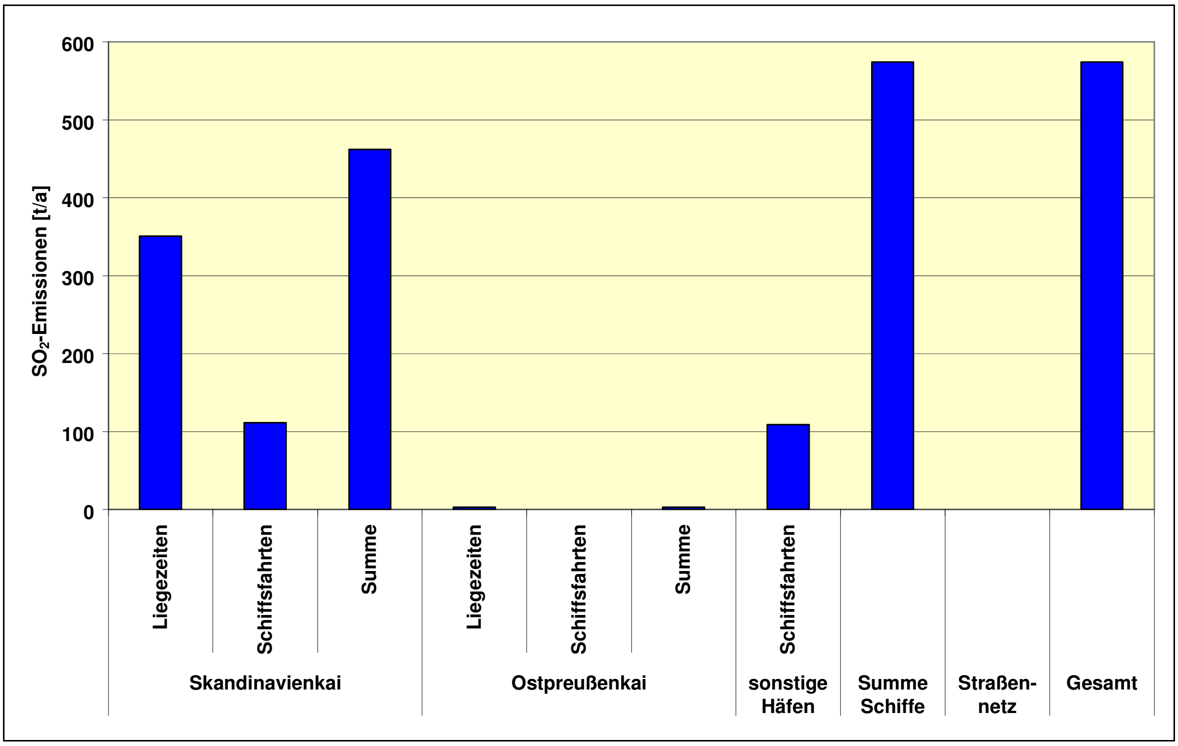
zole, NOx and diesel soot are 6% and lower. The proportion CO_2 is around 15%. Sulphur dioxide emissions from road traffic can be ignored.

According to these results, the greatest potential for reduction in the case of the prognosis, too, can clearly be seen as the limitation of the emission of pollutants during times at berth at the Skandinavienkai.

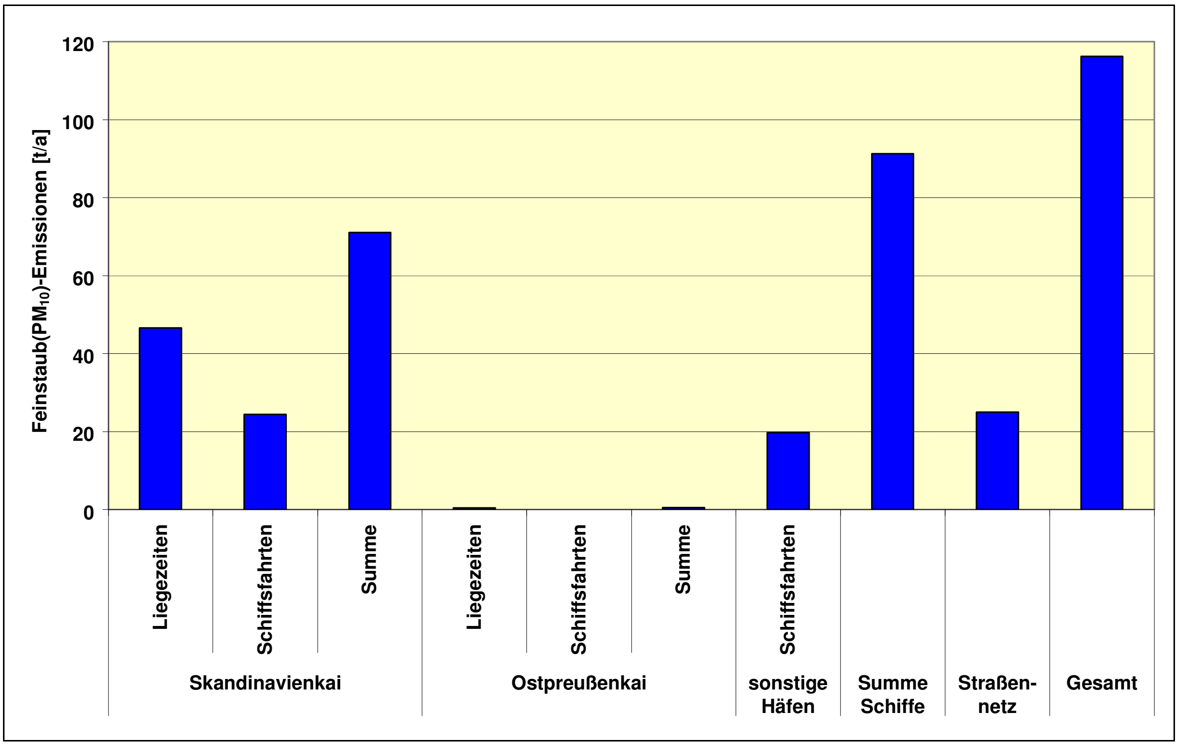
Picture 23: Total emissions of nitrogen oxide caused by shipping and road traffic in the survey area [t/a], prognosis



Picture 24: Total emissions of sulphur dioxide caused by shipping and road traffic in the survey area [t/a], prognosis



Picture 25: Total emissions of particle matter (PM_{10}) caused by shipping and road traffic in the survey area [t/a], prognosis



5.5.16.3 Prognosis together with concepts for reduction

The total emissions measured in the prognosis and those expected when the concept for reduction 1a/1b (shore-side electricity supply), 3 (limitation of sulphur content during times at berth) and combinations of 1 and 3 are listed in table 6. Detailed lists can be found in appendix LA3.13. Illustrations can be seen in pictures 20 to 25. The following results must be noted:

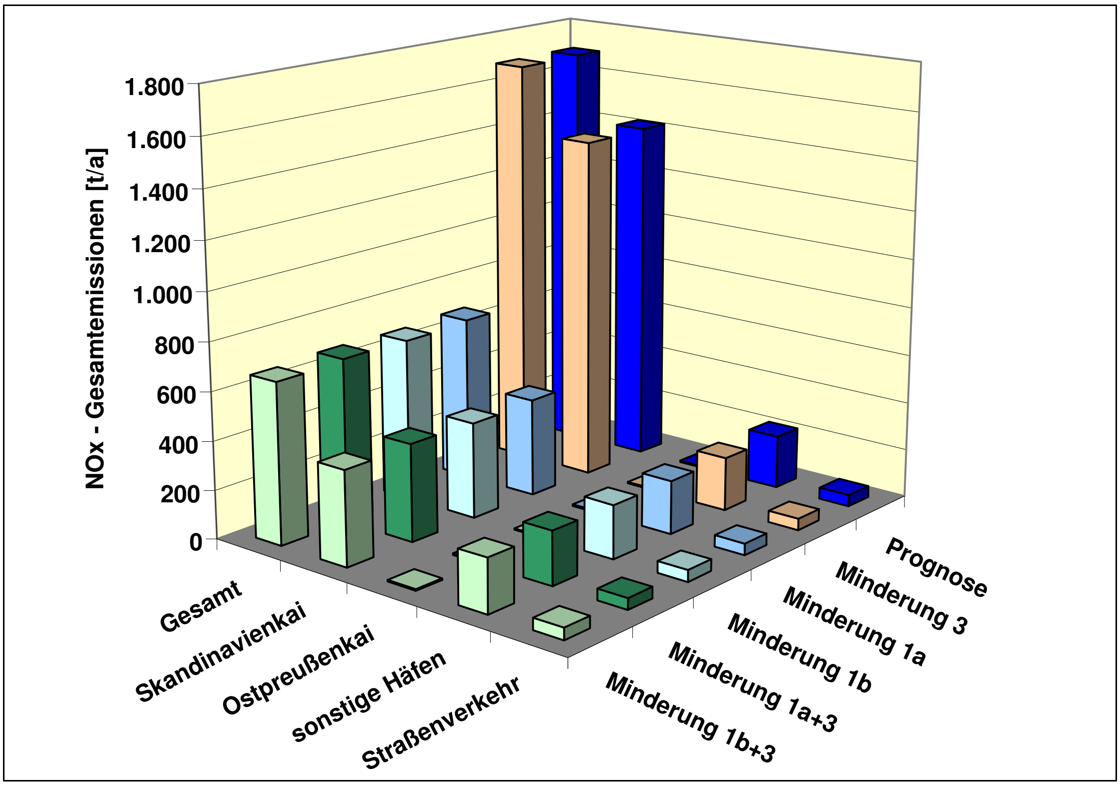
- **Concept for reduction 1 (shore-side electricity supply):** when the concepts 1a/1b are taken into consideration, reductions of 40 to 45% can be expected in the annual emissions of carbon dioxide, sulphur dioxide and benzole. Slightly higher reductions of just less than 60% are expected for nitrogen oxides. Particle matter (PM_{10}) and diesel soot will be reduced by around 25 to 35%. When the concepts 1a/1b are compared (auxiliary boilers in operation during times at berth with 10% / 1% performance), there are only slight differences from up to 6%.
- High reductions can be clearly seen for emissions in the area of the Skandinavienkai, in particular at the berths, with concepts 1a/1b. Reductions of 45 up to 70% can be expected in emissions caused by operations at the Skandinavienkai. When one considers only berthing times, considerable reductions between 70 and 90% can be expected.
- **Concept of reduction 3:** limitation of the sulphur content in fuels during times at berth to max. 0.1% leads to reductions worth mentioning only for emissions of sulphur dioxide. Here a reduction of the total annual emissions in the survey area of about one half can be expected. For other pollutants the reductions are around 5% and less.
- **Concept for reduction 1a + 3:** the combination of concepts 1a and 3 leads to comparable reductions as in concept 1a apart from sulphur dioxide emissions. The sulphur dioxide emissions sink by 12 % points in contrast to concept 1a, so that compared with the state of prognosis without any measures for reduction there is a lowering of about 60%.
- **Concept for reduction 1b + 3:** in comparison with the combination 1a + 3 only slight reductions of up to 3 % points can be expected here in contrast with the state of prognosis.

To sum up, the installation of an electricity supply proves to be an effective means of reducing the emission of pollutants into the air, especially as these improvements are in the immediate neighbourhood of the areas which are most affected by air pollutants. The limitation of the sulphur content to a maximum of 0.1% during times at berth would further reduce sulphur dioxide emissions considerably.

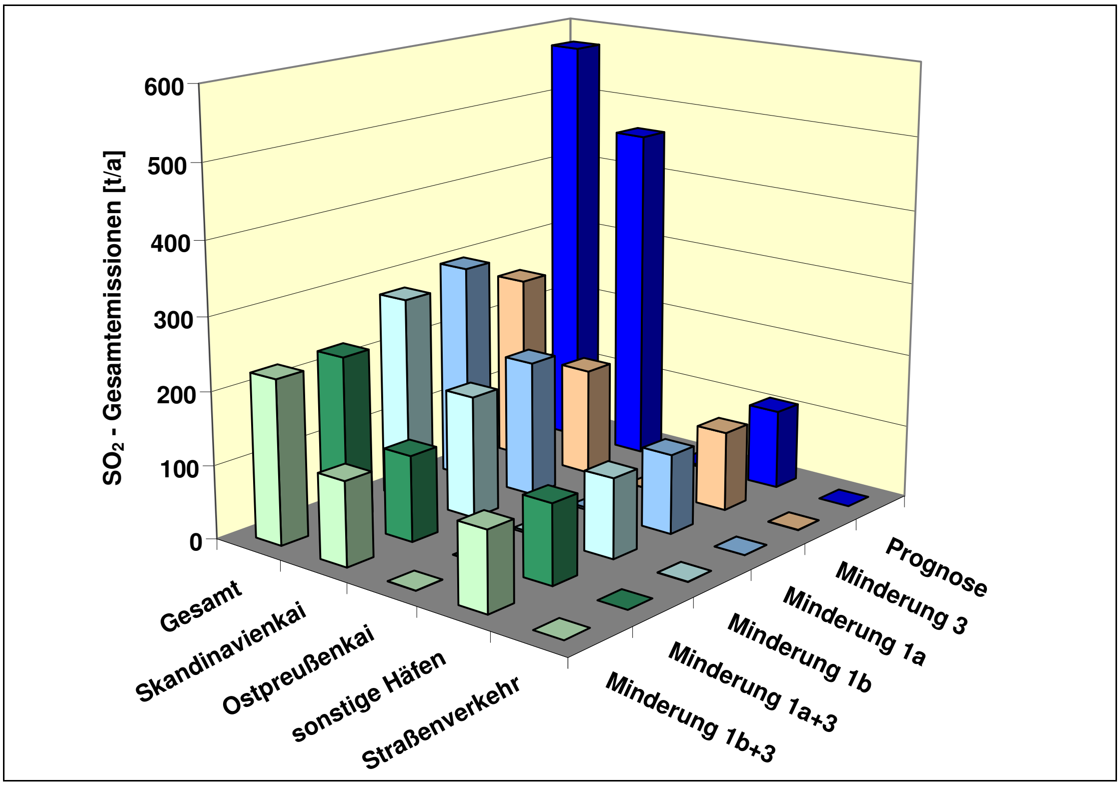
Table 26: Total emissions in the survey area under consideration of the concepts for reduction 1a/b and 2 (tonnes per year)

Hafen	Gesamtemissionen im Untersuchungsgebiet pro Jahr [t/a]					
	CO_2	NOx	SO_2	Benzol	PM_{10}	Ruß
Prognose						
Skandinavienkai	80.506	1421,2	462,1	1,735	71,02	28,33
Ostpreußenkai	437	6,4	3,0	0,013	0,49	0,19
sonstige Häfen	13.267	220,0	108,8	0,376	19,78	7,87
Straßenverkehr	16.312	47,4	0,08	0,137	24,94	0,65
Gesamt	110.522	1695,0	574,0	2,261	116,22	37,05
Minderungskonzept 1a						
Skandinavienkai	27.222	405,1	187,1	0,828	38,66	15,39
Ostpreußenkai	437	6,4	3,0	0,013	0,49	0,19
sonstige Häfen	13.267	220,0	108,8	0,376	19,78	7,87
Straßenverkehr	16.312	47,4	0,08	0,137	24,94	0,65
Gesamt	57.238	679,0	298,9	1,354	83,85	24,10
Minderung vs. Prognose	-48 %	-60 %	-48 %	-40 %	-28 %	-35 %
Minderungskonzept 1b						
Skandinavienkai	24.150	395,4	167,8	0,791	37,20	14,81
Ostpreußenkai	437	6,4	3,0	0,013	0,49	0,19
sonstige Häfen	13.267	220,0	108,8	0,376	19,78	7,87
Straßenverkehr	16.312	47,4	0,08	0,137	24,94	0,65
Gesamt	54.166	669,3	279,6	1,317	82,40	23,52
Minderung vs. Prognose	-51 %	-61 %	-51 %	-42 %	-29 %	-37 %
Minderungskonzept 3						
Skandinavienkai	80.290	1416,9	148,4	1,735	66,50	26,55
Ostpreußenkai	435	6,4	0,4	0,013	0,43	0,17
sonstige Häfen	13.267	220,0	108,7	0,376	19,78	7,87
Straßenverkehr	16.312	47,4	0,08	0,137	24,94	0,65
Gesamt	110.304	1690,7	257,5	2,261	111,65	35,24
Minderung vs. Prognose	0 %	0 %	-55 %	0 %	-4 %	-5 %
Minderungskonzept 1a+3						
Skandinavienkai	27.008	400,9	117,6	0,828	34,18	13,62
Ostpreußenkai	435	6,4	0,4	0,013	0,43	0,17
sonstige Häfen	13.267	220,0	108,7	0,376	19,78	7,87
Straßenverkehr	16.312	47,4	0,08	0,137	24,94	0,65
Gesamt	57.022	674,7	226,8	1,354	79,32	22,31
Minderung vs. Prognose	-48 %	-60 %	-60 %	-40 %	-32 %	-40 %
Minderungskonzept 1b+3						
Skandinavienkai	23.915	391,2	115,7	0,791	32,72	13,04
Ostpreußenkai	435	6,4	0,4	0,013	0,43	0,17
sonstige Häfen	13.267	220,0	108,7	0,376	19,78	7,87
Straßenverkehr	16.312	47,4	0,08	0,137	24,94	0,65
Gesamt	53.929	665,0	224,8	1,317	77,86	21,73
Minderung vs. Prognose	-51 %	-61 %	-61 %	-42 %	-33 %	-41 %

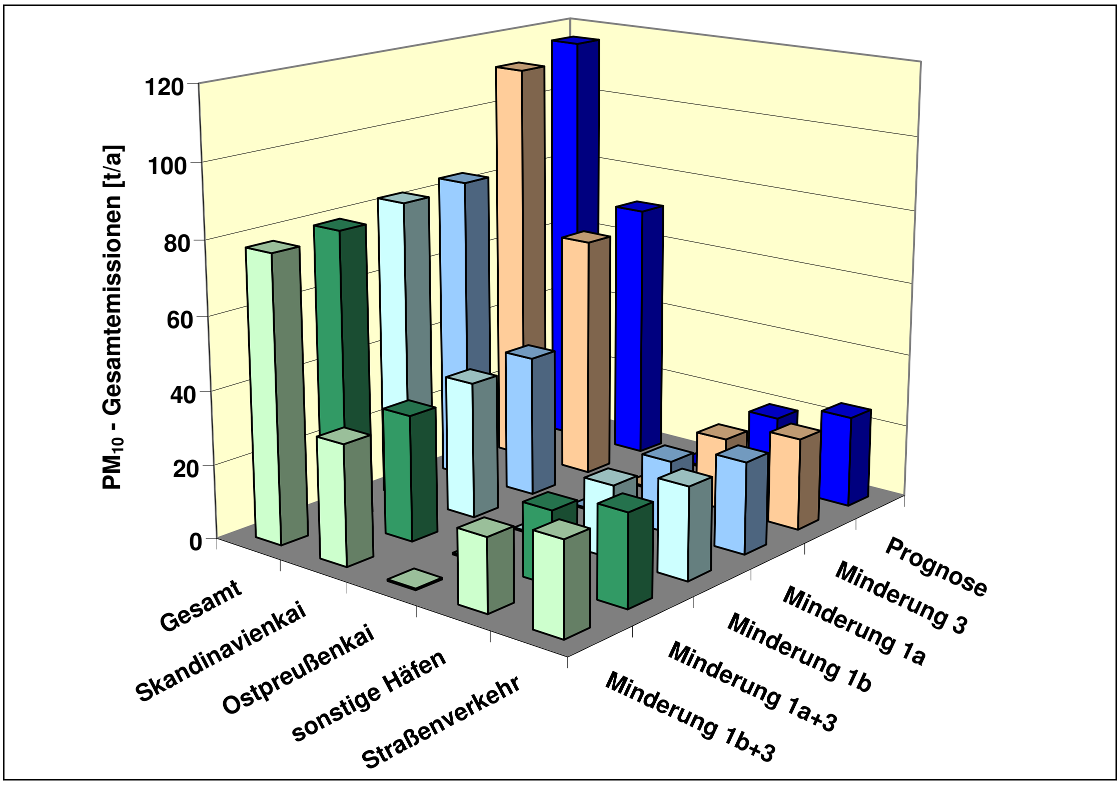
Picture 26: Total emissions of nitrogen oxides caused by shipping and road traffic in the survey area (t/a), taking the concepts of reduction into consideration



Picture 27: Total emissions of sulphur dioxides caused by shipping and road traffic in the survey area (t/a), taking the concepts of reduction into consideration



Picture 28: Total emissions of particle matter (PM_{10}) caused by shipping and road traffic in the survey area (t/a), taking the concepts of reduction into consideration



5.5.17 Summary and Evaluation

Within the scope of this survey, a prognosis was made of the air pollution caused by shipping in the area of the Skandinavienkai in Lübeck-Travemünde, and measures for potential reduction were considered. The wide road network within the area of survey was also included in order to determine the total pollution. Other sources were deemed insignificant, with only a slight contribution to the sum total of emissions. This had already been determined during the previous surveys made for the expansion of the Skandinavienkai.

The prognosis of imissions was carried out with the model AUSTAL2000 taking the annual sequences of the emissions as a basis. The input data and parameters were tested for plausibility in preliminary checks. In addition, the influence of varying meteorological conditions for different years was tested. At the end of 2003 under the Office of the Supervision of the Air in Schleswig-Holstein a series of measurements in the area of the Skandinavienkai was taken. In this the pollution from nitrogen dioxide and sulphur dioxide were measured in the annual mean. Reliable results however are not jet available so that at present it is not jet possible to calibrate the calculation model. In comparison with previous results and data from measurements taken in 2000, it appears that the calculation model shows sufficient credibility.

First of all it must be said that in the area of the Skandinavienkai and the Trave, the pollution caused by shipping and ships at berth is quite clearly to be seen.

It can however be assumed that the present imission limitations for the protection of the population are being kept to in all important areas. This also goes for the increases expected in the prognosis for 2010 after the expansion of the Skandinavienkai. As well as this the stricter standards regarding the status of Travemünde as a "marine spa" must be pointed out. In the present investigations the following idealised concepts for reduction of air pollutants emitted by ships were tested:

- Concept for reduction 1: supply of shore-side electricity for ships at the Skandinavienkai making the operation of auxiliary units on board superfluous: this was assumed for all ships during time at berth
- Concept for reduction 2: limitation of the sulphur content in fuels to a max. of 1% for all ships/ships´ units on the Trave and in the vicinity of the mouth of the Trave
- Concept for reduction 3: limitation of the sulphur content in fuels for all ships and ships´ units to a max. of 0.1% during times at berth (use of marine gas oil (MGO)).

The state of analysis (pollution in 2003) and the state of prognosis (prognosis 2010) were both included in this.

In summing up it can be said that the continuous operation of ships´ units during times at berth at the Skandinavienkai have considerable influence on the pollution in the survey area, both emissions and also imissions. Measures for reduction such as the provision of shore-side electricity are therefore concepts offering a high potential for reduction. Sulphur dioxide and nitrogen oxide pollution especially can be quite clearly reduced. Reductions can be measured even in areas further away from the Skandinavienkai.

Limitation of the sulphur content has an important effect only on the sulphur dioxide pollution. A measurable reduction in sulphur dioxide pollution can be achieved over a wide area with a limitation of 1%. Limiting the sulphur content to 0.1% during times at berth also leads to a reduction worth mentioning only in the sulphur dioxide pollution. A combination of this limitation and the shore-side electricity supply would only bring slight further improvements, as in this case ships´ engines are practically not in operation at all during times at berth. But as long as a shore-side electricity supply is not being used by all ships, a limitation of the sulphur content in fuels is one suitable measure for lowering at least the sulphur dioxide emissions and imissions considerably.

5.6 Calculation of emission of pollutants with the program MARION [28]

Originally it was intended to use a program commissioned by the UBA in order to calculate the emissions caused by ships in Lübeck-Travemünde. This program was meant to take "single ships" as its basis, i.e. data should not be used for ships wholesale as had been the case. Individual ships data were to be combined with their actual movements in coastal waters and at sea, in order to gain reliable information on the emissions. The functionality of the program could be confirmed in a practical test using data made available by Bremerhaven. The program however was hardly used after that for two reasons: as the pollution caused by ships still went almost entirely unnoticed by the public there was no call for these results and even if at first there was the chance that the program could be used it turned out that the information needed as input data, in particular data on movements within the ports, was either not available or was in such a form (generally only a hardcopy) that made feeding it into the computer very time consuming. When using the program *MARION* for processing this study, the problem arose that the program originally did not take times at berth into consideration. The program was modified here so that the calculations could be carried out.

[28] Umweltrelevantes Informations- und Analysesystem für den Seeverkehr, - Hansestadt Bremisches Hafenamt

5.6.1 Calculation of NOx and SO_2 emissions from ships in port and moving in Lübeck and Travemünde

In this study of emissions, emissions caused by shipping at berth and under way from and to Lübeck and Travemünde are to be calculated. The emissions of NOx, SO2, CO, HC and VOC from 41 separate ships at six quays in Lübeck and Travemünde and on one journey of each of these ships from Lübeck or Travemünde to buoy 5 on the "Lübeck-Gedser route" are to be examined. buoy 5 lays c. 23 nm in front of Travemünde. Information on the times at berth was taken from the statistics of the shipping traffic service.

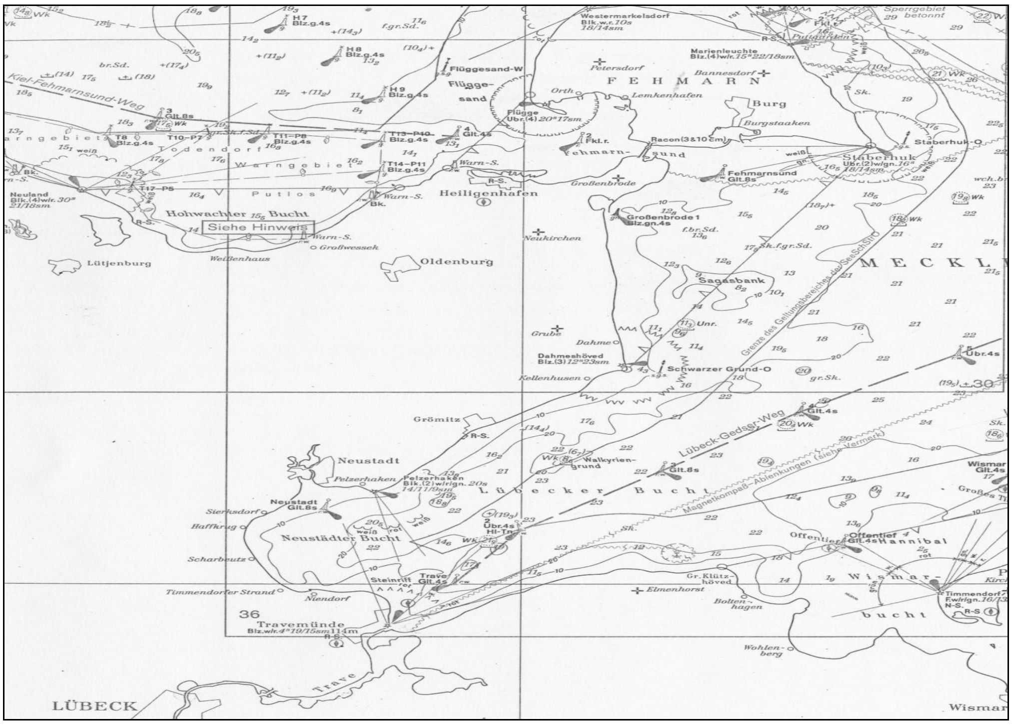
After analysing the data and consulting the relevant experts in the administrative bodies it can be seen that the ferry traffic examined here makes up at least 95% of the total shipping traffic in Lübeck-Travemünde.

The ships´ data needed for the calculations was supplied by GAUSS i.e. either taken from publications (e.g. Lloyds register) or obtained from the shipping companies. The relevant berthing times at the quays were also supplied by GAUSS or taken from the timetables of the different companies. With respect to the estimation for the projection it must be said that there are often changes in timetables at short notice and that ships sometimes change berth, and neither of these could be considered.

Bearing other imponderables in mind however (emissions from the use of auxiliary boilers in port) they are hardly of importance. The following 6 quays were taken into consideration for calculating traffic at berth:

- Nordlandkai, Lübeck
- Konstinkai, Lübeck
- Schlutupkai, Lübeck
- Container Terminal Lübeck
- Skandinavienkai, Travemünde
- Lehmannkai 1 – 4, Lübeck

Picture 29: Extract from the chart (Lübecker Bucht)



5.6.2 Emissions caused by shipping

When considering emissions caused by shipping a differentiation must be made between a ship moving or at berth, as the emissions depend on the operational state of the ship. When the ship is at berth, generally only the auxiliary units are needed for the supply of electricity, etc. on board and for load and discharge operations in port.

For a ship in motion, generally both the main engines and the auxiliary engines are in operation. The type and amount of pollutants emitted, whether the ship is still (i.e. at berth) or moving, depend directly on the efficiency and design of the engines, the “direct engine management system” (revolutions, temperature, etc.), the condition of the engines and the fuel used. This goes both for the main engines and the auxiliary diesels. Nitrogen oxide emissions are directly dependant on the configuration of the engines and the engine management system. The influence of the fuel used plays only a small part here. On the other hand, emissions of sulphur dioxide are in direct proportion to the sulphur content of the fuel. It is less dependant on the configuration of the engines and running condition.

5.6.3 General approach to calculations

The calculations of emissions here are based on the *MARION* system [B1]. Balances of emissions here are based on data from individual ships. In order to find these balances of pollutants in the marine environment, *MARION* uses mean values or estimated values only when detailed data on ships or ships´ movements is not available. Most importantly it is tried to use the data of individual ships (use of “single ship approach”).

When considering the „single ship approach” firstly two terms are calculated independently from each other:

- The traffic term (characterises the ships duration of stay or the distance covered by sea)
- Te emission term (shows the emission caused by a ship per time unit of the duration of stay or per length of the covered distance)

The total emissions caused by a single ship are calculated by connecting the traffic term with the emission term.

Emissions of single ship = traffic term * Emission term

Mathematically specified following relationship results for the calculation of emissions *Ei* for each single ship *i*:

$$E_i = \int_0^{\tau_i} E_i(t)\,dt \qquad [t]$$

The total emissions for a defined time span in a specified area to be looked at result from the sum of the emissions from single ships *Ei.*

$$E = \sum_{i=1}^{N} E_i = \sum_{i=1}^{N} \int_0^{\tau_i} \dot{E}_i(t)\,dt \qquad [t]$$

As a rule though, the emission rates dependant upon time will not be available. Ten it is expected in the "single ship approach" that a mean value for time is known for each ship *i*:

$$\left\langle \dot{E}_i(t) \right\rangle_t \equiv \dot{E}_i$$

So the following „working equations"are:

$$E_i = \dot{E}_i * \tau_i$$

and

$$E = \sum_{i=1}^{N} E_i = \sum_{i=1}^{N} \dot{E}_i * \tau_i$$

5.6.3.1 Method of finding a way to calculate the emissions caused by ships in motion

The emission rate of a ship, depending on the different kinds of emissions like NOx, SO_2, CO, HC or VOC is found with the help of mean values. For the emission of air pollutants an emission factor is used which is essentially defined in two ways, namely over the drive of a ship or the fuel used by the ship. In this calculation the information on the drive of a ship is being used.

The efficiency of a ship is defined by the total efficiency of the main engine/s and the total efficiency of the auxiliary engines. The total efficiency of the main engines is set up for the normal continuous use at sea with 85% of the named efficiency. The total efficiency of the auxiliary engines in the normal continuous use at sea is given at 35% of the named efficiency. For the traffic going to and from Travemünde, these input parameters are used. The route is calculated for each ship individually up to buoy 5 on the "Lübeck-Gedser route". Buoy lies c. 23nm in front of Travemünde. Times needed for manoeuvring, like docking and leaving berth, movements to/from other berths etc. are not considered as there is little information available on these.

$$\dot{E}_{i,Schadstoffart} = \begin{bmatrix} P_{i,Hauptmaschine} * 0{,}85 * e_{i,Schadstoffart,Hauptmaschine} + \\ P_{i,Hilfsmaschine} * 0{,}3 * e_{i,Schadstoffart,Hilfsmaschine} \end{bmatrix}$$

The movement on the Trave is being calculated separately for those ships travelling to Lübeck on the river. It is assumed that the main engine is run at 35% of the total efficiency on the river. The efficiency for the auxiliary units is assumed at 30% of the named efficiency. These input parameters are used for the traffic going to Lübeck.

The distance between Lübeck and Travemünde is about 12 nm. On rivers ships move on average with a speed of about 8 knots and so they have to travel for c. 1.5 hours to cover this distance. For movements from Schlutupkai to the mole at Travemünde, a distance of 6 nm is assumed. Times for manoeuvring, such as docking and leaving, movements from/to the berths, etc. are not included here. Data on the efficiency of the main and auxiliary engines was taken from Lloyds register.

$$\dot{E}_{i,Schadstoffart} = \begin{bmatrix} P_{i,Hauptmaschine} * 0{,}35 * e_{i,Schadstoffart,Hauptmaschine} + \\ P_{i,Hilfsmaschine} * 0{,}3 * e_{i,Schadstoffart,Hilfsmaschine} \end{bmatrix}$$

As it is necessary to know the type of fuel in order to define the emission factors ei, and as HFO is mainly used at sea, HFO was taken as a rule for the calculation of the amount of emissions, although the auxiliary engines are run mainly on MDO or MGO.

Many ships change from using HFO to diesel for the main engines while moving in local waters. As it is not known, however, how many/which ships change from using HFO to diesel, it is assumed as generally further calculations that only HFO is used (conservative approach). Information given by the shipping companies on which fuel was used was taken into consideration where available. Otherwise this information was taken from Lloyds register.

For the calculations, a fuel consumption of 190g/kWh was taken as the average. The emission factor ei for SO_2 is in direct proportion to the sulphur content of the fuel. An emission factor ei of 12g/kWh SO_2 was assumed for the use of HFO for the main engines. For the auxiliary engines running on MDO or MGO, an emission factor ei of 1.3g/kWh was assumed.

The emission factor ei for NOx is not dependant on the fuel but on the design of the engines. Here a mean value of 12g/kWh NOx was assumed for the main and auxiliary engines. Any uses of measures to reduce NOx were not assumed.

Table 27: Emission factors *Ei* according Hadler / Goetze [B2]

Type of ship	Main engine		Auxiliary engine	
	SO_2 [g/kWh]	NO_X [g/kWh]	SO_2 [g/kWh]	NO_X [g/kWh]
Up to 500 BRT	1,3	12	1,3	12
Up to 1000 BRT	4,0	12	1,3	12
over 1000 BRT	12,0	12	4,0	12

The emission factor Ei at CO is assumed at 1.6g/kWh, for CO_2 at 600g/kWh, for HC at 0.5g/kWh and for VOC at 0.4g/kWh.

Table 28: Emission factors for different pollutants

Emission	**g/kWh**	**Source**
CO	1,6	[M3][29]
CO_2	660	[M3]
HC	0,5	[M3]
VOC	0,4	[M4]

Calculation of air pollutants from individual ships is derived from the duration of the ships´ movement í with the rate of emissions.

$$E_{i,Schadstoffart} = \left\langle \dot{E}_{i,Schadstoffart} \right\rangle * \left\langle \tau_i \right\rangle$$

The total emissions of ships traffic under way is achieved by the sum of individual ships´ emission of pollutants into the air.

5.6.3.2 Method of determination for the calculation of emission caused by ships at berth

To determine the emission of shipping "at rest", meaning times at berth, it is assumed that the main engines are not in operation and that the auxiliary engines are running at 50% of their full capacity.

The electricity is needed for operations on board, electric units, hydraulics and heating/cooling systems. How much performance the engines must reach on each ship however depends on the particular circumstances on board. It cannot be denied that in a few cases the main engines (especially diesel electric drive) may be in operation the whole time at berth. This possibility, however, is not taken into consideration here. The engine performance is given as 30% with diesel electric drive.

$$\dot{E}_{i,Schadstoffart} = \left[P_{i,Hilfsmaschine} * 0,5 * e_{i,Schadstoffart,Hilfsmaschine} \right]$$

[31] The sources, illustrations etc. marked with „M" are not part of this report, they are part of the complete *MARION* survey in the appendix

and/or

$$\dot{E}_{i,Schadstoffart} = \left[P_{i,Haupt,Dieselel.} * 0{,}3 * e_{i,Schadstoffart,Haupt,Dieselel.} \right]$$

The calculation of the emission of pollutants by individual ships results from the duration of stay of the individual ship i at each quay with the rate of emission. The times at berth in each case were either supplied by GAUSS or taken from the relevant ships´ timetable.

$$E_{i,Schadstoffart} = \left\langle \dot{E}_{i,Schadstoffart} \right\rangle * \left\langle \tau_i \right\rangle$$

By adding up the emissions of each individual ship at each quay, the total sum of emissions from shipping "at rest" (i.e. at berth) at the quays can be obtained.

5.6.4 Boiler emissions

In this survey, emissions from auxiliary boilers could not be determined as data on auxiliary boilers already installed was not available. A purely statistical evaluation on the basis of analogy with other ships (ships´ data) could not be carried out either because at present not enough data on auxiliary boilers exists.

5.6.5 Distribution of shipping among the quays listed in chapter 5

The following ships dock regularly at the quays listed in chapter 5:

Table 29: The ships taken for the calculation of emissions using *MARION*

Name of ship	quay	berth
Serenaden	Container Terminal Lübeck	CTL
Longstone	Konstinkai	KK6
Birka Ex./Tr./Sh..	Konstinkai	KK6
Friedrich Russ	Konstinkai	KK8
Beachy Head	Konstinkai	KK8
Vilnius	Lehmannkai	Lkai 1
Mermaid II, jetzt Finnmaid	Lehmannkai	Lkai 1
Baltic Press	Lehmannkai	Lkai 2
Vasaland ex Oihonna	Nordlandkai	VH1
Aurora ex Arcturus	Nordlandkai	VH1
Translubeca	Nordlandkai	VH1
Transfinlandia	Nordlandkai	VH1
Finnhawk	Nordlandkai	VH2
Finnmill	Nordlandkai	VH2
Finnpulp, ex Finncarrier	Nordlandkai	VH2
Transgard	Nordlandkai	VH4
Bremer Uranus	Nordlandkai	VH4
Stena Forecaster	Schlutupkai	Schlutup 2

Helena	Schlutupkai	Schlutup 2
Viola Gorthon	Schlutupkai	Schlutup 2
Antares ex Finnforest	Skandinavienkai	Skai 3
Bore Nordia	Skandinavienkai	Skai 3
Kaptan Burhanetin Isim	Skandinavienkai	Skai 3
Ask	Skandinavienkai	Skai 3
Finnhansa	Skandinavienkai	Skai 4
Finn Arrow	Skandinavienkai	Skai 4
Finnfellow ex Stena Britannica	Skandinavienkai	Skai 4
Finntrader	Skandinavienkai	Skai 5
Transeuropa	Skandinavienkai	Skai 5
Finnpartner	Skandinavienkai	Skai 5
Nils Holgersson	Skandinavienkai	Skai 6a
Peter Pan	Skandinavienkai	Skai 6a
Robin Hood	Skandinavienkai	Skai 6a
Nils Dacke	Skandinavienkai	Skai 6a
Malmo Link, ex Finnhawk	Skandinavienkai	Skai 7
Lübeck Link ex. Finnrose	Skandinavienkai	Skai 7
Götaland	Skandinavienkai	Skai 7
Stena Freighter	Skandinavienkai	Skai 7a
Stena Carrier	Skandinavienkai	Skai 7a
Finnrider, ex Railship II	Skandinavienkai	Skai 8
Finnrunner, ex Railship III	Skandinavienkai	Skai 8

5.6.6 Results of calculations for shipping moving from Lübeck to Travemünde

For ships moving in local waters from Nordlandkai, Konstinkai, Schlutupkai and the container terminal Lübeck the following emissions were calculated for the month of July 2003.

- SO_2 13,36 t
- NO_X 15,94 t
- CO 2,12 t
- CO_2 877,15 t
- HC 0,66 t
- VOC 0,53 t

As the basis for this was data on ships´ movements from July 2003, in order to determine the total emissions of shipping moving from Lübeck to Travemünde for the whole year 2003, the results were multiplied by 12. It must be mentioned that this is a very conservative approach, as in the winter months passenger ferry traffic is less. The following emissions were thus determined for 2003:

- SO_2 160,33 t
- NO_X 191,37 t
- CO 25,51 t

- CO_2 10525,8t
- HC 7,97 t
- VOC 6,37 t

The results of individual calculations can be found in the appendix.

5.6.6.1 Results of calculations for shipping moving from the mole in Travemünde to sea buoy 5 “Lübeck-Gedser Route”

The following emissions were calculated for ships´ traffic from the mole in Travemünde to buoy 5 of the “Lübeck-Gedser Route” for the month of July 2003:

- SO_2 242,95 t
- NO_X 257,13 t
- CO 34,28 t
- CO_2 14142,20 t
- HC 10,71 t
- VOC 8,57 t

As here too the basis for this was data on ships´ movements from July 2003, in order to determine the total emissions of shipping moving from Travemünde to sea buoy 5 for the whole year 2003, the results were multiplied by 12. It must be mentioned here too that this is a very conservative approach, as in the winter months passenger ferry traffic is less. The following emissions were thus determined for 2003:

- SO_2 2915,46 t
- NO_X 3085,56 t
- CO 411,41 t
- CO_2 169706,5 t
- HC 128,56 t
- VOC 102,84 t

5.6.6.2 Results of calculations for ships at berth

The following emissions were calculated for ships at berth at the individual quays for the month July 2003:

Container Terminal, Lübeck

- SO_2 0,08 t
- NO_X 0,79 t
- CO 0,07 t
- CO_2 43,81 t
- HC 0,03 t
- VOC 0,02 t

Konstinkai, Lübeck

SO_2 1,47t
NO_X 13,59 t
CO 1,81 t
CO_2 747,97 t
HC 0,56 t
VOC 0,45 t

Schlutupkai, Lübeck

Skandinavienkai, Travemünde

- SO_2 0,60 t
- NO_X 5,56 t
- CO 0,74 t
- CO_2 306,33 t
- HC 0,23 t
- VOC 0,18 t

SO_2 8,98 t
NO_X 82,95 t
CO 11,06 t
CO_2 4562,40 t
HC 3,45 t
VOC 2,76 t

Lehmannkai, Travemünde

- SO_2 0,28 t
- NO_X 2,65 t
- CO 0,35 t
- CO_2 146,21 t
- HC 0,11 t
- VOC 0,08 t

Nordlandkai, Lübeck

SO_2 0,28 t
NO_X 2,65 t
CO 0,35 t
CO_2 146,21 t
HC 0,11 t
VOC 0,08 t

The following annual pollution levels were calculated as the average over 12 calendar months for the whole year 2003:

Container Terminal, Lübeck

- SO_2 1,03 t
- NO_X 9,55 t
- CO 0,95 t
- CO_2 525,76 t
- HC 0,39 t
- VOC 0,31 t

Konstinkai, Lübeck

SO_2 17,67 t
NO_X 163,19 t
CO 21,75 t
CO_2 8975,73 t
HC 6,79 t
VOC 5,43 t

Schlutupkai, Lübeck

- SO_2 7,24 t
- NO_X 66,83 t
- CO 8,91 t
- CO_2 3676,06 t
- HC 2,78 t
- VOC 2,22 t

Skandinavienkai, Travemünde

SO_2 107,83 t
NOX 995,43 t
CO 132,72 t
CO_2 54748,83 t
HC 41,47 t
VOC 33,18 t

Lehmannkai, Travemünde

- SO_2 3,45 t
- NO_X 31,90 t
- CO 4,25 t
- CO_2 1754,63 t
- HC 1,32 t
- VOC 1,06 t

Nordlandkai, Lübeck

SO_2 15,21 t
NO_X 182,22 t
CO 24,29 t
CO_2 10022,49 t
HC 7,59 t
VOC 6,07 t

The total emission of ships at berth at all quays was:

Table 30: Total emissions of ships at berth

For the month July 2003		For the year 2003	
SO_2	12,70 t	SO2	152,46 t
NO_X	117,27 t	NOX	1407,32 t
CO	15,63 t	CO	187,64 t
CO_2	6450,26 t	CO2	77403,12 t
HC	4,88 t	HC	58,63 t
VOC	3,90 t	VOC	46,91 t

5.6.6.3 Total results of calculations

Calculated total emissions of ships at berth at all quays and of the entire shipping traffic in motion for the year 2003:

Moving traffic			**+**	**Ships at berth**	**=**	**Total**
SO_2	=	2915,46 t	+	152,46 t	=	3067,92 t
	⇒	*[95 %*	+	*5 %*	=	*100 %]*
NO_X	=	3085,56 t	+	1407,32 t	=	4492,88 t
	⇒	*[68,7 %*	+	*31,3 %*	=	*100 %]*
CO	=	411,41 t	+	187,64 t	=	599,05 t
	⇒	*[68,7 %*	+	*31,3 %*	=	*100 %]*
CO_2	=	169706,5 t	+	77403,12 t	=	247109,62 t
	⇒	*[68,7 %*	+	*31,3 %*	=	*100 %]*
HC	=	128,56 t	+	58,63 t	=	187,19 t
	⇒	*[68,7 %*	+	*31,3 %*	=	*100 %]*
VOC	=	102,84 t	+	46,91 t	=	149,75 t
	⇒	*[68,7 %*	+	*31,3 %*	=	*100 %]*

The results of individual calculations can be found in the appendix.

6 Approaches for reduction of impacts for the environment

There are several different possibilities to reduce pollution caused by shipping. The most important ones, which are to be shown here, are technical and operational measures that have in niches already been put into force, that is, they have already been tested in reality. The at least theoretically existing possibility to ship traffic from the sea to land is not worth doing from the point of view of the shipping community and – under consideration of modern concepts for the protection of the environment when running ships – is also under consideration of aspects for the environment not wise. Measures where the potential for realisation in the near future is quite low, as e.g. the use of alternative energy, are also not considered here.

6.1 Possibilities for the reduction of harmful gaseous emissions

Gaseous harmful emissions caused by shipping correlate almost entirely to the fuel used, the consumption and the type of engine. The fuel consumption depends on different ship specific data, e.g. technical standard, efficiency and quality of the main and auxiliary engines, construction of the underwater part of the hull and the extent of growth at the hull respectively the water resistance, the efficiency of the propeller and the interaction of the parameters with the ships form. The maintenance of engine, propeller and the hull are also important. As well the given travelling speed has a great influence, as the consumption is magnified in the 3^{rd} exponent of the speed.

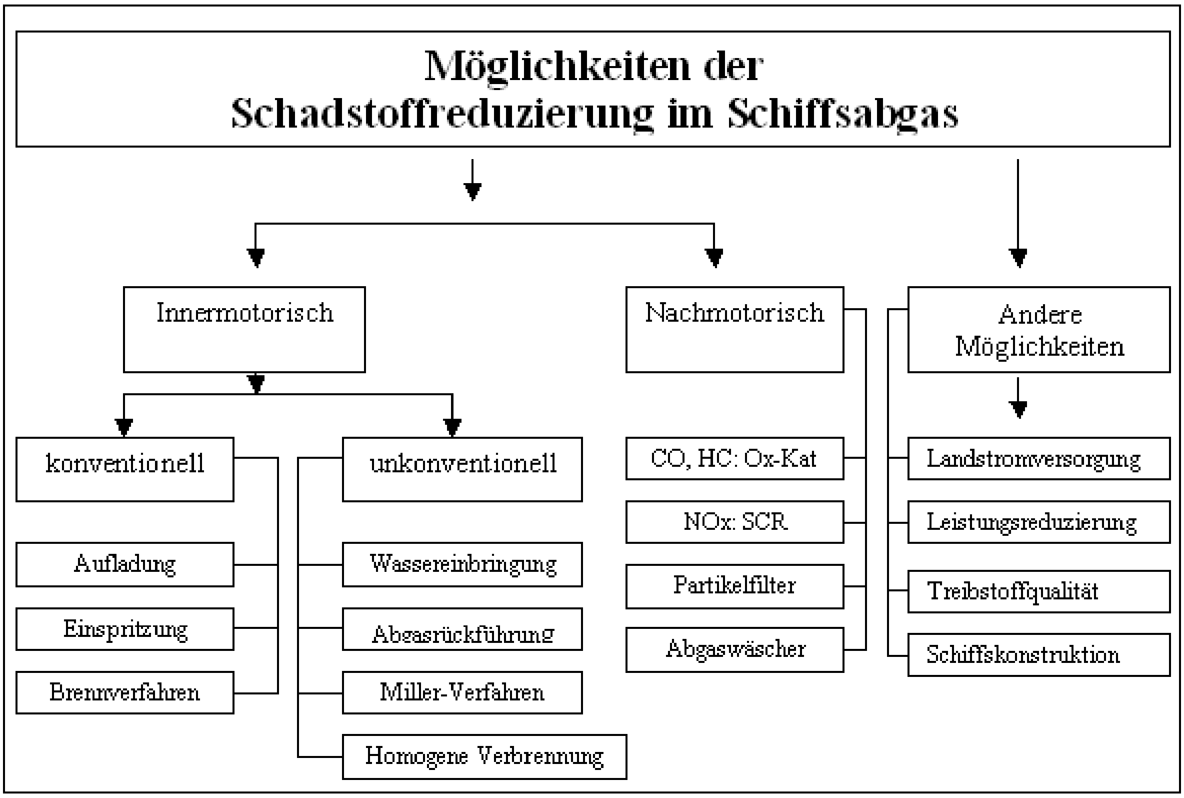
In port the greatest potential for reduction lies additionally with the vehicles used for shifting cargo to the warehouses respectivly the vehicles which carry out the immediate transportation. In this case it is mainly trucks which are waiting to pick up or to deliver containers with engines running.

6.1.1 Reduction of pollutants in the exhaust of main and auxiliary units

Until a few years ago ships engines were almost entirely optimised to get the most efficient use of energy. Because of the good proportion of used energy to the transported goods ships were automatically considered as being relatively "environmentally friendly". With the increasing awareness in the population especially in industrial countries and environmental legislation which is getting increasingly stricter on land, the emissions caused by shipping gained more and more importance (especially in ports) so that today engines are built under consideration of the environmental protection as well. While in the past disadvantages for the environment were accepted for reasons of efficiency, this is no longer the case.

Different measures are possible to reduce harmful emissions technically by means of different procedures. A rough outline is given in the following illustration:

Picture 30: Measures for the reduction of pollutants



Adapted from source [18]: Übertragung von Standards auf dem Gebiet der Umwelttechnik auf die Schifffahrt zur Reduzierung der Emissionen sowie für eine umweltgerechte Entsorgung an Bord von Seeschiffen, UBA FuE-project 102 04 416, GAUSS, Februar 1998.

The different ways of reducing emissions vary in efficiency and in cost. Except for the reduction of particle matter in the exhaust from big main engines using heavy oil, possibilities for reductions of the most important pollutants exist. The most important measure for the reduction of sulphur emissions is the use of low sulphur fuel, for the reduction of nitrogen oxide emissions especially fuel/water emulsions or catalytic converters are used. An especially high reduction of pollutants or impairments to the environment (noise, vibrations) of all kinds can be achieved with the supply of shore-side electricity for all ships at berth. Further pros and contras of the different measures are described in the appendix.

6.1.1.1 Decreasing of speed for the reduction of fuel consumption

It is theoretically also possible to reduce ships emissions by means of different operational measures. One example here is the reduction of speed of the ship. In a study for the IMO it was calculated that the reduction of the speed by 10% is followed by a reduction of CO_2 emissions of 23.3% by 2010 [35]. In theory, all other emissions are also lowered.

This makes this method the most efficient operational measure; further measures are e.g. special route planning, weather routing, etc. For this reason a voluntary *Code of Conduct* was suggested to the IMO by environmental groups, so as to motivate shipping companies to do this.

Because of the high air pollution level in Los Angeles such a voluntary agreement actually exists between the port and shipping companies that within a 20 nm radius of the port a maximum speed of 12 knots are allowed. By this the NOx emissions in this area are to be reduced by up to 4t per day.

However, arguments against these measures have also arisen: in areas at sea with impaired manoeuvrability this reduction can lead to safety risks, especially with containerships which offer a large surface for wind. As well as this, this measure could lead to a general reduction in ships´ speed in northern Europe because of the many ports, which could possibly affect competition adversely especially for *Short Sea Shipping* in view of other means of transport. Additionally this reduction in speed must not lead to the fact that the engines are run at part-efficiency all the time, because this would not lead to a reduction in pollutants but could actually increase these.

6.1.1.2 Technical improvement: sulphur oxides

Two options for the reduction of SOx emissions are available: firstly the reduction of the sulphur content in fuels and secondly the treatment of the ships´ exhaust [12].

It does not cause technical problems to remove sulphur from residue oils during the refinement process. This requires a lot of energy however, and at the same time high quantities of CO_2 are generated. Low sulphur residue oils are therefore a lot more expensive than the oils now in use, a fact which also explains the strong opposition against the low sulphur values in context with the new MARPOL Annex VI from both the oil industry and the shipping companies.

In the same extent in which the SOx conditions for the burning on land are increased a high interest will continue to use fuels with high sulphur content for shipping.

Even though a drastic reduction of the sulphur content in fuel for shipping would be the cleanest option it remains to be feared that, in view on the present state of discussions, large-scale exhaust-filtering systems will be used on ships to reduce the emission of sulphur to the standards given by the IMO instead of using accordingly low sulphur fuels on board.

The procedure of washing SOx out of exhaust by means of a so-called *scrubber* and pumping it directly into the sea, is considered to be not dangerous, depending on the amount of dilution. There is however no scientific data available on this. Two de-sulphuring systems are currently in use on two P&O ships for testing. The test results have not yet been made public. While the supporters of this system see this as a relatively low-cost possibility for the reduction of pollution, sceptics say there is still a whole number of unsolved technical problems. For example, adapting the *scrubber* to the present performance of the engines is said to be difficult. Apart from this other pollutants are let out in to the environment as well as sulphur and these can be seen as even more critical in sea water. Because of this, technically complicated water purifying systems would have to be added after the *scrubber*. Finally there have been even fewer (or none at all) examinations of the harmfulness of sulphur in sweet or brackish water (i.e. in coastal waters, local waters and ports) and it can be assumed that pumping them in here is not harmless.

6.1.1.3 Installation of technical measures for the reduction of NOx emissions

A whole range of different technologies exists for the reduction of NOx emissions. Apart from their different efficacy, they differ above all in size and especially in costs for their installation and operation. The following table gives an outline of this:

Table 31: Comparison of the different parameters in methods for reduction of NOx

NOx Control Technology	% NOx Reduction	Capital Costs US $ (Hardware, Installation, Design)	Annual Operating Costs US $ (Maintenance, Fuel and others)	NPV Costs (15% over 23 years) US $	Cost effectiveness (US $/ton NOx)
Selective catalytic reduction	81	285,000	30,000	477,000	5,889
Water/fuel emulsion	42	119,000	32,000	324,000	7,714
Injection upgrade	16	41,000	24,000	195,000	12,188
Water in combustion air	28	134,000	36,000	364,000	13,000
Fuel pressure increase	14	36,000	29,000	222,000	15,857
Aftercooler upgrade	10	12,000	27,000	185,000	18,500
Injection timing retard	19	250	57,000	365,000	19,211
Engine derating	14	34,000	55,000	386,000	27,571
Exhaust gas recirculation	34	...	...	...	...

J. Corbett and Fischbeck: study for large vessels.

Using technical measures within the engines for the reduction of NOx, attempts are being made to lower the pressure as well as the combustion-temperature in the combustion chamber, and thus reduce the proportion of NOx in the exhaust. One practise already in use is e.g. the reduction of the combustion-temperature by cooling down the air supply and/or the injection of water or of air enriched with water into the combustion chamber. Another procedure with the same aim re-circulates the exhaust gas, which is fed back into the combustion process to reduce the pressure. By cooling down the combustion process (injection of water) and by reduction of the combustion pressure, considerable reductions in NOx are possible without having to use SCR-catalysers. Values of 20 to 50% are given here (DNV/GL) [12].

In order to reduce NOx emissions by means of catalysers, the exhaust must have a minimum temperature which is as a rule ensured when four-stroke engines are running at medium speed. This procedure is combined with the addition of various substances as e.g. ammonia. As a rule however the exhaust temperatures from slow-running two-stoke diesels are too low so that the catalytic converters has to be installed between the cylinder and the turbo-charger to achieve the necessary temperature.

The costs when retrofitting SCR- catalytic converters depend among other things on the layout of the engine room. It is generally easier to retrofit four-stroke than two-stroke engines. It can however be generally stated that the retrofitting or installation of SCR-catalytic converters is at present the *Best Available Technology* (BAT) [12]. On the Baltic Sea there is already a whole range of ships fitted with SCR-catalytic converters:

Table 32: Examples of ships with an SCR-catalytic converter in 2003 (Siemens/SINOx)

Ship name	Build	DWT	GT	Fuel	NOx Reduction by:	Total engine power in KW	NOx Aver. g/Kwh	NOx Reduction Tons per year	NOx Reduction %
Birka Princess	1986	1,825	22,412	HFO/MDO	SINOx	23,055	0.5	1,409.7	96.3
Cellus	1998	6,350	4,231	HFO/MDO	SINOx	4,619	1.3	371.9	91.0
Forester	1996	6,471	4,110	HFO/MDO	SINOx	3,016	1.8	243.0	96.9
Gotland	1999	450	5,632	-	SINOx	29,685	0.8	1,781.3	94.5
Gabriella	1992	2,962	35,492	D/MDO	SINOx	2,000	-	-	-
Nils Dacke	1995	6,538	26,790	D/MDO	SINOx	4,500	-	-	-
Ortviken	1996	11,521	20,154	-	SINOx	9,930	0.8	860.0	94.7
Thjelvar	1981	4,150	17,046	D/MDO	SINOx	17,320	0.6	1,054.5	95.9
Timbus	1999	6,389	4,230	HFO/MDO	SINOx	4,627	1.1	392.0	89.3
Visby	2003	4,700	29,746	D/MDO	SINOx	26,015	0.8	1,561.1	94.5

Source: Presentation or the Projects SEAM by GAUSS Ltd., 12th April 2004.

6.1.1.4 Technical improvements: carbon dioxide

Special technology for the reduction of CO_2 on ships has not yet been developed. It can however be expected that the improvements of the combustion process required under Marpol Annex VI for the reduction of NOx will influence the CO_2 output favourably [12]. The CO_2 output has already been considerably reduced by using diesel electric motors as opposed to engines running on HFO [15]. Operational measures for the reduction of CO_2 emissions could be much more effective than technical measures, but hardly can be realised because of the competition in international shipping or because of external pressures (*Just in Time Concept*). Among the possible measures are the reduction of speed, optimised weather navigation, modifications in the engines and propellers, reduction of amount of ballast water on board, more efficient planning of time at berth [I12].

6.1.1.5 Technical improvements: diesel electric concept

The diesel electric concept has gained in importance especially for RoRo-shipping (but not only here). However here the reduction of exhaust emissions was not the main aim in the development of this principle, but rather specific demands on manoeuvrability and safety, in particular for RoRo- ferries and shuttle-tankers [12].

The diesel electric concept, developed above all by *Deltamarine* (Finland) and already put into practise (e.g. the TT Line), has also led to an increase in length of the lower cargo holds of four 15m units additionally. The economic advantages of the diesel electric drive on RoRo-ferries are obvious, even without taking the exhaust emissions into considerations.

The advantages are inter alia that the usual division in main engines for the drive and auxiliary units for the supply of electricity no longer exists. By this concept the total required amount of energy needed on board is supplied in form of electricity by the diesel generators. The number of required diesel engines is reduced from 8 to 4 compared to similar RoRo-ferries.

The entire auxiliary diesel installations normally in use disappear (and with them the costs for instalment, operation and maintenance). In their optimal operation the diesel engines always run with constant revolution per minute (rpm.). So only few signs of wear occur. Noise and vibrations can be reduced [15].

Generally such systems have a higher reliability and considerably less need for maintenance than diesel mechanical systems. It is to be seen positively under the aspect of exhaust emission, that the diesel electric-principle makes the use of marine diesel oil necessary (SO_x<0.5%). Apart from that this principle offers (in addition to exhaust emissions) also further economical advantages:

- Heating systems for tanks, pipes and corresponding units fall away. The number of required separators, pumps, filters, etc. is reduced drastically and the insulation of tanks becomes unnecessary.
- An emergency MDO fuel systems is superfluous. As considerably less heat is needed complicated thermal oil- and steam-systems can be replaced with a simple warm water system [15].
- In the diesel electric concept by *Deltamarine* it is prognosed that on the ships where these units are installed there will be a reduction of 30% on time spent on maintenance and a reduction of about 60% of the costs for replacement parts, compared to diesel mechanical units running on HFO. In this concept following advantages are seen for exhaust emissions:
- MDO contains about 85% less sulphur than the normally used HFO. Thus, the sulphur dioxide emissions are reduced in the same proportion. The emission of particle matter is reduced by c. 1/3, the share of sludge as well as heavy metals is reduced drastically.
- In addition, the low sulphur content offers convenient conditions for the use of the SCR-catalytic converters for the reduction of nitrogen oxides.

As it is only possible to meet the requirements of the future NO_x-limits without outside-engine measures (e.g. SCR-catalytic converters) with higher fuel consumption, it is uncertain if the diesel engine can continue to be the dominant type of engine on ships. The diesel electric-concept would also be affected by this. At the present new cruise liners are being designed with following concept: gas turbine coupled with a generator, drive with E-engine as Azipod (drive and steering).

Table 33: Potential for CO_2 reduction by technical measures[30]

Measures new ships	Fuel/CO_2 saving potential	Combined 1)	Total 1)
Optimised hull shape	5 - 20 %	5 – 30 %	
Choice of propeller	5 - 10 %		
Efficiency optimised	10 – 12 % 2	14 – 17 % 2)	
	2 - 5 % 3)	6 - 10 % 3)	15 – 50%
Fuel switch fuel oil → diesel	4 – 5 %		
Plant concepts	4 - 6 %	8 – 11 % 4)	
Use of sails	10-20%		
Machinery monitoring	0.5 –1 %		
Measures existing ships			
Optimal hull maintenance	3 – 5 %	4 - 8 %	
Propeller maintenance	1 – 3 %		
Fuel injection	1 – 2 %	5 - 7 %	
Fuel switch fuel oil → diesel	4 – 5 %		4 – 20 %
Efficiency rating	3 – 5 %	7 - 10 % 4)	
Eff. Rating + TC upgrade	5 – 7 %	9 - 12 % 4)	

1) Where potential for reduction from individual measures are well documented by different sources, potential for combination of measures is based on estimates only.
2) State of art technique in new medium speed engines running on heavy fuel oil.
3) Slow speed engines when trade-off with NOx is accepted.
4) Including fuel switch. Sources: IMO (2000a, p. 14), Michaelis (1996, p. 693).

[I11]: Bode, Krause, Michaelowa: Forschungsschwerpunkte Klimapolitik

Table 34: Potential for CO_2 reduction by operational and design measures

Measures	Fuel/CO_2 saving potential	Combined 1)	Total 1)
	Operational planning / Speed selection		
Fleet planning/lower speeds	5 - 40 %		
"Just in time" routing	1 - 5 %	1 - 40 %	
Weather routing	2 - 4 %		
	Miscellaneous measures		
Constant RPM	0 - 2 %		
Optimal trim	0 - 1 %		
Minimum ballast	0 - 1 %	0 – 5 %	1 - 40 %
Optimal propeller pitch	0 - 2 %		
Optimal rudder	0 - 0.3 %		
	Reduced time in port		
Optimal cargo handling	1 - 5 %	1 – 7 %	
Optimal berthing, mooring and anchoring	1 - 2 %		

1) Where potential for reduction from individual measures are documented by different sources, potential for combination of measures is based on estimates only
Source: IMO (2000a, p. 15)

[I11]http://www.hwwa.de/Projekte/Forsch_Schwerpunkte/FS/Klimapolitik/PDFDokumente/Bode,%20Krause,%20Michaelowa%20(2002).pdf

30 http://www.hwwa.de/Projekte/Forsch_Schwerpunkte/FS/Klimapolitik/PDFDokumente/Bode,%20Krause,%20Michaelowa%20(2002).pdf

6.1.1.6 Technical improvements for the reduction of VOC

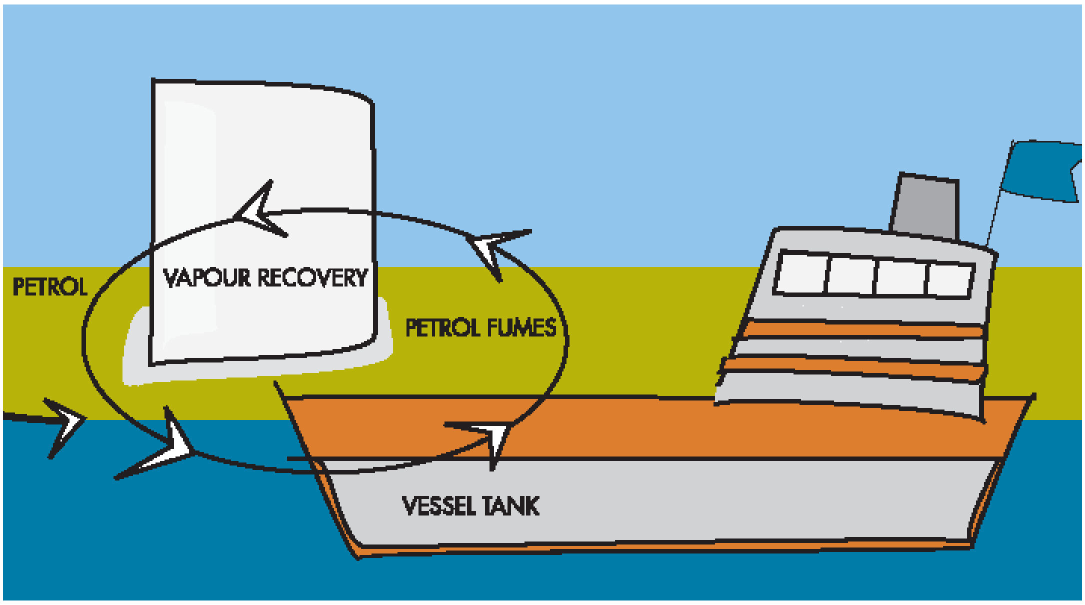
Possibilities for the reduction of VOC are given especially with tankers. Generally the development of gas can be reduced with the help of a slight rising of the pressure in the cargo tanks as well as by cooling the cargo down. *crude oil washing* is an ideal method for cleaning the tanks of crude oil tankers in an environmentally friendly way. The question of how to avoid the development of gas when washing down the tanks with raw oil is however still not answered. For crude oil short sea shipping the use of these emissions for the ships engine after the VOC have been filtered and segregated from the other components in the tanks air by condensation is being discussed

6.1.2 Reduction of VOC emissions on land

Reduction of VOC emissions can be achieved most of all in ports dealing with oil terminals, i.e. measures for reduction are not possible in ferry ports to any great extent. In ports with oil terminals, emissions can generally be avoided during the process of loading by sending the gas pressed out of the tank back to land through a special pipe (pendulum gas conduction) and then either burning it or re-liquidising it.

As has been shown in practice in the port of Gothenburg, possibilities for considerable reduction do exist. Here in Gothenburg three *Vapour Recovery Units* have been installed, which retain up 95% of the VOC. With a turnover of c. 1.4 million tonnes of fuel per year, loss through emissions could be reduced from c. 450 t to 25 t. The installation cost c. 65 million SEK, including the modifications necessary on ships. As well as relieving the environment, the reduction of the health danger for the personnel on the terminal and ships must be especially emphasised.

Picture 31: The function of the *Vapour Recovery Unit*



[I4]: Vapour recovery when loading vessels in the port of Gothenburg.

6.2 Reduction of the emission of liquid pollutants

The most important liquid emissions are above all oily residue or waste water (sludge and bilge water) and waste water from the fresh water circulation (washing, toilet, kitchen, etc.). The damage to the environment by the influx of sludge and bilge water and various projects has long been known and initiatives were started to solve the problem. Sludge may not be discharged into the environment any more, and bilge water only under certain conditions. In order to save on costs for the disposal on land, however, these regulations are often side-stepped, especially as the probability that such irregularity will be found out is very small and that the penalties for this – if it comes to this – are low. One possibility of achieving sensible results is given in the implementation of the EU regulations on port reception facilities and the no special fee system related to this.

Whereas the pollution of water or the organisms in the water with waste water from freighters can be considered relatively harmless, as they generally less than 20 persons, the situation on passenger ships and ferries is quite different. The fact that vast amounts of waste water are being generated on these ships and discharged into the environment has already led to protests from the population in some regions.

6.2.1 Purification of sewage, grey water and bilge water on board

Conventional biological micro-filtration systems purify the waste water of the substances causing CSB (Chemischer Sauerstoffbedarf – chemical demand for oxygen) and BSB5 (bio-chemical demand for oxygen) and also of ammonia, nitrate and phosphate. They reach dis-charge values better than the binding legal rulings.

Since about 1993 the combination of biology and micro-filtration for the purification of ships´ waste water has been tested by different companies in Germany. Although the combination of a process using bacteria with micro-filter technology offers the possibility of saving on costs and increasing efficiency, the use of the procedure on board ships has been realised only much later. The installations for operation on board were developed only at the end of the nineties, at first treating sewage and grey water. Later oil-free bilge water was included in some treatment processes. Since then tests have been carried out on board for the combined purification of ships sanitary waste water and pre-treated bilge water in a single unit.

The technique of combining aerobic biological purification and micro-filtering is based on the biological decomposition of residues followed by membrane-filtering. By installing over- or under- pressure on the semi-permeable, selective micro-filtering membrane, matter suspended or dissolved in the waste water and in the residue can be separated out. Through the decompo-sition of matter in the bio-reactor and the following micro-filtering, the waste water is free of coli-bacteria and contains only traces of CSB, BSB5, nitrogen and phosphor. In this way the water let out does not only conform to the legal limitations of today, the performance is often much better. Because of this, micro-filtering in combination with bacteria is an extremely efficient procedure for the purification of waste water.

The biological system of the membrane is also able to remove the substances given above from the waste water. Because of the filtering process, in contrast with conventional bacterial systems, waste water from these systems is free from infectious germs. It thus achieves the values of the EU regulations on swimming water and reaches an important goal for the protec-tion of the waters, especially for coastal areas. As an example of such a system, a description of the method of functioning of the MEMROD-system follows.

On the basis of the combination of procedures of biological waste water purification and submerged micro-filtering units the MEMROD®-reactor (**MEM**brane **R**eactor **O**peration **D**evice) was developed and optimised for the use on board ships within the scope of a project promoted by the BMBF.

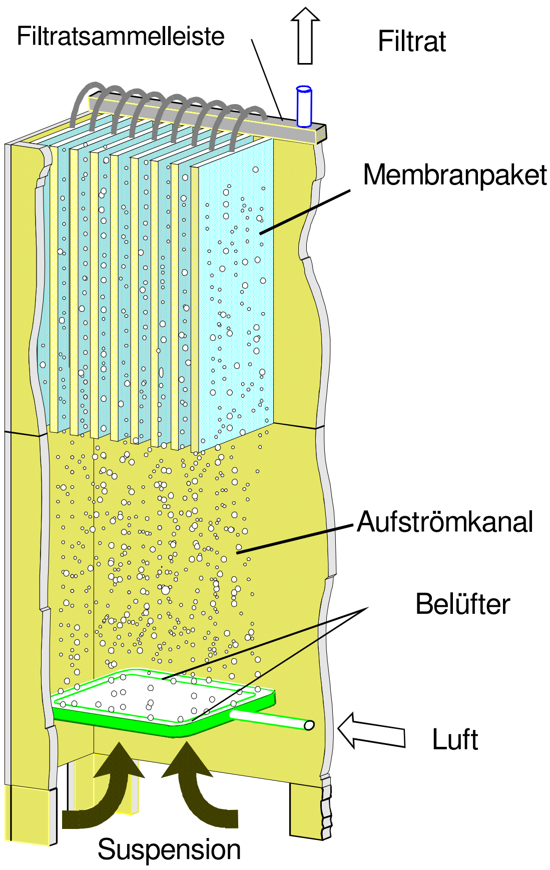
In this the micro-filter membrane was built directly into the bio-reactor. The biologically purified water is then sucked solely through the membranes. Thus the membranes are a barrier to the organic sludge, suspended matter and bacteria and even agglomeration of viruses.

The oxygen necessary for the aerobic breakdown of the contents of the waste water is pumped in through ventilation below the membrane unit (see picture 32). By means of the invection developing within the membrane unit, water passes over the surface of the membrane continually and frees it from clogging substances. The slight suction of 0.1 – 0.2 bar (max. 0.6 bar) on the permeable side of the membrane effectively stops any compact caking of the filters/clogging layers on the membrane. This highly developed technical system offers the following advantages for the purification of ships´ waste water:

- A space-saving, compact method by means of high sludge drying in the reactor. This offers the possibility of using much needed space on board ships more economically.
- A simple mainly automatic procedure. Less work for the crew, problems of understanding and acceptance are reduced, even completely avoided.
- A much higher decomposition is achieved compared to existing standards. This gives a higher margin of safety as regards possibly stricter legislation in the future. It is perhaps also possible that the residual water may be discharged into areas where it is at present forbidden (Zero-Emission-Areas).
- Treatment of all waste water (sewage, grey water and oil-free bilge water) in one reactor. This means it is possible to save the space of other expensive or bulky equipment. E.g. an ordinary bilge water separator may continue to be used for de-oiling, and the installation of an expensive and maintenance intensive bilge water membrane separator is superfluous. Residuals $CO2$´s in bilge water are broken down by specialized bacteria in the membrane biological system.
- Environmentally harmful and expensive final treatment for disinfection can be disposed of. The otherwise usual chlorination is no longer necessary when the biological membrane method is used. The residual water comes up to the values given in the EU regulations for swimming water without any further treatment. A re-use of this residual water for different purposes is conceivable and well possible.

Up to now these units have been increasingly installed on passenger ships, in particular on those used in ecologically sensitive areas. The local residents in these areas are already very sensitive to the possibility of pollution of the sea and the coastal waters because of the high amounts of sewage and grey water from such ships.

Picture 32: Function of the MEMROD-system



6.2.2 Purification of sewage, grey water and bilge water on land

According to HELCOM[31] on ships with conventional toilet systems there is c. 70 litres sewage per person per day (in vacuum systems 25litres per person per day). The amount generated in the grey water system is c. 230 litres per person per day (in vacuum systems about 185 litres), which can amount to several hundred tonnes per day already on medium sized ships. It is probable that because of the offered leisure facilities (pool, sauna, etc.) even more waste water is generated.

As these ships often cruise near the coasts the discharge accumulates sooner or later and so has a direct negative influence on the environment of the people on the coast (not to mention the continuous stress on fauna and flora). For this reason several shipping companies whose ships are on regular routes (in the main between Sweden and Finland) already dispose of their sewage and grey water on land.

Discharge of sewage and grey water is not yet technically possible in many ports today. From an economic point of view this in some cases is also not reasonable, as in some ports only low amounts of waste water are generated on ships with few crew members. If the waste water is purified in an up-to-date installation, the pollution of the environment is relatively slight when compared with other types of emission. It is not worth the expense therefore for freighters. However, for large amounts of sewage from passenger ships the ports are normally also not equipped with adequate reception facilities. Nevertheless, for passenger ships and ferries, dis-

[31] http://www.helcom.fi/recommendations/rec11_10.html

posal on land will be introduced in the medium or long term. The number of persons on board these ships has increased continually up to now. More than 2000 persons can be conveyed on ferries, c. 5000 persons on passenger ships.

Bearing all this in mind, the delegation from Finland has suggested to the *Nordic Council of Ministers and the Governments of the Nordic Countries,* that measures be taken to achieve an overall ban on the discharge of waste water into the Baltic Sea as soon as possible[32].

6.2.3 Treatment of ballast water on board

A threat of increasing importance for the marine environment is the ballast water carried and the discharge of foreign organisms. Because of a possible rapid spread of these organisms, which sometimes have no natural enemies in their new environment, there may be ecological damage (et al. a reduction of the natural stock of fish) and considerable financial damage, e.g. damage to aquaculture and to building constructions (growth on the pipes of cooling systems, damage to wooden constructions, etc.). Measures for the reduction/solution of this problem are being sought internationally.

Exchanging the ballast water at high sea is presently still the only effective solution for dealing with the ballast water threat. A difference is made between two main methods:

- The ballast water tanks are washed through continuously with sea water: also known as "Flow Trough" or "overflow" method.
- As far as possible the tanks are emptied completely and refilled: also known as the "Sequential" method.

In most cases ships have only one pipe for filling and emptying the ballast tanks. For safety reasons they have an overflow pipe to allow overpressure to escape. This pipe normally ends on deck and has a diameter c. 1½ times as big as the filling pipe. When considering the design and size of these overflow pipe, the authorities took an occasional overflow of the tanks into consideration. For effective treatment, the "Flow-through" method from the IMO demands that the water be replaced at least three times. For this, water is sucked in through the sea chest and pumped via the existing ballast pipe system into the tank which then continues to overflow until three times the tank-volume of water has flowed through. Under this method there is not 100% guarantee that the content of the tank has been replaced. There has only been a dilution of the contents, and this holds only when the water has been perfectly mixed. Whether or not the tank content is well mixed depends on e.g. the construction of the tank, the positioning of the inflow/outflow pipes, the duration of the pumping process and possibly the ships´ movements.

Table 35: Idealised replacement of ballast water

Volume of tank to be washed through	Content of freshly pumped water %
1x	63,2
2x	86,5
3x	89,2
4x	95

[32]http://www.helcom.fi/dps/docs/documents/Heads%20of%20Delegation%20(HODS)/HODS%2011%202003/5.2-4.pdf

O. Mühr: Presentation of a technical concept for the reduction of exotic species in ships´ ballast water tanks (Darstellung technischer Konzepte zur Reduzierung von exotischen Spezies im Ballastwasser von Seeschiffen), Dissertation fort the University of Applied Sciences, Faculty of Nautical Science, 05.12.2000.

In the "sequential method", the tank is totally emptied and is then refilled. In theory this method is most effective, but for various reasons it is often not feasible. The IMO considers total replacement of ballast water at high sea to be a very risky manoeuvre for the ship. Among others, the following dangers and problems are given:

- A reduction of the ships´ stability to below the specified minimal levels
- Great bending and shearing forces are caused above permitted limits. Older ships are particularly affected here
- Weather conditions at the time of or developing during ballasting. The ballast-operations can last several hours. If the weather worsens suddenly, it may not be possible for the captain to deal with the problems given above
- The ships´ trim must not be altered in such a way that the steering deteriorates beyond given limits. The viewing angle prescribed by SOLAS must be maintained and the screw must remain deep enough in the water to ensure sufficient propulsion.

For the treatment of ballast water on board many different techniques and solutions are being developed and discussed to ensure ecologically safe ballast water. Previous investigation has already shown that one single technique is less suitable than a combination of various methods for the future treatment of ballast water. The most promising appears to be the combination of a pre-treatment followed by the main-treatment e.g. a filter to cut out most of the organic substances followed by a further step such as UV-radiation or chemical treatment to eliminate smaller organisms such as algae, larvae, eggs and bacteria. When researching and developing suitable methods of treatment, the requirements of ships´ safety, legislation regarding the construction and operation on board, a simple and safe handling of the installation, its ecological suitability and also the standards of effectivity at present in preparation must be taken into consideration.

Potential methods from probably all branches of science and technology were examined. Various methods were identified: these can be divided into three main groups:

- Mechanical treatment
- Physical treatment
- Chemical treatment

The development of treatment plants is relatively complex because effectivity must be guaranteed under very different conditions: for example fresh water, brackish water and salt water with their relevant physical and chemical properties (salt content, temperature, density, etc.), the degree of pollution and the organisms contained in the water. As well as this there are the technical requirements of ships´ operations (the amount of water to be treated, efficiency of the pumps, ships´ stability, etc.). For economic reasons, the construction and the operation of the installation must be financially viable. Filtering is considered to be the most important pre-treatment.

6.2.3.1 Function of a filter

Filtering the ballast water considerably improves the efficiency of other techniques, or rather is an absolute condition for the efficiency of other techniques (e.g. UV-radiation). The size of the mesh of the filter of course plays a decisive role in the effectivity of the system. Filters with a mesh of up to 25 µm can be used in practise. These extremely fine filters hold back almost every organism and particle apart from bacteria and viruses. They mean however a lot of technical work and financial investment. The following table shows a selection of organisms typically found in ballast water and their approx. size[33].

Table 36: Relative sizes of mikro-organisms

Organism	Typical sizes	Additional information
Viruses	**0,01 – 0,3 µm**	Hepatitis Virus, 0,02 µm; HIV, 0,08 µm
Bacteria, round and cylindrical	**0,1 – 100 µm**	*Vibro Cholera,* 1 µm Most bacteria are c. 3µm.[34] in size[35]
Protozoa (monocellular)	**1 – 80 µm**	*Myxosporeans,* 5 – 30 µm Microsporidians, 1 – 10 µm
Fish eggs	**0,5 – 5,0 mm**	
Fish	**> 1 mm**	
Invertebrates	**1-100 mm[36]**	Zebra shell
Phytoplankton (vegetable plankton) and **Zooplankton** (animal Plankton)	**< 50 µm to max. 1 m**	*Nanoplankton* (e.g. Bacteria), *Mikroplankton* (mostly monocellular), *Mesoplankton* (z.B. Larvae and Pfeilwürmer), *Makroplankton* (z. B. Seagras)

Source: Northeast Midwest Institute / USA.

With a flow-through of up to several hundred tonnes per hour, these filters need a vast filter surface. Cleaning such filters is technically very complicated. Self-cleaning filters are on offer also with a mesh of down to 25 µm. One advantage of this technique is that most of the particles suspended in water are filtered out. If these form sediment in the tanks, they can offer several organisms a perfect basis to survive long ships journeys without harm.

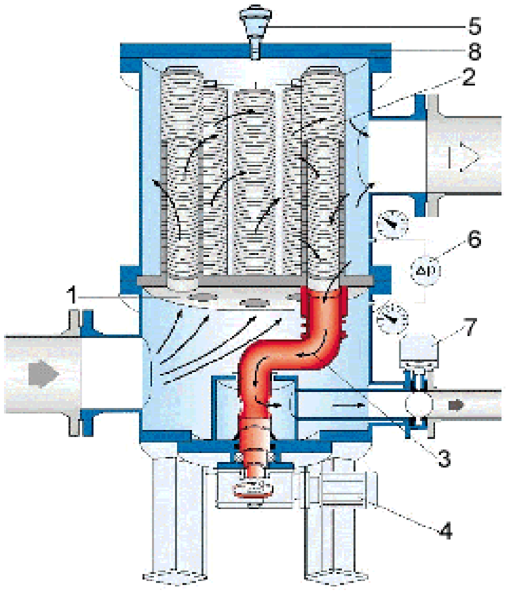
[33] cf. *Marine Organisms Transported In Ballast Water* / Department Of Primary Industries and Energy Bureau of Rural Resources 1991 / Bulletin #11:1-48

[37]cf. *Marine Organisms Transported In Ballast Water* / Department Of Primary Industries and Energy Bureau of Rural Resources 1991 / Bulletin #11:1-48

[35] cf. *Marine Organisms Transported In Ballast Water* / Department Of Primary Industries and Energy Bureau of Rural Resources 1991 / Bulletin #11:1-48

[36] cf. www.pollutech.com/papers/p22.htm / Pollutech Group of Companies / Canada

Picture 30: Screen filter by Co. Fiola, (graphically modified illustration) [34]



The following picture shows a back flushing screen filter system made by the company Fiola from Hattingen. One of these modules is designed to have an efficiency of up to 300 m³/h. The diameter of the filter-chamber would be 1.30m and it would use up a space of c. 4m². The mesh in this system is at 50 µm as fine as is at present technically possible in this factory. A back flushing pressure of at least three bars is necessary to ensure that the self cleaning filter is operating properly. The filter elements were constructed as screen filter and they expand due to their elasticity and form dynamically during the back flush process. By this, even objects that have got stuck or fibrous objects can be removed from the filter surface. Air in the ballast water would be let out automatically by the de-aerator (no. 5) in the lid of the casing (no. 8). When the differential pressure switch (no. 6) registers a defined pressure difference in front of and behind the filtering surface, which shows a grade of pollution of the filter elements that can no longer be tolerated, the back flush activates itself; this also happens when a defined time span has passed. After this the back pressure valve (no. 7) would open automatically and the back flush process would start.

The often variable degree of pollution in the water could perhaps cause problems. Mostly such units are used for filtering in areas where it is known beforehand which particles and organisms are to be filtered out. This is however not possible for units used on ships in international trade

6.2.3.2 Ultraviolet light (UV-Radiation)

The use of UV-radiation is seen as a promising technique for the disinfection of the water after it has been filtered (UV-C 200-280), especially with a wavelength of λ=254 nanometres. At this level the absorption level of the organisms for UV-radiation reaches its maximum[37]. This radiation level has the property to break up the chemical bonds of the DNA. Either the irradiated organisms die at once because of changes in the metabolism, or they can no longer reproduce. This deadening/disinfecting effect is used for example for the treatment of waste water, in medicine, for the treatment of drinking water, etc. Because of the low penetration depth this technique is only applicable for micro organisms, bacteria, viruses and spores. Unlike chemical disinfectants, UV-radiation does not change the ph-value, colour, taste or smell of the water.

[37] www.visa-uv.com/water/t_g.htm and www.visa-uv.co/knowhoe/index_g.htm

6.2.3.3 Use of chemicals

Disinfecting the ballast water with chemicals is a commonly used method. Chile and Argentina already demand that the ballast water be treated preferably with chlorine before entering port. It is however not the bigger, complex life forms which are to be eliminated by this, but bacteria and viruses. As now scientific solutions for the killing-off of all organisms in the ballast water are sought, other chemicals apart from chlorine have been found, which are being examined by different scientific institutions on their practical use. An important indication for the chlorine content of the water is given in the TRC-Content (Total Residual Chlorine). This is the chlorine content in ppm (parts per million) which is actually in the water after the chlorination and which is used in examinations as a standard for the toxic effect of the chlorine.

Table 37: Efficiency of chlorine

TRC-Content in ppm	Kills following life forms
2,5	Most fish, algae and phytoplankton
10	Robust fishes, algae and species, as e.g. snails, which are very resistant against chlorine
100	Organisms in the tank sediments and many species, which protect themselves by creating a cyst (capsulation)
500	all species

O. Mühr: Presentation of a technical concept for the reduction of exotic species in ships´ ballast water tanks (Darstellung technischer Konzepte zur Reduzierung von exotischen Spezies im Ballastwasser von Seeschiffen), Dissertation fort the University of Applied Sciences, Faculty of Nautical Science, 05.12.2000.

An automatically regulated supply of chemicals into the ballast water by means of the main ballast water pipe used for filling the ballast tanks is the best method of bringing these chemicals from a separate tank into the water. By continually adding the disinfectant to the passing ballast water an optimal mingling of the components can be achieved. In some cases it is possible, to produce the disinfectant directly on board; this is for example necessary when using ozone because of the short half-life period.

6.2.3.4 Replacement of ballast water with fresh water

Most seagoing ships are equipped with an installation for generating fresh water. It is therefore quite possible that during a voyage the ballast water be replaced with fresh water or even distillate. The units work on the principle of reverse osmosis or use the waste heat of the main engine. The required capacity of such an installation would depend on the amount of ballast water to be replaced and the time given in which the unit can generate fresh water between two ports. This kind of installation is possible for ships needing little ballast water, e.g. passenger ships.

6.2.4 Treatment of ballast water on land

Up to now installations for the treatment of ballast water (elimination of organisms) on land do not exist. For non-tankers the possibility of treatment of ballast water on land, however, is at least in petro-chemistry, already practised. For example there are several installations in the Canadian part of the great lakes for the reception of ballast water/washing water of tankers. Generally such installations are also suitable for disinfecting ballast water. The water purified of chemicals and oil residues could be further treated with the available technology (e.g. UV-radiation, ultrasound treatment or chlorine)[38].

The ships in question would have to have a standardized release flange, to ensure comparability with the collecting devises on land. As well as this the ballast water pumps on board the ships would have to be modified in order to make them more efficient.

In Valdez, Alaska, such an installation exists which can purify up to 3.6 million tonnes of water in three phases every day. The first step is a separation of the raw elements by using gravity. After the very light and very heavy particles have been separated out, the water is treated with compressed air, giving organisms good living conditions in the water to destroy the remaining oil residues[39]. The third step includes after-purification. In this phase the instalment of a disinfection unit would be possible, in order to eliminate any exotic Neozoic organisms[40]. This possibility has already been discussed intensely; it is however only feasible for ships where large amounts of ballast water and liquid cargo are "exchanged", e.g. crude oil tankers, where only few loading and discharge ports are frequented and the routes are known.

From the point of view of environmental protection these installations offer the highest amount of safety. They are run by specialists who only work in the field of treating ballast water, in contrast to units available on board which are run by people having to cope with other things as well. It is difficult to find out the costs of such units on land. However, it probably amounts to several million euros. Sums of "several ten million dollars" were given in the Wall Street Journal[41].

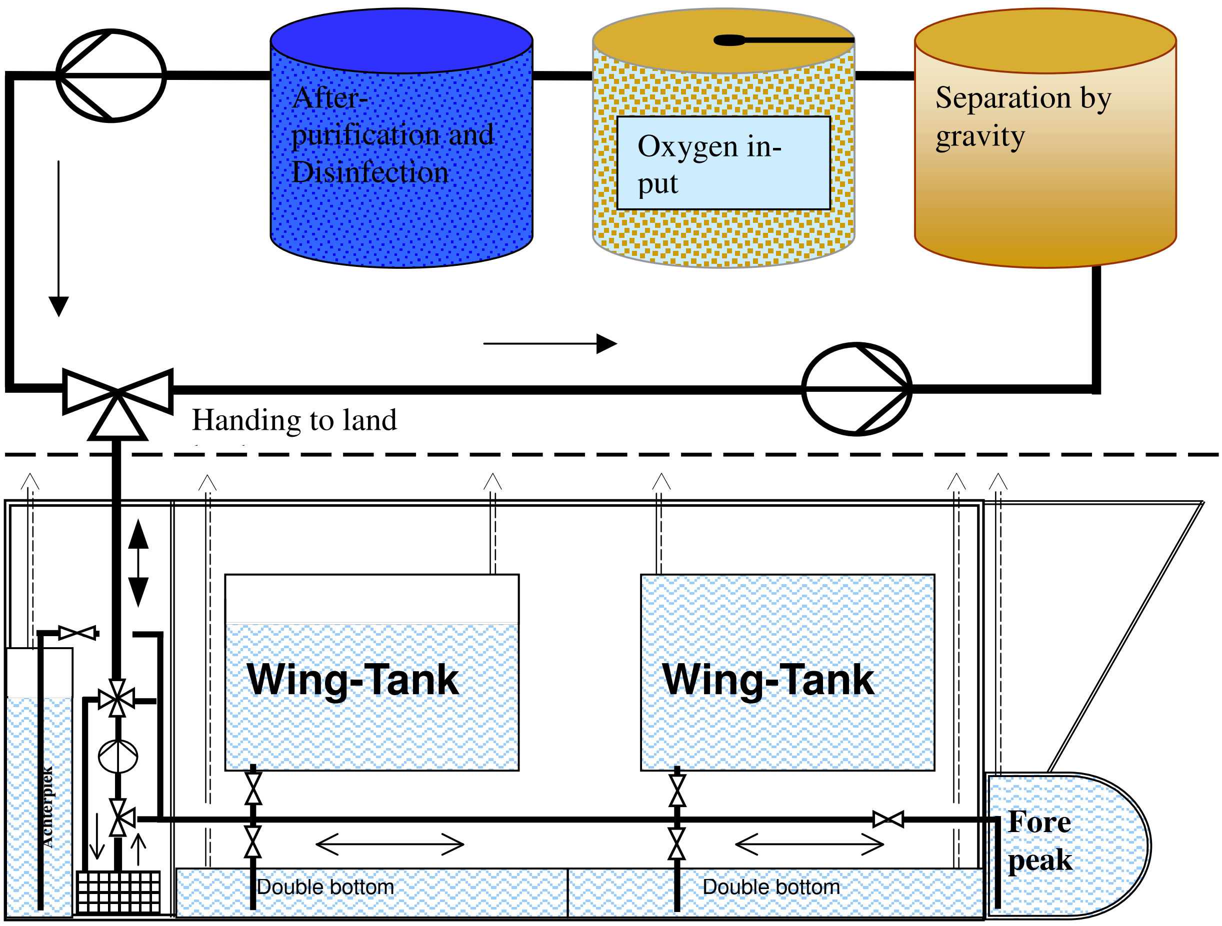
[38] cf. www.pollutech.com/papers/p22.htm / Pollutech Group of Companies / Canada

[39] Cf. www.state.ak.us/dec/dawq/wsm/pictbook/wsprogra/alyeska.htm / Ölseparation / Valdez Bay / Alaska

[40] cf. *Bill Aims to Clear Up Murky Policy On Ship´s Ballast-Water Dumping* / The Wall Street Journal / New York / 10.03.1999 / S.2

[41] [44] cf. *Bill Aims to Clear up Murky Policy on Ship's Ballast-Water Dumping* / The Wall Street Journal / New York / 10.03.1999 von Shirley Leung / S.2

Picture 33: Function of a ballast water treatment unit



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The costs of installing such devices are dependant to a great extent of the space available in the ports. Additionally, trained staff is needed for the running and maintenance of such a unit. Ports trying to divert the costs of such a device to shipping could be affected adversely in competition with other ports. Shipping companies would try to shift their traffic to other ports with lower charges[42].

If delays are caused for shipping because the installations on land would accept ballast water not or too slow, the economic damage for shipping could be immense[43]. Under the conditions given above, a solution to the problem of ballast water is best to be seen in the treatment of the water on board.

[42] cf. http:// web.pdx.edu/~sytsmam/pbwg/pbwg%20report1.html / Pacific Ballast Water Group / Working Draft / S.28

[43] cf. Stemming The Tide / Shore Based Treatment and Ballast Lighters / S.39

Initiative action however is being taken, and by the Baltic states too, for a reduction of the dangers through organisms in ballast water. HELCOM suggests in a report[44] that within the scope of ballast water management:

- The compulsory registration of the ship and a report on its ballast water status before the ship enters a Baltic port shall be introduced,
- Compulsory procedures for disposal be developed by national authorities for ships wishing to discharge ballast water in territorial waters or in the EEZ.

6.3 Reduction of solid waste

There are many different possibilities to reduce the production of waste. As well as a careful choice of a product and its packaging, separating waste on board offers great potential. If the amount of "normal waste" on board is reduced by using different recyclables, this not only protects the environment because of the smaller amount of material to be incinerated: costs are often also reduced because in some cases, e.g. with certain metals, the recyclables are taken back on land and paid for and moreover because the amount of normal waste, which is a mixture of many different materials and therefore expensive to dispose of, is reduced. In other words, an optimal separation of waste on board can also be economically sensible.

The collection, separation and treatment of waste at sea/on land offers potential for optimizing existing procedures. More or less waste is generated depending on the type, size, construction, age and other factors of the ship. From the collection of waste to its transport on land to the recycling dump there are possibilities of coordinating the logistics between ship/port so that the entire process is more efficient and economically in the long run.

The German law on recycling and waste[45] gives standards for a long term handling of waste. Generally it is to follow the guideline "Avoidance above Recycling above Disposal". A further criterion for long-term recycling is the distance covered during the disposal process and the emissions caused here. In order to create a positive balance, by preference local businesses are to be hired if they can offer the same standards for recycling and disposal of waste as supra-regional firms without a branch in the region concerned.

The suggestions given below cover all waste generated on board ships which cannot be disposed of on board. According to the amount of waste calculated it must be decided in each case whether a "bringing system" or a "collecting system" shall be introduced. The decision for one of these two systems must be made both from an economic and an ecological point of view. Ideas for a reasonable categorisation of ships according to size and type are to be found in the appendix.

6.3.1 The reduction of waste on board

The separation of waste is mainly carried out by the crew of the ship or by the cleaning personnel on board. The different components in personal waste must be separated as thoroughly as possible, wrong sorting must be avoided and if necessary constructive organisational

[44] BALTIC SEA ENVIRONMENT PROCEEDINGS No. 86, PROCEEDINGS OF THE JOINT IMO/HELCOM/EU WORKSHOP "ENVIRONMENTAL IMPACTS DUE TO THE INCREASED DENSITY OF SHIPPING IN THE BALTIC SEA AREA –COPENHAGEN PLUS 1", Rostock-Warnemünde, Germany, 11-12 March 2003

[45] Deutsches Kreislaufswirtschafts- und Abfallgesetz: KrW-/AbfG

measures must be introduced. In order to have economically sensible amounts, collecting separated waste at a central collection point before it is later transported on land is necessary.

The installation of special differently marked rubbish shafts for the different sorts of waste and the provision of the right numbers of suitable containers, etc. are constructional ways of assisting successful separation. Hints on sensible constructional possibilities for the system of collecting separated rubbish are given in the appendix.

6.3.2 Required waste container capacity

The calculation of the container capacity necessary is carried out with the help of calculation models given in the appendix. This model divides wastes into different categories:

- Waste caused during ships´ operations
- Waste caused by cargo
- Waste created by people

It is unlikely that great amounts of waste created by people will occur on conventional cargo ships. On these ships, wastes caused by ships´ operations and by cargo predominate. These kinds of waste depend strongly on the type of ship and the cargo transported. A calculation of the amounts of waste varies a great deal, depending on the cargo. For this reason the waste container capacity on board is best calculated from experience. Where this is not possible, suggestions for a calculation can be found in appendix.

Large amounts of waste created by people can be expected on passenger ships. The amounts of waste arising depend on the number of passengers, the duration of the voyage and in particular whether there are overnight cabins with sanitary facilities on boards.

Marking the containers in such a way that they cannot be mistaken helps the separation of waste into the respective method of disposal. This marking should follow the suggestions for the DIN ISO norm *handling of ship generated waste* made by the DIN committee *2.2.8 Protection of the Marine Environment*.

Different containers for the collection of waste are to be provided on board The different types of containers and the materials they are made of are decided upon according to the physical properties of the waste.

6.3.3 Standardized waste systems

The "bringing system" as described by the DIN 30706 [46] is a system of dealing with ships´ waste, by which the crew members bring the waste to an interim deposit on land. Recommendations concerning the creation of a standardized system would be valid for ships on which relatively small amounts of waste are created by persons.

For the bringing system it is recommended on board that waste is transported by means of special shafts, slides and similar installations, as these offer advantages regarding the amount of work necessary and working conditions. From board, waste is removed by the ships´ crew. The port must ensure that this waste can be emptied at the collecting points. Equipment needed for emptying the containers must be provided, according to appendix A9, chapter IV.

[46] DIN Deutsches Institut für Normung e.V.: Entsorgungstechnik, begriffe für Hausabfallentsorgung und Entsorgungsfahrzeuge, DIN 30706 Teil 1, Berlin: Beuth, 1991

As an alternative rubbish bags (DIN EN 13592) and/or rubbish sacks (DIN EN 13593), must be provided.

The „collecting system“ is described by the DIN 30706 as a system of dealing with waste on board a ship by which the waste is fetched from on board on demand. This method is preferable to the bringing system when the costs of fetching and disposal are less than the costs for interim storage, collecting and disposal. Recommendations concerning the creation of a standardized fetching system would be valid for ships transporting a high number of passengers. This is economically and environmentally sensible for passenger ships.

The waste is taken from the ship by the disposal firm. The containers to be emptied or taken away are to be designed according to DIN EN 840 (mobile waste containers), DIN EN 12574 (stationary waste containers) or DIN EN 30737 (motorised containers to be emptied) so that there are no problems when the disposal firm collects them. Local circumstances must be considered.

6.3.4 Containers for the storage of waste

Depending on the length of and reason for storage of waste on board, the relevant containers are necessary. Crew members must be able to fill the separated waste into these containers without problems. The containers used for the storage of waste on board must be so designed that they can be fetched from board by the waste disposal firms without problems. DIN EN 840 (mobile waste collection) must be taken into consideration.

6.3.5 Instructing/informing the passengers

Informing the passengers by means of memos, leaflets, notices, etc. can help a lot with the separation of waste. These memos contain all information to the possibilities of disposal, the containers on board, their location, markings, etc. The aim of this is to persuade the passengers to take part by giving them precise information on the possibilities, advantages and why the waste collection system on board is necessary in order to achieve a high level of separation. To avoid misunderstandings the different markings for the different containers should be described in these leaflets. If the information is given in an appealing way it helps to spread the information. The leaflets can be handed out together with the safety information.

6.3.6 Reduction of waste on land

The collection points in port help to create economically sensible amounts of waste to be disposed of and can be seen as “interim stores” for ships on which little amounts of part-waste are created. For this it is necessary that the ports/managers supply collection points for the different kinds of waste. The installation of waste container limits is advised according to DIN 30736 [47] or DIN 30719 [48].

In order to coordinate existing systems and to save costs it is advised to adapt the containers which are to be used to the amount of waste usually generated here. An illustration of Gothenburg is given as an example for a collection point.

[47] for MGB with a content of 120 to 2401

[48] for MGB with a container content of 1.1m³

Picture 34: Collection point in port Gothenborg[49]

[36]: SMA: THE BALTIC STRATEGY, A report on the progress of the Baltic Strategy for Port Reception Facilities for Ship-generated Wastes and Associated, issued April 1999.

6.3.7 Communication for disposal in port

Proper communication is necessary in order to ensure easy handing-over of the separated waste from ships. Ships have to declare the amount and kind of waste to be disposed of 24 hours before entering port in accordance with MARPOL V. a return service the ships are to be informed about the existing waste points and their location in the port, including among others information on the waste container capacity. Furthermore all relevant information on the collection points and on other port reception units is to be given to the ships.

An organizational measure is instructing the staff of the steps taken to be able to influence the waste collection directly. Especially a better separation of the recyclables is to be achieved by this. It is hoped that this will have lasting effect, and costs can be reduced this way, too, because the components can be utilized better by the recycling firms.

6.3.8 Instructing the staff

The efficiency of the separate collection should be increased by instructing the staff members with the following:

- Society related and ecologically backgrounds, to show the importance of the tasks
- Economical and ecological potential for saving by means of the separation system
- Kind and design of the installed collecting system

[49] Source: SMA, THE BALTIC STRATEGY, A report on the progress of the Baltic Strategy for Port Reception Facilities for Ship-generated Wastes and Associated Issues, Photo: Stichting Werkgrtzee, Issued April 1999, oep Noor

- Reasons for installing the chosen system
- Demonstration that waste handling can be carried out easily and without problems.

6.4 Noise emissions

Examinations show that 65% of the European population is exposed to unacceptable noise-levels mainly caused by traffic in towns. This can cause health and emotional impairment (stress, anger). Complaints about disturbed rest or sleep are common. Other signs are loss of the ability to concentrate and difficulties in understanding. Damage to hearing can occur if the noise level exceeds 85 decibel, which is however seldom the case[50].

Noise is an increasing problem in towns because of the ever increasing traffic. Apart from the objective increase in noise-pollution, the population is less prepared to accept noise. This leads to protests in many towns, of which the initiatives of people living close to airports are best known.

6.4.1 Reducing of noise emissions on land

Complaints about noise are voiced increasingly often in towns where the port is close to the centre of the city. This is why measures to reduce noise are sometimes being introduced – as it would be much more expensive to relocate port facilities.

In order to mitigate noise a EU-Directive on “Noise Emission by Outdoor Equipment”[51] was decided in June 2002 This Directive relates firstly to areas with a high concentration of over 250.000 inhabitants (100.000 in the year 2012), meaning that some ports will be affected by this. The main issues are roads, trains and airports. The explicit application on ports was discussed but not introduced for the moment. “Noise charts” are to be made (2006) which show the noise levels, especially for industrial areas, in this case including ports. Based on this “plans for action” are to be worked out (2008) for the management of excessive noise pollution.

A port has to draw up noise-plans and *plans of action* in accordance with the EU-*Noise-Directive*. At the moment Amsterdam is drawing up an *EU Noise Zoning and Management-System* as well as a suggestion for an acceptable standard for the development of noise in ports. The aims of the project are:

- Drawing up an over-view about existing *Noise management systems*
- A comparison of existing systems for the reduction of noise
- List the most important *peak noises*
- Taking stock of the *Best practise* for the reduction of noise
- Report to the *EU Noise Steering Group* [15]

In some ports measures have already been introduced because of complaints from local residents. Most important of these are:

- Construction of noise barriers

[50] www.t-e.nu/docs/Factsheets/2003/12203UrbanHealth.pdf
[51] Directive relating to the assessment and management of Environmental noise 2002/49/EC of 25 June 2002

- Capsules of loud units made of noise absorbing materials
- Positioning of noise emitting units as low as possible
- Replacement of forklifts and reach-stackers with gantry cranes with rubber tyres
- Replacement of diesel vehicles with electric vehicles
- Abandonment of vehicles with high revolutions per minute
- Modification of acoustic signals when moving cargo
- Replacement of large vehicles with several smaller ones
- Covering of buffer stops with rubber-protectors (trailers, and wagons).

Additionally, loud activities are to be carried out during day-time and the traffic in port is to be reduced. Communication with residents is also mentioned as an important factor, in order to be able to respond in time to their reservations and to find solutions together with them. As is shown below, the supply of ships with electricity from land can also reduce the emission of noise considerably.

6.4 2 Reduction of noise emissions on board

For units to be installed on board there are generally noise emission regulations in place, including certain levels which may not be exceeded. These serve above all the protection of the health of the ships´ crew on board. Additionally in ports ambient noise is often caused during the loading and discharge operations which can hardly be avoided (noise caused by the setting down of containers, of shunting heavy goods, noise caused by the movement of ramps and hatch covers, signalling for moving vehicles and the ship at berth in general). In order to avoid or reduce noise there are however some operational measures available, which can help to abate the nuisance.

These measurers include e.g. the ventilators running during loading or discharging operations especially when vehicles on RoRo vessels are deployed. The ventilators are used to exchange the air polluted by exhaust gases and they cause considerable noise when blowing the air out. In addition, the noise is often increased by loose parts which rattle. Normally these ventilators can be switched off when loading or discharge operations are finished (after waiting a few moments so as to get rid of the polluted air). Examinations in some ports have shown however, that this is often not done. The ventilators often were left on much longer than necessary probably because of carelessness or because there was no “understanding” of the problem. After instructions were issued to the relevant persons the noise could be reduced considerably without much effort. Additionally reductions in cost were achieved for the shipping companies, as the ventilators were now running for much shorter periods of time.

6.5 Reduction of vibrations

The main sources of vibrations are the main and auxiliary engines on board. Theoretically a reduction of vibrations could be achieved by placing the engines on flexible supports. This is done on ships where vibrations have to be avoided at all costs, e.g. on research ships for carrying out geophysical measurements. However, this is in general not important for conventional cargo ships as usually the problem of having to avoid vibrations at sea or in ports near residential areas does not come up. If at all this is relevant for ferries and passenger ships because these vessels often berth as close to city centres as possible, as is e.g. the case with the new cruise ship terminal in Hamburg near the old "Speicherstadt".

The alternative to shift the berths of cruise ships to areas further away of residential and shopping areas, is generally not supported by the town- and port authorities who wish to keep the ports attractive for the tour operators. A possibility for reducing vibration in ports is to supply the ships with shore-side electricity in order to turned off the engines while being alongside. This is on certain cruise terminals already in practise.

This situation, however, will be no problem in Lübeck-Travemünde anyway, as in future a bridge will block the entry to the berths in question. Cruise ships with a length of more than 100m will not be able to enter the town centre when the bridge has been built.

7 Supplying ships with shore-side electricity during time at berth

As this measure can reduce several problems in port, the supply of is shown here separately. By applying shore-side electricity a reduction or even avoiding of emissions caused by ships´ operations as well as a reduction of noise and vibrations can be achieved. Technically it is generally possible to supply ships with external electricity. This is carried out for example while the ship is in the shipyard, because in this time the engines and auxiliary units are often overhauled. But in this situation the consumption of energy on board is reduced to a minimum, creating a considerable difference to the level needed during normal ships operations.

Because of the different voltages and frequencies on shore and their relation to the required power on board cost and personnel intensive solutions would be necessary, which are presently not feasible for realisation. In this context the required power of different types of ships plays an important role. While a consumption of c. 2MV is assumed for ferries, passenger ships or container ships with many reefer-sockets can require 7 to 11 MV. On the other hand on land in Europe a mean voltage of 10, 20 or 30 kV/50 hertz is supplied as a rule (other data apply in foreign countries), whereas the situation is quite different on ships. Here 3 to 11 kV and 50 or 60 Hz are in place.

However since powerful, interruption free switchboxes for the electricity supply have been developed it is generally possible to supply the amount of energy required for normal ships´ operations during time at berth. The electronic and electro technical equipment can be run without disturbance or interruption, also when switching from shore-side electricity to board generated electricity.

The transmission of the required energy using manageable cables can be achieved only by voltages in the medium voltage range. Using the existing electricity supply on land, ships as a rule can be supplied with 6.6 or 10 kV. In the long term this means standardising ships´ equipment and supplementing the main electric circuits so that medium voltage can be used, and transforming as ships´ operations require. The supply must be made available to ships at the quays either from stationary or mobile units, or if necessary via a boom to the power unit on board.

Such systems are used by the navy at high sea in order to supply electricity to other ships, too. As these systems have up to now hardly been used in commercial shipping, or only with very low efficiency, the development and testing of such a connection should be undertaken within further research projects.

A realisation of this concept could also present economic advantages, as in some cases the cost of a kilowatt/hour generated on board can well be more than the trade rate for a kilowatt/hour on land. In addition, it is pretty well certain that fuel costs will rise, and that with shore-side electricity the intervals between engine maintenance will be lengthened.

There has been shore-side electricity for commercial shipping for some years. Between the ports of Stockholm and Helsinki Viking-Line started a land-based supply of electricity for their passenger ships already in the 90s. The Princess-Line has installed land-based electricity in Juneau (Alaska), which is used by five of their ships. This cost the Princess-Line c. 5.5 million US dollars for the station on land and c. 550,000 USD for each of the installations on board. The running costs per day per ship at berth are c. 1,000 USD more than would be the case if fuel was used to generate power during this time.

Shore-side electricity for freighters has been available in Gothenburg for some years. Originally it was installed because the port area affected was directly next to living areas and the inhabitants complained about the emissions. The only alternative to re-locating the berths was to provide the ships with electricity from land. This facility has been in operation since 2000, as has also the one in Zeebrugge, which is used regularly by the ships of Stora Enso transporting cellulose on fixed routes. Calculations have shown that there have been reductions of c. 80 t nitrogen oxide, 60 t SOx and 2 t particles annually in the port of Gothenburg. In shipping circles these examples have generally been dismissed as "not viable for normal commercial shipping".

Picture 35: Supply of electricity for ships by means of a cable connection in port

www.portgot.se

7.1 Shore-side electricity for ships in Los Angeles

The construction of shore-side electricity for conventional large container ships in Los Angeles and the official opening of this on 21st June 2004 could be a breakthrough to increased acceptance of the concept. As wide-ranging research was carried out for this project, it is described in more detail here.

The total port has eight modern container terminals. It has a turnover of c. 5.5 million TEU per year, thus lying in seventh place on the list of turnover worldwide. It had been calculated that of the 33 t nitrogen oxides emitted daily by ships (including times at berth and in local waters), c. 11 t came from the auxiliary engines during times at berth. This ratio between main engines and auxiliaries was seen to be similar in the case of particles, too. The reasons for installing the first shore-side supply were the same as in other ports: the public was no longer prepared to accept the pollution caused by ships[52]. In order to ensure that the port could continue to expand a number of different measures were taken to reduce emissions. One of these measures was the provision of shore-side electricity.

The first ship to be provided with shore-side electricity was *M/V Xin Yang Zhou* of the China Shipping Company. The company has agreed to equip five new ships with the necessary

[52] "Environmentalists and homeowner groups sued the port in 2001 over the China Shipping terminal, successfully shutting down work on the project for several months. The lawsuit was settled in March, resulting in a precedent-setting agreement that required the port to provide $50 million worth of environmental projects to San Pedro and Wilmington" [http://209.157.64.200/focus/f-news/928831/posts].

technology, and will check to see whether 14 other ships can be refitted. During the official opening of the electricity supply from land, a *Memorandum of Understanding* was signed between the port and seven further shipping companies, agreeing on the future use of shore-side electricity installations.

7.1.1 The *Cold Ironing* Study: Shore-side electricity for ships in Los Angeles

In the *Cold Ironing Study* [32], first of all the operative conditions for the various berths were recorded and the ships docking here were identified. The size and multiple function of the port meant that all important types of ship were included.

In addition, the technical prerequisites and the energy needed on board the various ships were determined. It became clear that there is considerable variation in requirements relevant to the supply of electricity. It was particularly important to determine the amount of energy needed during times at berth, which varies according to the type of ship.

Table 38: Conditions necessary for supplying ships with shore-side electricity

Vessel Type	Vessel Name	Vessel ID	Year Built	Vessel Operator	Usual Terminal & Berth	Terminal Operator	Average Berth Time (hrs/call)	Calls per Year
Container	*Victoria Bridge*	9184926	1998	K-Line	J232	International Transportation Services	44	10
Container	*Hanjin Paris*	9128128	1997	Hanjin	T136	Total Terminals	63	10
Container	*Lihue*	7105471	1971	Matson	C62	SSA Terminals	50	16
Container/ Reefer	*OOCL California*	9102289	1996	OOCL	F8	Long Beach Container Terminal	121	8
Reefer	*Chiquita Joy*	9038945	1994	Inchcape/WD	E24	California United Terminals	68	25
Cruise	*Ecstasy*	8711344	1991	Carnival	H4	Carnival	12	52
Tanker	*Alaskan Frontier*	NA	2004	Alaska Tanker	T121	ARCO Terminal Services Corp	33	15
Tanker	*Chevron Washington*	7391226	1976	Chevron Texaco	B84	Shell	32	16
Tanker	*Groton*	7901928	1982	BP	B78	ARCO Terminal Services Corp.	56	24
Dry Bulk	*Ansac Harmony*	9181508	1998	Transmarine	G212	Metropolitan Stevedore	60	1
RO-RO	*Pyxis*	8514083	1986	Toyofuji	B83	Toyota	17	9
Break Bulk	*Thorseggen*	8116063	1983	Seaspan Shipping	D54	Forest Terminals	48	21

[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: “Cold ironing cost effectiveness”, Volume I Report, California, March 30, 2004.

Table 39: Type and size of ship and required energy

Vessel Type	Vessel Name	Gross Registered Tonnage	Number of Generator Engines	Installed Generator Capacity (kW)	Average Load (kW)	Load Factor (% of capacity)
Container vessels	*Victoria Bridge*	47,541	4	5,440	600	11%
	Hanjin Paris	65,453	4	7,600	4,800	63%
	Lihue	26,746	2	2,700	1,700	63%[1]
	OOCL California[2]	66,046	4	8,400	950	62%
Reefers	*Chiquita Joy*	8,665	5	5,620	3,500	62%[1]
Cruise vessels	*Ecstasy*	70,367	2	10,560	7,000	66%[1]
Tankers	*Alaskan Frontier*	185,000	4	25,200	3,780	15%
	Chevron Washington	22,761	2	2,600	2,300	89%
	Groton	23,914	2	1,300	300	23%
Dry bulk	*Ansac Harmony*	28,527	2	1,250	625	50%[1]
Auto carrier	*Pyxis*	43,425	3	2,160	1,510	70%
Break bulk	*Thorseggen*	15,136	3	2,100	600	29%

[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: "Cold ironing cost effectiveness", Volume 1 Report, California, March 30, 2004.

Depending on various factors the provision of costs for a shore-side electricity on land and on board can vary considerably. These factors include particularly the types of ships, how often they docked at the port and how long they are at berth. The following table 40 shows the electrical layout on board, the amount of energy needed and the costs.

Table 40: Summary of costs for installation on board

Vessel	KW	Volts	Amperes	Cost
Victoria Bridge	700	450	1120	$296,000
Hanjin Paris	4800	450	7700	$1,106,000
Lihue	1700	450	2800	$452,000
OOCL California	5200	450	8300	$977,000
Chiquita Joy	3500	450	5600	$751,000
Ecstasy	7000	6600	765	$574,000
Alaskan Frontier	7800	6600	850	$457,000
Chevron Washington	2300	4160	400	$380,000
Groton	300	450	480	$202,000
Ansac Harmony	600	450	960	$296,000
Pyxis	1500	450	2420	$414,000
Thorseggen	600	450	960	$236,000

[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: "Cold ironing cost effectiveness", Volume 1 Report, California, March 30, 2004.

On the basis of the fuel used, engine performance and time at berth, emissions were quantified to be able to reckon potential use. As well as the pollutants presently under discussion other pollutants on which there will be regulations within the foreseeable future were also taken into consideration.

Table 41: Emissions from selected ships during times at berth

Vessel Name	Emission (tons/yr)					
	VOC	CO	NO_X	PM_{10}	SO_X	Combined
Victoria Bridge	0.0	0.7	3.8	0.43	3.5	8.4
Hanjin Paris	0.6	2.3	53.9	4.93	40.4	102
Lihue	0.1	0.4	4.1	3.64	22.8	31.1
OOCL California	0.7	13.7	73.5	8.36	68.4	165
Chiquita Joy	0.9	15.9	85.5	9.72	79.5	191
Ecstasy	0.8	2.9	69.3	6.34	51.9	131
Chevron Washington	0.1	0.1	7.4	0.29	1.5	9.4
Groton	0.1	0.6	4.3	0.10	0.4	5.5
Alaskan Frontier	0.4	1.4	25.3	2.98	24.4	54.5
Ansac Harmony	0.0	0.1	0.5	0.06	0.5	1.2
Pyxis	0.0	0.6	3.2	0.36	3.0	7.1
Thorseggen	0.1	1.6	8.6	0.15	0.6	11.0
Total	**3.9**	**40.3**	**340**	**37.4**	**297**	**718**

[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: "Cold ironing cost effectiveness", Volume 1 Report, California, March 30, 2004.

In the quantification, special consideration was given to those ships with frequent and/or long times at berth and with relatively high engine performance, causing the greatest emissions of pollutants. It turned out that cost effectiveness was different in each case. It was best of all for the cruise ship *MV ECSTACY* because of the high amount of energy needed, the high potential pollution and the fact that the ship docked in port practically every week, even if only for 12 hours.

Table 42: Energy needed and cost effectiveness of shore-side electricity

	Victoria Bridge	*Hanjin Paris*	*Lihue*	*OOCL California*	*Chiquita Joy*	*Ecstasy*	*Chevron Washington*	*Groton*	*Alaskan Frontier*	*Ansac Harmony*	*Pyxis*	*Thorseggen*
Total calls per year	10	10	16	8	25	52	16	24	15	1	9	21
Average Berth Time (hrs/call)	44	63	50	121	68	12	32	56	33	60	17	48
Average Power Demand at Berth (kW)	600	4,800	1,700	5,200	3,500	7,000	2,300	300	3,780	600	1,510	600
Total Annual Power Use (Million kW-hr)	0.3	3.0	1.3	5.0	5.8	3.8	1.1	0.4	1.8	0.0	0.2	0.6
Cost Effectiveness ($1,000/ton)	$87	$15	$37	$11	$11	$9	$44	$42	$15	$426	$38	$90
Ranking	10	5	6	3	2	1	9	8	4	12	7	11
Cost-Effective (Yes/No)	No	Yes	No	Yes	Yes	Yes	No	No	Yes	No	No	No

[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: "Cold ironing cost effectiveness", Volume 1 Report, California, March 30, 2004.

The most important prerequisite for positive cost effectiveness is a high supply of electricity to ships at berth, with a consequent reduction of emissions. Under the conditions given in Los Angeles, an electricity supply of at least 1.800,000 kWh was necessary for a positive balance in cost effectiveness. Under the supposition that there is cost/benefit effectiveness when costs are less than 15,000 USD per ton of reduced emissions, supplying ships with shore-side electricity could be seen as meaningful in five cases.

Table 43: Review of the total results of the survey

Vessel Name	Vessel Operator	Vessel Type	Pier and Berth	Combined Emission Reduction (tons/yr)	Total NPV ($)	Cost Effectiveness ($/ton)	Rank
Victoria Bridge	K-line	Container	J232	8.3	$7,251,000	$87,000	10
Hanjin Paris	HANJIN	Container	T136	100.3	$14,717,000	$15,000	5
Lihue	Matson	Container	C62	30.2	$11,266,000	$37,000	6
OOCL California	OOCL	Container	F8	165	$18,527,000	$11,000	3
Chiquita Joy	Great White	Reefer	E24	187.9	$20,155,000	$11,000	2
Ecstasy	Carnival	Cruise	H4	129.0	$12,160,000	$9,000	1
Chevron Washington	Chevron Texaco	Tanker	B84	8.7	$3,817,000	$44,000	9
Groton	BP	Tanker	B78	5.3	$2,202,000	$42,000	8
Alaskan Frontier	Alaska Tanker	Tanker	T121	53.4	$8,251,000	$15,000	4
Ansac Harmony	Transmarine	Dry Bulk	G212	1.2	$5,032,000	$426,000	12
Pyxis	Toyofuji	RO-RO	B83	7.0	$2,693,000	$38,000	7
Thorseggen	Seaspan	Break Bulk	D54	10.7	$9,589,000	$90,000	11
Average of All Vessels				**59.0**	**$9,638,000**	**$69,000**	
Total of All Vessels				**698.3**	**$108,409,000**	**$16,000**	

[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: "Cold ironing cost effectiveness", Volume I Report, California, March 30, 2004.

In addition to the cost/benefit effectiveness, the table shows the quantities of possible emission reduction for each and terminal. The following table shows that there are not only in costs but also savings for shipping, mainly due to reduced fuel consumption.

Table 44: Annual saving on fuel

Vessel Name	Fuel Type	Fuel Savings	
		(metric tons/yr)	($/yr)
Victoria Bridge	HFO	57	$9,000
Hanjin Paris	HFO	655	$106,000
Lihue	HFO	371	$60,000
OOCL California	HFO	1,111	$181,000
Chiquita Joy	HFO	1,291	$210,000
Ecstasy	HFO	842	$137,000
Chevron Washington	MGO	330	$100,000
Groton	MGO	87	$26,000
Alaskan Frontier	HFO	397	$64,000
Ansac Harmony	HFO	8	$1,000
Pyxis	HFO	48	$8,000
Thorseggen	HFO	130	$39,000

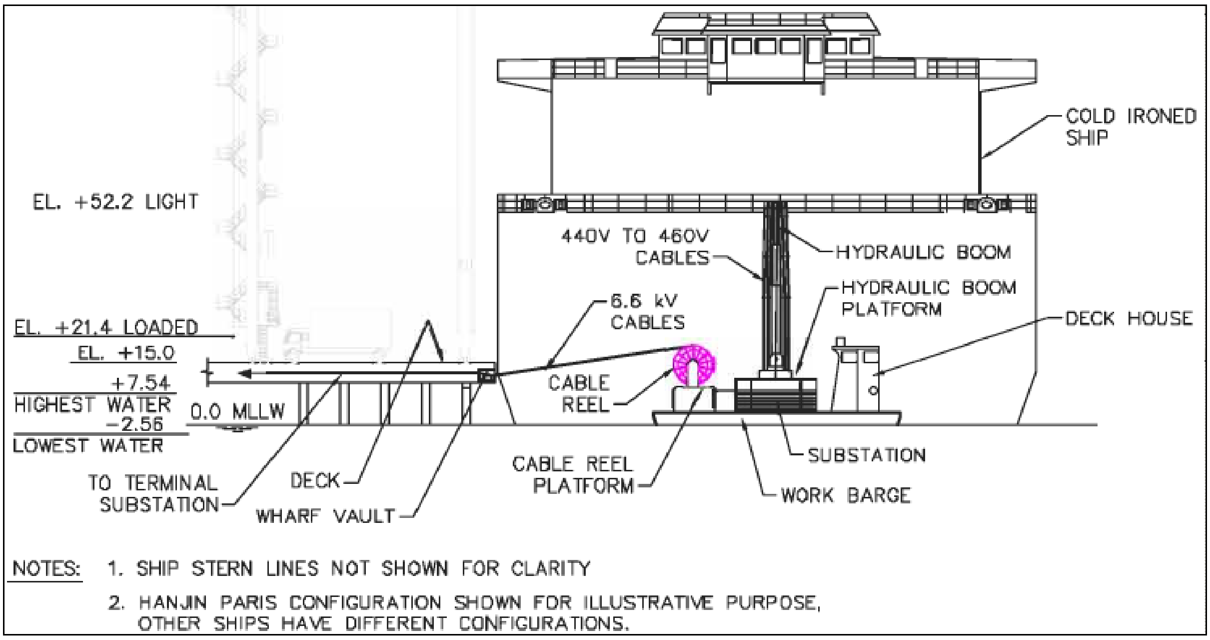
[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: "Cold ironing cost effectiveness", Volume I Report, California, March 30, 2004.

7.1.2 Installation of shore-side electricity on land in Los Angeles

Apart from a few particular cases (see above), there has been hardly any experience in the construction of electricity connecting points on land for ships. It was seen that different designs for different terminals are possible and sensible. For reasons of flexibility, and in order to avoid disturbing harbour operations by construction on land, the transformer, cable drums etc can be installed on a barge (picture 37).

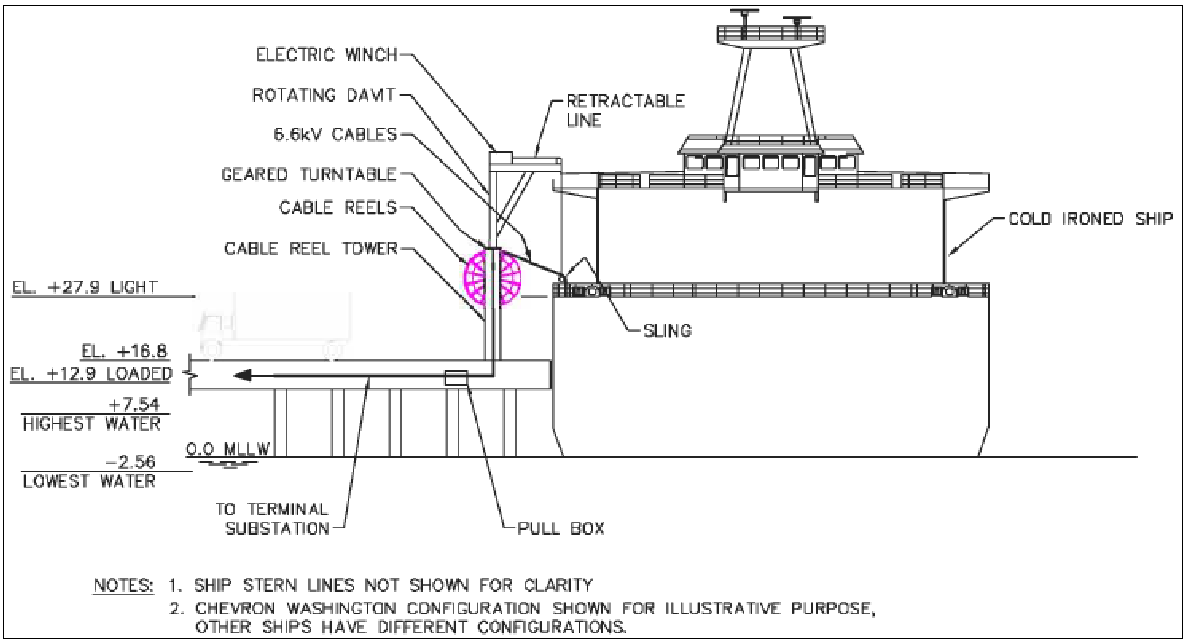
This version however is comparatively expensive and requires a relatively high number of personnel. Construction of the necessary installations on land is simpler and less expensive, but as a rule demands modification of existing structures.

Picture 36: Connection of shore-side electricity from land to ship via barge



[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: “Cold ironing cost effectiveness”, Volume I Report, California, March 30, 2004.

Picture 37: Connection of shore-side electricity from land installations only



[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: "Cold ironing cost effectiveness", Volume I Report, California, March 30, 2004.

Both variants were calculated through and included in the analysis of cost effectiveness for each berth. The following table gives a summary of the installations on land:

Table 45: Survey of costs for shore-side electricity of land installations

Vessel Name	Terminal	Meter to Terminal Substation Run	Substation	Terminal Substation to Wharf Run	Run Under the Wharf	Wharf Vaults	Fender Piles	Wharf Ladder	Single Cable Reel Towers (6.6kV)	Double Cable Reel Towers (2x6.6kV)	Combo Single and Double Reel (3x6.6kV)	Total
Victoria Bridge	ITS	$15,471	$57,973	$13,326	$103,318	$163,367	$23,725	$25,188	$0	$0	$0	$402,000
Hanjin Paris	TTI	$15,471	$112,390	$13,326	$6,078	$163,367	$23,725	$25,188	$0	$0	$0	$360,000
Lihue	SSA	$134,085	$107,344	$115,495	$6,078	$163,367	$23,725	$25,188	$0	$0	$0	$575,000
OOCL California	LBCT	$15,471	$57,973	$13,326	$6,078	$163,367	$23,725	$25,188	$0	$0	$0	$305,000
Chiquita Joy	CUT	$39,194	$107,344	$33,760	$103,318	$163,367	$23,725	$25,188	$0	$0	$0	$496,000
Ecstasy	Carnival	$59,822	$143,636	$51,528	$32,211	$0	$0	$0	$0	$0	$468,455	$756,000
Alaskan Frontier	BP	$49,508	$143,636	$42,644	$27,957	$0	$0	$0	$0	$378,690	$0	$1,642,000[(1)]
Chevron Washington	Shell	$11,346	$107,344	$9,773	$6,078	$0	$0	$0	$0	$378,690	$0	$513,000
Groton	BP	$150,587	$57,973	$129,709	$6,078	$0	$0	$0	$247,845	$0	$0	$592,000
Ansac Harmony	MS	$20,938	$57,973	$18,035	$103,318	$163,367	$23,725	$25,188	$0	$0	$0	$413,000
Pyxis	Toyota	$2,063	$57,973	$1,777	$6,078	$0	$0	$0	$247,845	$0	$0	$316,000
Thorseggen	FT	$36,925	$57,973	$31,805	$97,240	$163,367	$23,725	$25,188	$0	$0	$0	$436,000

[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: "Cold ironing cost effectiveness", Volume I Report, California, March 30, 2004.

Because of the high need of energy and the available medium electricity supply of 6.6 KV the ship *MV ECSTACY* needs three cables; this is very cost-intensive. Following table shows the cost-situation on board and on land:

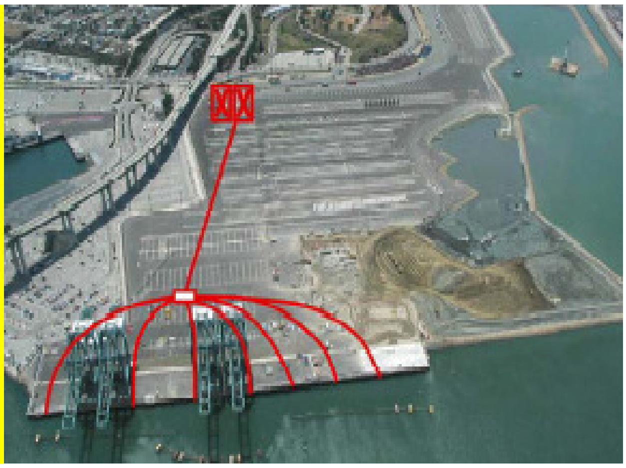
Table 46: Survey of costs on board and on land

Vessel Name	Vessel side ($)	SCE ($)	Terminal ($)	Work-barge ($)	Terminal O&M ($/yr)	Workboat O&M ($/yr)
Victoria Bridge	$296,000	$944,000	$402,000	$1,805,000	$49,000	$350,000
Hanjin Paris	$1,106,000	$3,039,000	$360,000	$2,216,000	$49,000	$462,000
Lihue	$452,000	$941,000	$575,000	$2,048,000	$49,000	$530,000
OOCL California	$977,000	$761,000	$305,000	$2,216,000	$49,000	$6,000,000
Chiquita Joy	$751,000	$977,000	$496,000	$2,048,000	$49,000	$979,000
Ecstasy	$574,000	$2,323,000	$756,000	$0	$71,000	$0
Alaskan Frontier	$457,000	$2,413,000	$1,642,000	$0	$21,000	$0
Chevron Washington	$380,000	$796,000	$513,000	$0	$22,000	$0
Groton	$202,000	$495,000	$592,000	$0	$33,000	$0
Ansac Harmony	$296,000	$717,000	$413,000	$1,805,000	$49,000	$150,000
Pyxis	$414,000	$707,000	$316,000	$0	$12,000	$0
Thorseggen	$236,000	$567,000	$436,000	$1,805,000	$49,000	$641,000

[32]: ENVIRON International Corporation for Port of Long Beach, Long Beach, California: “Cold ironing cost effectiveness”, Volume I Report, California, March 30, 2004.

The shore-side supply of electricity actually realised in Los Angeles is shown in following picture. (In this case the shore-side connection could be installed without a barge).

Picture 38: Shore-side electricity at Terminal 100 in Los Angeles



http://pnwis.org/2004%20Events/PortAQ/T.L%20Garrett.pdf

In an official statement at the opening of the installations it was said, "Port officials estimate that the cost of retrofitting container vessels for AMP will range from $200,000 to $500,000 per ship. They are currently negotiating with other shipping companies to partner in the technology. So far, six other firms have signed a memorandum of understanding with the port for future use of AMP while their container vessels are berthed: Evergreen America, Mitsui OSK, Nippon Yusen Kaisha, Orient Overseas Container Line, P&O Ned Lloyd and the Yang Ming Line."

Picture 39: Supply of electricity at Terminal 100 in Los Angeles

CHINA SHIPPING PLUGS IN

The Port of Los Angeles unveiled the world's first electrified container terminal in June 2004, where ships can plug in to shoreside power while at berth instead of continuously running their dirty diesel engines to generate electricity. The new China Shipping Line terminal facility is expected to eliminate at least 1 ton per day of nitrogen oxides and particulate matter for each ship that plugs in, and can accommodate two ships at one time, according to the Port of Los Angeles. The Port of Los Angeles also reports that one vessel call is equivalent to about 69,000 diesel truck miles—enough to drive around the world nearly three times.

The shoreside power facility is part of a legal settlement negotiated by NRDC, Coalition for Clean Air, Communities for a Better Environment, and two San Pedro homeowner groups, who sued the Port and City of Los Angeles in 2001 alleging they had approved the China Shipping Line terminal without considering or mitigating harm to neighboring communities. The final settlement also requires the port to use terminal tractors that run on cleaner, alternative fuels instead of diesel; to evaluate the feasibility of cleaner marine fuels; and to minimize aesthetic impacts of cranes. The port must also establish a $50 million fund for mitigation of air quality and aesthetic impacts in the community, including $10 million to clean up old trucks.

Sources: Port of Los Angeles, Alternative Marine Power, 21 June 2004, http://www.portoflosangeles.org/Environmental/AMP.htm (29 June 2004).

[37]: D. Bailey, T. Plenys, G. Solomon, T. Campbell, G. Ruderman, J. Masters, B. Tonkonogy: HARBORING POLLUTION - Strategies to Clean Up U.S. Ports, August 2004.

7.1.3 Summary of the results of the *Cold Ironing* Study

Supplying ships in port with shore-side electricity may solve a whole range of problems. It has been reckoned that cruise ships manoeuvring and berthing in port emit daily the equivalent of 12,400 cars or 1.5 tons of nitrogen oxide. Compared with the operation of auxiliary boilers, the use of shoreside power means c. 99% less NOx emissions, 83-97% less particle emissions, almost 100% less SOx pollutants and 66% less greenhouse gases[53].

With a supply of shore-side electricity, the auxiliary diesels, or under the diesel-electric principle, the main engines can be shut down. This achieves the following consequences:

For local residents around the port

- Reduction of the emission of pollutants (various pollutants)
- Reduction of noise and vibration

[53] Source: Environ for the Port of Long Beach, West Coast Governor's Global Warming Initiative Ports Working Group Report.

For shipping companies/ ships´ crews

- Saving on costs for fuel and lubrication oils
- Reduction of exhaust emission, noise and vibration
- Opportunity for maintenance/repair of auxiliary generators
- Lengthening of periods between maintenance

The shore-side electricity cannot reduce all ship-generated emissions in port. During times at berth, heating is needed which at present cannot be supplied by electricity. This means that the auxiliary boilers must be in operation even if there is a shore side power supply. Other solutions must be found for this (e.g. use of exhaust filters). In addition, shore side power is only effective after a certain length of time at berth, as shutting down and starting up the engines and running at low load or with cold engines lead to higher emissions.

Handling cables, synchronisation, etc. can be seen as no problem, at least for the power needed in ferry traffic in Lübeck-Travemünde, and cannot be compared with the situation several years ago often quoted or e.g. with solutions applied with the navy. The power needed can be easily supplied by means of one cable (diameter c. 7 cm) and practical plug/socket connections. The design for such a shore-side installation has been summarised by the Siemens Company.

7.2 Description of a shore-side installation from Siemens Company

The following description of the project gives the construction of the individual primary and secondary functions of a 10 kV shore-side connection point for ships with a total capacity of 1.6 MVA at 50 Hz (6o Hz. see point 11). The technical points described in the following have already been agreed on with German Lloyd.

1. 10 kV power controls for the shore-side power supply to the 1.6 MVA transformer on board ship. The vacuum power control is for the rated voltage of 10 kV and equipped with a short circuit power cut set at 16 kA.
2. 10 kV main cables for the supply of power. The main cable is to be designed to take 320 A, in order to achieve standardisation of the cables and the 10 kV plugs/sockets on land. The main cable not only conducts the electricity but also contains the core for potential equalisation and the fibreglass conductor for land-to-ship communication.
3. Cable drums on land. Units of medium voltage are only permitted on board ship if they are securely fixed. For this reason, the cable drum must be installed on land and designed to extend to the connecting point on ship. The cable drum has a check on the max. tension allowed with an emergency switch-off function. This implies already standardisation together with those ships equipped with 10 kV electric circuits on board.
4. Industrial sockets for the power and control cables. To connect the 10 kV and the control cable, an industrial socket for a rated power of 320 A was chosen. This socket has a pilot contact serving as the emergency switch-off function and also contains the secondary fibreglass conductor. Two further contacts provide the power compensation from land-to-ship. The 10 kV plug is to be installed on the cable drum. The socket is to be installed on the ship.
5. 1.6 MVA transformer on board. The cast resin transformer may be constructed in IP 00 if it is installed in an electrically secured room. If this cannot be guaranteed, the

transformer must be installed in a protective casing IP 23. Bearing in mind the strain caused by vibrations on board, the transformer must be constructed with mechanical reinforcing laterally and crosswise. Depending on the length of cables from the sockets to the transformer it must be checked whether the cable needs to be protected with fuses.

6. Measurement of electricity and voltage on board. A meter is to be installed in the transformer room for the measurement of electricity and voltage. This is necessary for the realisation of the differential safety device, the over-current-protection timer device on board and the automatic switch off of the board network in the case of trouble. Integrated in this are the signals for the transformer- warning and the transformer-switch off.

7. Secondary protection equipment on land. A digital safety device is installed in the 10 kV power switchboard of the shore-side supply which communicates with the board network by means of a fibreglass conductor and Profibus DP. This device registers if earthing occurs towards the ships´ supply. On board such a device is already installed in the main switchboard.

8. Secondary emergency equipment on board ship. In the course of the transformer control the transformer- temperature warning is provided for further processing. The signal of the transformer-switch off is led directly to the 10 kV power switch of the shore-side supply. This results in immediate 10 kV switch-off and automatic earthing of the shore-side power supply.

9. Shutdown conditions, land – ship. It must be assured, that plugging the 10 kV shore-side socket in can only be possible when the supplying circuit is earthed. Is the plug pulled out during the supply of shore-side 10 kV electricity the 10 kV power switch opens automatically on land and the additional earthing switch is closed.

10. Land – ship communication. After the primary and secondary shore-side supply connections have been installed the energy supply is switched on automatically by means of the fibreglass connection on land per Profibus DP from the ship under consideration of the required shutdown conditions. Only the mechanic socket connection is done by the personnel on land. The shore-side supply is then activated automatically on board.

11. 60 Hz supply. There are two possibilities to connect a 60 Hz board circuit to a 50 Hz shore-side supply, namely by means of rotating or stationary transformers. As one can expect not inconsiderable problems trying to control the short-circuit power of rotating transformers the use of stationary transformers is advised which have already been realised by Siemens with efficiencies of 1 MVA and more.

12. In general. All required changes and modifications on the ships switchboard are not part of this document. Following conditions have to be considered in all possible shore-side connections:

- Neutral point treatment
- Effects of too high voltage, e.g. caused by lightning
- Network coupling and respective short-circuits when supplying several ships with one shore-side connection.

8 Consideration of the legal possibilities for environmental protection

Several international and national legislations, rules and voluntary commitments together with their respective limits of action and responsibility create the basis for options of action. It is being examined in the following whether the legal framework can give a foundation of authorisation to commit the ship owners as well as the port authorities to introduce measures for the enhanced protection of the environment in view of the background of increasing shipping traffic and the emissions resulting from this in German ports. Topics of relevant international, European as well as national legislations are discussed. Especially the question, whether it would be possible to introduce obligatory commitments on the basis of UNCLOS[54], European or national law, is followed. Lastly a voluntary commitment of ports as well as ship owners as an alternative to the command and control and relevant questions are discussed.

8.1 International Law

Within the scope of international law UNCLOS as well as the MARPOL and the Helsinki-Convention are relevant.

8.1.1 United Nations Convention on the Law of the Sea (UNCLOS)

The United Nations Convention on the Law of the Sea is, with its 436 articles, a very extensive and important multilateral contract. It has replaced the four Geneva marine law conventions of 1958 and gives regulations on almost all areas of the international marine law (the definition of the different zones of the seas, namely coastal waters, connecting areas, straits, archipelago waters, exclusive economic zones, continental shelf, high sea; use of these areas by shipping, flying over, laying cables, fishing and scientific marine research, protection of the marine environment, development and of marine technology; regulation of seabed mining; settling of arguments, especially the introduction of the international marine court of law). Valid international marine law was codified by the SRÜ (Seerechtsübereinkommen = German translation of UNCLOS) and new international marine law standards were introduced, e.g. in the area of marine protection.

According to article 17 [Right of innocent passage] of UNCLOS[55] ships of all nationalities have the right of innocent passage through coastal waters. This law is to be taken as an important limitation of the sovereignty of the coastal states. The word "passage" is defined in article 18 [meaning of passage] of the SRÜ as: "Moving through coastal waters in order to, […] b) enter internal waters or leave them or enter or leave such a roadstead or port facility".

According to article 19, paragraph 2 SRÜ[56], when a foreign ship carries out activities mentioned in 19 paragraph 2 lit. a-1) of the SRÜ, e.g. according to art. 19 paragraphs 2 lit h SRÜ causing "deliberate heavy pollution against this agreement" this right of peaceful passage

[54] UNCLOS: United Nations Convention on the Law of the Sea

[55] Agreements on shipping regulations of the United Nations from 10th December 1982 [BGB1. 1994 II, p. 1799].

[56] cf. article 19 paragraph 2: "Passage of a foreign ship shall be considered to be prejudicial to the peace, good order or security of the coastal State if in the territorial sea it engages in any of the following activities: […]". A summarisation of several different activities in point a. to 1.

does not apply. If air pollution can count as "deliberate heavy pollution" within the scope of the generally accepted standards in sight of article 19 paragraph 2 lit. h) is uncertain.

Air pollution caused by shipping could fall under the definition of article 1 paragraph 1 no. 4 of the SRÜ, apart from the fact that the air is polluted and the marine environment only indirectly. This could be derived from the wording "pollution of the marine environment means the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, […] into the marine environment". This view is also supported by article 194 [measures for the prevention, reduction and supervision of pollution of the marine environment] paragraph 3 lit. a), in which the "setting free of noxious or harmful substances, especially of those which are stable, from land, from the air or by the air or by input" are included. Additionally it is demanded in article 212 [pollution from the air or by the air] paragraph 1 SRÜ that the states introduce "laws or other regulations for the prevention, reduction and supervision of the pollution of the marine environment from the air or by the air". Both regulations can, however, only apply to own ships, meaning here ships under German flag or ships in the German register[57]. As well as this, article 21 [laws and other regulations of the coastal state on innocent passage] paragraph 2 SRÜ comes before article 212 [pollution from the air or by the air]. And it has to be a "deliberate heavy pollution" according to 19 paragraph 2 lit. h SRÜ. When in doubt this will not be the case if the internationally valid technical standards are considered.

Even so, the coastal state may, according to art. 21 [laws and other regulations of the coastal state on innocent passage] paragraph 1, introduce laws and other regulations about innocent passage. These can be introduced, among others, according to lit. f) in the area "protection of the environment of the coastal state and prevention, reduction and supervision of their pollution"[58]. Restrictions about the content are given in article 21 II and article 24 of the SRÜ. Because of this the regulations may not lead to a restriction of the innocent passage not mentioned in the SRÜ, and may not affect the construction, manning or equipment of a foreign ship. Restrictions in the speed of a ship would be possible according to this.

Article 211 [Pollution from vessels] in the SRÜ determines the right of the states to introduce regulations for the prevention, reduction and monitoring of the pollution caused by ships (regulating authority). In the articles 218 ff. [59] [Enforcement by port States] and especially article 222 [Enforcement with respect to pollution from or through the atmosphere] of the SRÜ establish special authorisations of the port- and coastal state for the protection of the marine environment. Explicit regulations for the protection of the marine environment are to be found in article 211 paragraphs 3 and 4 in the SRÜ. According to these, a state has the right and the obligation to create suitable international regulations and standards within the scope of the competent international organisations or a diplomatic conference.

In view of article 194 [Measures to prevent, reduce and control pollution of the marine environment] paragraph 1 SRÜ a state, "shall take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and in accordance with their capabilities, and they shall endeavour to harmonize their policies in this connection.; […]". These measures can also relate to air pollution.

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[57] Regulations about the flag rights of seagoing ships and the flagging of inland ships (flag right regulation) of 26th October 1994. Cf. also the flag right regulation from 4th July 1990 [BGB1. I 1990, p. 1389]

[58] cf. article 211 paragraph 4 as well as article 212 SRÜ.

[59] The regulation of article 218 in the SRÜ is not to be mistaken for the "port state control" in the Paris MOU or the PSC guideline.

So, because of the provisions in the SRÜ, no obligations can be implemented regulating the use of units for peaceful passage. However, this does not mean the use of all other units, e.g. the installations for loading and discharge operations as well as units used during times at berth. The coastal state does have extensive regulating and authority competence[60] for the internal waters [61]according to article 2 [legal rights of the coastal state] in the SRÜ. Shipping rights for inland waters are not explicitly regulated. There are at any rate no regulations for peaceful passage in internal waters as in article 17 ff. SRÜ. Generally the coastal state does not have to permit foreign states access to their internal waters or even their ports[62]. Article 25 [Rights of protection of the coastal State] paragraph 2 SRÜ, states: "In the case of ships proceeding to internal waters or a call at a port facility outside internal waters, the coastal State also has the right to take the necessary steps to prevent any breach of the conditions to which admission of those ships to internal waters or such a call is subject." This regulating power can also be derived from article 211 paragraph 3 SRÜ[63].

8.1.2 The MARPOL Convention

In a conference in 1973 the *International Maritime Organisation* (IMO), decided on the MARPOL Convention. The aim of the international agreement, was the "prevention of maritime pollution caused by shipping" and the reduction of pollutants into the sea from ships. This is to be achieved by extensive regulations on ship construction, on the equipment on board, regulations on ships´ operations and laws against the disposal of wastes. Because of the increased international awareness with respect to air pollution and the growing importance of shipping the member states urged to take air emissions 1990 on this topic. The parties of the agreement commit themselves to enforce these rules on the ships under their jurisdiction.

Presently, MARPOL contains 6 Annexes, with Annex VI being, relevant for ships exhaust gas emissions. Only minimum standards are set by MARPOL, meaning the "smallest common nominal value". With this the technical possibilities are not in the least exhausted. The needed ratifying extent in Annex VI "rules for the prevention of pollution of the air caused by ships" of the protocol from 1997 to the MARPOL agreement 73/78 was reached with the signing of Samoa on the 18th may 2004. With this, Annex VI was enforced on 19th may 2005.

The view is taken, that the member states of the SRÜ and the MARPOL agreement gave away their rights on national regulations for the entering of their ports by agreeing to the MARPOL standards. Against this, however, should be said that according to article 9 paragraph 2 of the MARPOL agreement, that the SRÜ would be considered first, should conflicts arise between MARPOL and the SRÜ.

[60] Internal waters according to article 8 on behalf of 5 SRÜ from the mean water level in the Baltic Sea [Petersen, German Coastal law, 1989, p. 32 f., 39ff.].

[61] cf. the Nicaragua case (Nicaragua vs. the United States) 1986 [ICJ reports 1986, p. 14].

[62] for this cf. the prohibition of discrimination according to article 227 SRÜ, the Geneva sea port-agreement from 1923 as well as the bilateral shipping and shipping traffic agreements [Lagoni in AVR 1988, p. 284 ff., 296 ff. and 307 ff.]; the exception are ships in emergency situations (force majeure).

[63] 64 so also Koch/Ziehm, safety on board and protection of the marine environment, ZUR 2005, p. 16, 20. Further, see advise of the EU, expert opinion of the legal services from 21.3.2003 for the cooperation of a regulation for changing the regulation (EG) no. 417/2002 in international shipping law, 7610/03.

The right to introduce national laws for entering their ports is therefore given within the scope of regulations in the MARPOL agreement, according to article 25 paragraph 2 and article 211 paragraph 3 in the SRÜ[64].

8.1.3 Helsinki-Convention (HELCON) [65]

The Convention from 09.04.1992 about the protection of the marine environment in the Baltic Sea area [1] (Helsinki Convention or HELCON) contains with article 15 page 1 a regulation for the protection of the environment which commits the parties of the contract to "take all appropriate measures with respect to the Baltic Sea Area and its coastal ecosystems influenced by the Baltic Sea to conserve natural habitats and biological diversity and to protect ecological processes. Such measures shall also be taken in order to ensure the sustainable use of natural resources within the Baltic Sea Area". The main instrument for the realisation of this commitment is, according to the HELCOM-recommendation 15/5 (HELCOM, 1994a), the introduction of a system of protected coastal and marine areas in the Baltic (Coastal and Marine Baltic Sea Protected Areas – BSPAs). Special attention is to be paid, in addition to (further) coast-near areas, marine areas outside the territorial waters. Further HELCOM- recommendations are about:

- Protection of seals (recommendation 9/1)
- Protection of the coast (recommendation 15/1)
- Conservation of the natural coastal dynamics (recommendation 16/3)
- Reduction of inputs from marine fish farming (recommendation 18/3)
- Protection and improvement of the salmon population in the Baltic (recommendation 19/2)
- Sustainable and environmentally sound tourism in the coastal areas of the Baltic (recommendation 21/3)
- Protection of strongly endangered or threatened marine and coastal biotopes of the Baltic (recommendation 21/4).

The revised Helsinki-Convention for the protection of the marine environment of the Baltic was enforced at the beginning of the year 2000.

In HELCON article 8 about the "Prevention of Pollution from Ships" it is pointed to Annex IV in which a ban on burning of waste by ships under the flag of a member state is mentioned in Rule 4, article 10. Other regulations about emissions into the air caused by ships are not included in the Convention.

Additionally, the Convention demands from the contracting partners (Denmark, Germany, EU, Estland, Finland, Latvia, Lithuania, Poland, Russia and Sweden) to take all measures, individually and together, to conserve, look after and develop natural living space, natural processes and the biological variety of the ecological system in the Baltic, including the coastal areas. Until now the Convention had mainly been active with questions of the protection of the marine environment.

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[64] for this see "Koch, Ziehm, aaO, page 21

[65] Convention for the protection of the marine environment in the Baltic Sea Area from 9th April 1992 [BGB1. 1994 II, page 1397].

8.2 European Law

The efforts of the EU strengthen the global acknowledgement of MARPOL 73/78 and create the basis for pressing ahead with the cooperation of the international shipping laws under European legislation.

The ventures of the EU try to bind the international community to stricter demands. In July 2004 the Council agreed to define the proposals of stricter demands on the suggestion of the EU-Commission. According to this, the limit on sulphur dioxide in fuel for ships moving in special areas, and for special ship traffic, will be lowered to 1.5%[66]. Several newer reports and reviews of the EU-Commission exist in which the importance of reducing the emissions caused by shipping is pointed out (e.g. as an approach, to introduce sanctions).

By enforcing the air-quality-regulations the European Community has created the framework for the future development of legislation in the area of air quality. The Air-Quality-Directive especially follows up four aims:

- Definition of air quality goals
- Evaluation of the air quality by means of standardised methods
- Availability of information on air quality and the instruction of the public
- Preservation of good air quality and the improvement of the air quality

The aims and principles named in the air-quality-guidelines are further defined in so-called “daughter directives”. The limits for sulphur dioxide, nitrogen dioxide and nitrogen oxides, particles and lead in the air are given in guideline 1999/30/EG. The European laws on the reduction of emissions are however in most cases not applicable on seagoing vessels. For example, heavy fuel oils on ships are not legally regulated by the EU yet. However, the EU is engaged in the IMO and coordinates the cooperation of the EU member states. The regional standards for protection within the EU give impulses for the international development. Three different regulations for the reduction of air emissions in sea transport are currently in force, two additional guidelines are being worked out:

A). Guideline 2001/81/EG

In guideline 2001/81/EG of the European parliament and in the council from 23rd October 2001 about national limits to emissions of defined air pollutants[67] it is intended, in article 8 paragraph 2, that the Commission report about national programs for the increasing reduction of national emissions[68] caused by shipping to the European parliament and the Council by the 31st December 2002. By 2010 at the latest, the member states have to limit the emissions of

[66] Maximum sulphur content of marine fuels used in SOx Emission Control Areas and by passenger ships operating on regular services to or from ports in the European Community: 1. Member States shall take all necessary measures to ensure that marine fuels are not used in the areas of their territorial seas, exclusive economic zones and pollution control zones falling within SOx Emission Control Areas if the sulphur content of those fuels exceeds 1.5% by mass. This shall apply to all vessels of all flags, including vessels whose journey began outside the Community. (…) 4. Member States shall take all necessary measures to ensure that, from the date referred to in paragraph 2(a), marine fuels are not used in their territorial seas, exclusive economic zones and pollution control zones by passenger ships operating on regular services to or from any Community port if the sulphur content of those fuels exceeds 1.5% by mass. Member States shall be responsible for the enforcement of this requirement at least in respect of vessels flying their flags and vessels of all flags while in their ports.
[http://register.consilium.eu.int/pdf/en/04/st11/st11483.en04.pdf

[67] Official Gazette no. L 309 from the 27/11/2001 S. 0022-0030.

[68] With this the total emissions caused by shipping in the territorial areas is meant independently of the flag state.

sulphur dioxide (SO_2), nitrogen oxides (NOx), volatile organic compounds (VOC) and ammonia (NH_3).

B). Guideline 1999/32/EG

The guideline 1999/32/EG of the council of 26th April 1999 about a reduction of the sulphur content in some liquid fuels and the change of guideline 93/12/EWG70 formulates the contributions of sea traffic to emissions of sulphur dioxide and nitrogen oxides as well as concentrations and the deposition of pollutants in the community.

It becomes obvious, that emissions must be reduced. In article 7 paragraph 3 of guideline 1999/32/EG of the council from 26th April 1999 about a reduction of the sulphur content in some liquid fuels, and for changing guideline 93/12/EWG8, it is planned, that the Commission work out the possible measures which could help to reduce the acidification caused by the burning of fuels in shipping not mentioned in article 2 paragraph 3 of the respective guideline.

C). Guideline 1994/63/EG[69]

The guideline 1994/63/EG of the European parliament and the council from 20th December 1994 for the limitation of the emissions of volatile organic compounds (VOC) set free when storing fuels and its distribution from the delivering stores to the petrol stations[70] is being enforced in the German law with the 20th regulation for the implementation of the BImSchG[71]. The requirements for the installation and the design and use of tanks and other containers are described here, as well as defining limitation values for the VOC emissions which are set free during the load and discharge operation of ships.

D). Outline of a EU guideline for changing the RL 99/32 concerning the sulphur content in fuels used by ships.

In a suggestion for a guideline of the European Parliament and the Council for the changing of guideline 99/32/EG about the sulphur content of fuels used on ships from the 20th November 2002, volume II (draft for the Commission)[72] it is demanded that the sulphur dioxide emissions caused by shipping in European marine areas be reduced by 80% instead of the original 10% stated in RL 99/32 as compared to emissions in the year 2000.

Measures, like the introduction of a limitation of the sulphur content to 1.5% for all types of fuel used on ships moving in the North Sea, in the Channel and in the Baltic Sea, the introduction of a sulphur limitation of 1.5% for ships´ fuel used on ferries on regular routes (from 1st July 2007), the introduction of a limitation on the sulphur content of 0.2% (0.1% from 1st January 2008) in fuels used by ships moving in inner waters and at berth, so as to improve the quality of the air in ports and interior waters or the introduction of a limitation of the sulphur content of 1.5% for ships´ diesel sold in the EU are intensified in the RL 99/32.

Additionally, control mechanisms like taking samples of ships´ fuels, the keeping of a log including information on fuel changes and compulsory reports are defined in the recommendation. A report about the use of the guideline and possible changes are to be presented to the European parliament and the council by the 31st of December 2010.

[69] Official Gazette no. L 121 from the 11/05/1994 S. 0013-0018.
[70] Official Gazette no. L 365 from the 31/12/1994 S. 0024-0033.
[71] regulation for the limitation of emissions of volatile organic compounds set free during the storing and pouring of Otto fuels from the 27. Mai 1998, BGBI. I. S. 1174, latest change by Art. 3 of the regulation from 24. Juni 2002, BGBI. I S. 2247
[72] KOM(2002) 595 final - Official Gazette no. C 045 from the 25.05.2003].

E). Draft of an EU guideline about pollution caused by shipping and the introduction of sanctions.

The draft was accepted by the European Parliament in january 2004 (Doc A5-0388/2003;2003/0037 COD). The aim of this planned guideline is the introduction of international standards for pollutions caused by shipping according to MARPOL 73/78 into the laws of the European community. It is to be ensured that persons responsible for illegal pollution will receive adequate sanctions[73]. If the EU member states would include conventions on the protection of the environment (e.g. HELCOM[74]) into their respective national legislation, an EU guideline about sanctions would not be necessary.

8.3 National Law

The UNCLOS/SRÜ came into force in Germany on the 16th of November 1994. Since then, the regulations of the SRÜ come first to the national laws, meaning the regional law and the entire federal law, according to article 25 GG. The inclination should be pointed out[75] that the German legislation gives international law a priority above national law. This principle of priority of the international law does, however not describe an overall regulation of the international law. It follows especially from the preamble of the constitutional law, from article 1 paragraph 2 and articles 24 to 26 GG and commits apart from the common regulations given in article 25 GG of the international law to an inclination towards international law[76].

However, the SRÜ leaves the states tasks or hands out commitments. The states continue to enforce laws and regulations for the reduction, prevention and monitoring of the pollution of the marine environment caused by ships under their respective flag or which are entered in their ships register (SRÜ article 211, paragraph (2)). Coastal states can also enforce laws and regulations for the reduction, prevention and monitoring of the pollution of the marine environment caused by foreign ships, including those using the right of innocent passage. These laws and regulations may not, however, impede the peaceful passage of foreign ships (article 211, paragraph 4). Additional laws and regulations can be about the discharge of waste and other shipping habits, but may not commit foreign ships to have to mind other rules concerning design, build, manning or equipment than the commonly accepted international rules and standards (article 211, paragraph 6 c). Shipping laws of a state within its own economic territory have to be carried out according to the SRÜ. States may, however introduce EEZ regulations in accordance with SRÜ article 211 (3)in conjunction with article 25 (2) to regulate the prepositions for entering national ports.

8.3.1 Federal Law

On the basis of the SRÜ the Federal Republic of Germany extended its coastal waters in the North Sea and the Baltic to 12 nm and introduced its own exclusive economic zone in both seas from the beginning of 1995.

[73] "The Wadden Sea: Maritime Safety and Pollution Prevention of Shipping: Analysis of the existing measures and the implementation of agreements regarding maritime safety and prevention of pollution from ships"; Wadden Sea Forum 2004, Rep. No. 5.

[74] Convention for the protection of the marine environment of the Baltic from the 9. April 1992 [BGBl. 1994 II, S. 1397];

[75] For this cf. *Bleckmann*, Der Grundsatz der Völkerrechtsfreundlichkeit der deutschen Rechtsordnung, DÖV 1996, S. 137 ff.

[76] cf. Jarass, in: Ders./Pieroth, GG, 5. vol. 2000, Art. 25 Rn. 4

The EU Air Quality Directive and the first two daughter guidelines have been converted to federal law in September 2002 by changing the federal-imission law (BImSchG) and amending the imission value regulation (22.BImSchV). The third daughter guideline is being converted at the moment.

The regulations of the EU for the control of air emissions are not entirely new for the Federal Republic of Germany. Air measurements have been carried out in all federal states for a long time, and the results are being summarised by the Federal Agency of Environment. The EU guidelines, however, bring following changes:

1. The limits defined by the EU are much stricter than those valid in Germany until that time; especially the new limit for nitrogen oxides is problematic. Additionally, limitations on single substances, as for example the daily limitation on particles, did not exist at all.

2. The EU commits the participants to introduce and implement air purifying plans in areas where the limits have been exceeded. Comparable regulations did exist in the federal imission protection law before, but they were not effective in some federal states because of high limitation values. Because of the lowering of the limitation values measures for the improvement of the air quality have to be introduced now in several areas which will be sometimes difficult to realise.

In contrast to the former German regulations which were based upon measures relating to installations and products for the control of air pollution, the EU air quality regulation with its subsidiary rules is based upon air purification in different areas. This evaluation of air pollution, which does not depend on single causers of pollution but is strictly related to the different pollutants, means that all decisive polluters, e.g. industry, trade, agriculture, households and traffic, have to contribute to keeping the air clean. Basically, however, increased requirements[77] for technical equipment on ships sailing under foreign flag cannot be enforced[78].

8.3.2 Law of Federal State Schleswig-Holstein / town of Lübeck

The port regulation[79] (Hafenverordnung / HafVO) is valid in public ports in Schleswig-Holstein, and so also in Lübeck/Travemünde, according to § 1 paragraph 1 of the HafVo. According to §5 paragraph 3 of the HafVO the port authorities have the power, to introduce "regulations that are […] necessary for the protection of the environment". According to § 8 of the HafVO the basic rules for conduct in port also include matters of environmental protection. The port authorities are authorised to "regulate matters in the use of the port facilities and the port area that are related to special regional and legal conditions with general orders (port use regulations)". For the protection of the environment the port authorities may, according to § 11 of the HafVO, "temporarily limit, restrict or deny the stay in or use of port facilities and installations for […] ships".

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[77] Germany could introduce stricter measures for e.g. the quality of the air, citing article 95 paragraph 5 of the EG-founding contract (EGV). However, such a request would not make sense, if the conditions of the standards are not fulfilled. These require new scientific data relating to the protection of the environment or work environment, which would motivate the respective member state to consider the introduction of single regulations for the federal states because of a defined problem that has come up for this state after the introduction of the coordination measures.

[78] For this cf. §§ 2 paragraph 3, 14 and 15 as well as the appendix about ships safety law, international ship related safety standards.

[79] Federal regulation for ports in Schleswig-Holstein from 15th December 1998 [GVOB1. Schleswig-Holstein 1998, p. 503]

According to § 12 paragraph 4 of the HafVO vehicles which have caused pollution of the port area because of acting or neglect of their ships managers, or against whom sufficient suspicion exists, may not leave these facilities without permission of the port authorities. Additionally, § 15 paragraph 2 of the HafVO regulates that in port noise-, dust- or exhaust emissions are to be kept as low as possible. In sentence 2 is said further:

> "As far as reasons for averting dangers are given, the port authority can, in accordance with the office in charge of imission protection, take the necessary steps to reduce shipping traffic and/or load and discharge operations or, if reduction is not possible, order vehicles and movable units to leave port or stop all turnover operations in port if the noise-, dust- or exhaust emissions reach unacceptable levels".

A port use regulation in sight of § 10 paragraph 2 of the HafVO is not foreseeable for Lübeck-Travemünde and does not exist according to the port operator. Single-case orders are therefore possible.

8.3.3 Port Regulation

Consequently, the use of port facilities can also be connected to requirements related to the prevention, reduction and monitoring of air pollution by ships. This means, that entry to the port of Lübeck-Travemünde can be denied to a ship where the standards do not meet the requirements. Following exemplary measures for realising this would be possible for the port/coastal state:

- Denying access to the port
- Temporary stay in port and starting of administrative or legal prosecution
- Detention of ships that did not meet the standards in the territorial waters after leaving port (international agreement to the detention of seagoing vessels)
- Right of hot pursuit on ships offending the standards after leaving territorial waters (article 111 [Right of hot pursuit.] SRÜ).

A proper announcement of these standards in sight of article 211 [Pollution from vessels] paragraph 3 of the SRÜ is absolutely necessary for a smooth course of events in shipping. However, a non discriminating port access is also to be considered[80].

Especially the right of authority of the port and coastal state for the protection of the marine environment is stated in articles 218 ff[81] [Enforcement by port States] and especially 222 [Enforcement with respect to pollution from or through the atmosphere] of the SRÜ (right of authority). These special rights are to be understood as counterweights to the authority of flag states. They offer a possibility of compensation for the port and coastal states, in the case of a flag state is not able to keep to the international standards.

Article 220 [Enforcement by coastal States] paragraphs 2 of the SRÜ can however not apply relating to air pollution caused by shipping during load and discharge operations. As a rule, however, there is no objection to the examination of foreign ships in sight of article 226 [Investigation of foreign vessels] SRÜ even if article 222 [Enforcement with respect to pollution

[80] VO No. 4055/86/EWG [Abl. EG 1986 No. L 378/1].

[81] The regulation of Article 218 SRÜ is not to be mistaken for „Port State Control" in sight of the Paris MoU resp. the PSC guideline.

from or through the atmosphere] SRÜ is not explicitly mentioned. Most relevant is article 218 [Enforcement by port States] of the SRÜ:

> "When a ship is staying in a port voluntarily […], this state may carry out examinations and, if the evidence justifies this, can open a legal case against this about any discharge from this ship outside the internal waters, the coastal waters or the own exclusive economic zone of this state, if this discharge violates any of the international regulations and standards valid in this area that were put into force by the responsible international organisation or a common diplomatic conference".

8.4 Result and recommendation

International habitual rights, international contract right as well as common principles are being considered for forming the international law. It is unsure, if states (especially hegemonial powers) can create new international habitual rights just by repeating (consuetudo) when this behaviour is accepted or at least is not opposed to by other states. According to the definition given above, the required conviction of the legal validity for habitual rights would not be given. In case of doubt: the right follows the power.

The general meeting of the UNO cannot set international law but can only give initiatives for respective negotiations about contracts between the different states. Announcements of the states and their votes can however be a sign of their conviction in the duration of international habitual rights (e.g. coastal waters, nautical mile zones and fishing zones).

The competence between EU and IMO are not always clear. The EU has certainly helped the development of the international law along with the regulations they introduced after the Prestige and Erika disasters. On the other hand, it is still uncertain whether the EU can take on regional protective measures without the consent of the IMO. Only a short time ago the IMO and EU have taken up negotiations about the distribution of authority.

A coastal state can only legally commit a ship sailing under a foreign flag within the scope of article 21 paragraph 1 lit. f) in comparison with 211 paragraph 4 of the SRÜ. Hereby article 21 paragraph 2 of the SRÜ must be considered. It is unsure, how far the division between flag states and port states will blur in the future, meaning that a commitment would apply to the flag state too (erga omnes).

National regulations only commit ships sailing under their own flag, not those sailing under foreign flag. For this reason they are rather unimportant in view of international shipping. According to national law there is no possibility to commit ships under foreign flag to higher technical standards than those agreed upon internationally (cf. SRÜ82).

The only possibility of indirectly committing foreign ships is by having the port operators introducing stricter rules, who would then make the load and discharge operations only possible for these ships under heightened requirements (cf. HafVO). On principle the coastal states do not have to grant access to their internal waters or port to foreign ships.

In European as well as international law there are few regulations concerning the limitation of noise- and exhaust emissions from ships in port. Only on the basis of port regulations accord-

[82] Agreement on maritime law of the United Nations from the 10th of December 1982 [BGBl. 1994 II, S.1799]. Article 21 (2): „these laws and other regulations must not extend to the design, build, manning ort he equipment of foreign ships, as far as they do not give internationally accepted regulations or standards effectiveness."

ing rules could basically be introduced. The legal requirements, e.g. limitation values, are however not standardised.

9 Alternatives to a legal commitment

An alternative to the police law is given by a voluntary self-commitment, being agreed upon for example in a Memorandum of Understanding (MoU). Such memoranda are however not legally enforceable, but have a "soft-law" character.

They can present international law contracts in some cases, if both parties are at least to some extent legal capacity, meaning they have to be qualified to enter into international contracts. Only sovereign states as law subjects fulfil these requirements easily. A Memorandum of Understanding is suitable for a contract between e.g. the port state and the state where the shipping company/ the ship owner is situated. However, this contract is legally binding only for those ships that are also listed in the respective registers. For this reason, the chances to make contracts with so-called flag-of-convenience-states would be low.

As the ports are concurring strongly with each other they generally cannot introduce regulations going beyond those internationally agreed upon. This is why a reduction of conflicts can only be reached within the scope of an over regional cooperation together with the competing ports.

The contents of a MoU can still be a guideline and lead to international standards, as was the case in the Stockholm agreement. At least, quick results in the solution of regional problems can be reached with voluntary self commitments, meaning the binding to higher standards from the point of view of the ports or shipping companies towards the state within the scope of a MoU.

Another important advantage of a MoU is, that it is based upon the fact, that the parties enter into the "contract" voluntarily and thus in the first instance only little liability results from this. For this reason the parties are as a rule not bound to the limiting conditions of international law but may implement more ambitious standards.

9.1 Areas in which Memoranda of Understanding apply

There is a wide spectrum of different international and national MoU. These are agreements to which the parties commit themselves voluntarily. They contain certain measures that go beyond the minimum requirements stated by the law and can develop into legally binding regulations in time. The Stockholm agreement is an example for this83. This agreement was brought on the way by some Baltic states after the disaster of the "MS ESTONIA" in order to increase safety for RoRo ships in the Baltic above the level of international binding measures. Not all Baltic states entered into this agreement at first as there were "technical difficulties in the realisation of the requirements"[84]. These requirements are now to be spread to all European states by now.

[83] "Agreement Concerning Specific Stability Requirements for Ro-Ro Passenger Ships Undertaking Regular Scheduled International Voyages between or to or from Designated Ports in North West Europe and the Baltic Sea"

[84] A curious fact is, that Estland, the state to which the vessel MS ESTONIA belonged did not at first enter into this MoU, although the ship was the reason for the agreement.

9.1 Short description of different MoU

The institutional relation of MoU can reach from agreements between states to agreements between single corporations. The focus can be of quite different nature. In order to make clear the possibilities of MoU, some existing MoU about "shipping and safety/protection of the environment" are to be described here:

9.1.1 The Memorandum of Understanding on Port State Control

On the 26th of January 1982 the ministers of traffic in western and northern European states introduced a *Memorandum of Understanding on Port State Control* (port state control) in order to reach a greater efficiency in enforcing international agreements. The reason for this line of action was the fear that ships sailing under foreign flag, especially those listed in "international registers"[85], would be increasingly criticised because of safety and environmental deficits was. The aim of the introduction of the MoU was to gain the right to carry out comparable inspections on ships by representatives of the port states. Presently about 20 member states are part of this MoU[86], comparable MoU can now be found on other continents, too.

All ships moving in European waters or using European ports are subject to this MoU. At least 25% of the ships sailing under foreign flag entering a (German) port are to be inspected every year. This right is based upon rule 19 in SOLAS, according to which the validity of the certificates of foreign ships can be checked in port.

The Port State Control was put into SOLAS, chapter XI, special measures to enhance maritime safety, rule 4 in 1994. If there are sufficient reasons to suppose that on a ship the safety standards, e.g. maintenance, running of the ship, safety manoeuvres, etc., are not as they should be, inspections can be carried out, and the ship can be detained until all defects have been taken care of. These detentions are listed statistically and were sent to the main office in St. Malo.

Some types of ship, including ferries and RoRo ships, are inspected more often (article 7(4)). From the statistical values can be seen that the record of passenger/RoRo ships is above average. The port states are supposed to inspect about 25% of all ships sailing under foreign flag that enter port, using different criteria (type of ship, flag and rating of the ship). In some states the number of arrests is very high, pointing at a strict implementation of the regulations in these states.

Member states are the European Union as well as Canada and Russia. In order to commit ships sailing under flags of states not part of a international agreement to these regulations too, as far as is practicable, a stipulation not to favour single parties was introduced[87].

In article 15 [publication of detentions] is described, that every three months a report is to be made containing information about those ships that were detained more than twice in the last 24 months. In this context, the name of the ship, name of the owner or the person in charge of the ship, the reasons for the detention is to be stated among other things. The "See-Berufsgenossenschaft" is responsible for the realisation of port state control in Germany[88].

[85] Some of these registers belong to the so-called "flags of convenience" or so-called cheap flags.

[86] Member states are the European Union as well as Canada and Russia.

[87] "safety on sea 1994", yearly report of the See-Berufsgenossenschaft, page 65.

[88] for example, 1761 inspections were carried out in German ports in 2002; hereby 951 ships showed considerable deficits, in 112 cases the ships were detained.

One attribute of the MoU is that all coastal states in the EU as well as further non-European states are members. The standards relating to the possibilities of intervention are above those stated in internationally given standards. Inspections and sanctions can be put into action within the scope of the MoU. Ships sailing under foreign flags are also, of especially, subject to the requirements of the MoU (ships of member states are inspected by other member states). By now the standards have reached almost international law character.

9.1.2 The Memorandum of Understanding for the transportation of packed dangerous goods in the Baltic Sea (Baltic-MoU)

Until the end of 2003 apart from the normal regulations for dangerous goods transport in shipping, SOLAS and the IMDG-Code, in a defined area of the Baltic alternatively modified regulations could be used. These were developed at first for the regulation of the transport of dangerous goods on land, in trains or on the road. One justification for this is the close proximity of these areas to the coast and the availability of help from others because of this, another reason are the technical requirements listed in § 7 of the MoU that had to be fulfilled.

The MoU existed since 1974 and was based upon § 3 paragraph 1 of the GGV sea. It was constantly changed in order to adapt it to the changing IMDG Code on one hand, and the technical and safety relevant developments on the other hand.

In the earlier edition considered here[89] the national island traffic (northern and east-Friesian islands) in the North Sea was regulated in part I and the transportation of dangerous goods in the Baltic in part II. The MoU is currently not in use, as the IMDG-Code is now internationally binding and has a very similar content, and exceptions, e.g. the Baltic-MoU are not considered in this.

Part II is divided in long and short routes. At first the IMDG-Code was the basis for the setting of long and short routes. It was changed within the scope of § 6. All topics that are regulated in the IMDG Code and are not named in MoU § 6 as a variation remain to be valid according to the IMDG Code. As a result, some land based rules on the transportation of dangerous goods for roads and trains were implemented for shipping, with all their positive and negative aspects.

Signers of the MoU were Baltic states[90]. Right of intervention existed only for ships sailing under the flag of a signature-state. Shipping companies situated in one of the member countries could use the MoU, but didn't have to. Some shipping companies did not want to do this anyway. The introduction made transportation of dangerous goods easier in comparison to the use of the IMDG-Code, meaning the standards of the MoU were below those of the international rules, which was justified 1: special circumstances would exist (short routes, height of waves), 2: an increase in safety would follow special requirements included in the MoU.

9.1.3 The Memorandum of Understanding between the International Council of Cruise Liners (ICCL) and some American Federal States

The reason for introducing the MoU between the *International Council of Cruise Liners* (ICCL) and different American states was at first the rapid increase of cruise shipping in some areas and especially in Alaska. In population the fear of pollution of the environment caused

[89] In the edition 27.12.96 with the 1st change from 19.12.97, in the "Bundesanzeiger"

[90] In the year 2002: Denmark, Germany, Estonia, Finland, Latvia, Lithuania, Poland and Sweden

by the ships frequenting this area increased although shipping was legal on the basis of MARPOL 73/78.

More than 100 cases of pollution from bilge water, waste water and rubbish were registered (!) so that alleged deficits in environmental politics of the shipping companies and in the (American) regulations for the protection of the environment were identified.

A petition of the organisation for the protection of the environment *Bluewater* and another 55 organisations was passed in the year 2000, in order to get rid of these deficits. Before, the Ministry for the Environment in Alaska started a *Alaska Cruise Ship Initiative* in the year 1999 and following this the ICCL committed itself to voluntary measures (among others *voluntary waste management practices*) for the reduction of environmental pollution in order to meet the pressure from the population. These measures were not, however, seen as sufficient from the point of view of the environmental organisations, additionally at least 50 breaches of these measures were found out.

Voluntary agreements were increasingly seen as not sufficient, and the *Alaska Cruise Ship Initiative* was changed into the legally binding *Commercial Passenger Vessel Environmental Compliance Program*, by this the requirements became binding also for cruise shipping. It could be proven that violations against laws for the protection of the environment became less. Punishments were given in those cases that were found out[91]. In other Federal States of the USA the voluntary limitation of the ICCL ships was still in force.

That these voluntary limitations were not always kept to became known, however, too. In one special case (MS Crystal Harmony) the town council decided to ban the ship from entering the port of Monterey. Following this, California decided upon several new regulations for the reduction of different environmental pollutions (*hazardous materials, oily water, and sewage sludge*), further, regulations for *low sulphur fuel, ship incinerators, black and grey water* were developed. MoU taking the ICCL standards as a basis were introduced in Florida and Hawaii between the representatives of the participating federal states and the local cruise shipping companies. Violations of these standards however continued.

Signers of the MoU are in these cases the representatives of the federal states and the cruise shipping companies, or the ICCL. The standards are slightly higher than the international ones. Possibilities of enforcing the standards were reached only after they were transferred into the respective federal law. Before this happened, the shipping companies which had been caught violating the standards sometimes claimed that they were keeping to the international limits.

9.2 Summary of the advantages and disadvantages of the MoU

MoU can, as described above, regulate quite different subjects on different levels. They are cited for different cases that have to be regulated but for which no suitable laws exist.

From the point of view of those affected most closely a law that would change unfavourable circumstances would surely be more efficient. But the MoU comes into force in situations that are not or not yet regulated by the law.

[91] punishments of 18million USD for different violations of environmental law for Carnival Cruise Lines, 27 million USD for Royal Caribbean Cruises and 1 million USD for Norwegian Cruise Lines were given. Additionally the shipping companies had to implement an *Environmental Compliance Program* (ECP) [I1].

9.2.1 Advantages resulting from a MoU

- By using a MoU problems can be dealt with where a regulation is strictly speaking "forbidden". The UN *Convention on the Law of the Sea* (UNCLOS) "forbids" taking influence on the technical equipment of foreign ships. But by voluntary commitments and in cooperation with each other agreements can be decided upon in order to achieve the wanted changes.

- Changes that are desirable and possible often fail because of the argument that the competitive situation of those operating independently from the attitude of competing firms by investing in innovative technology (for the protection of the environment) is influenced adversely. For this reason a status quo often happens, as each participant waits for the other to act or accuses them at an early stage that they do not make the same efforts. A MoU can decrease a competitive situation between several parties through a consensus about common procedure.

- Many desirable changes have to go through a long administrative procedure before they can be realised in a very binding way. This is especially the case for regional problems for which there is no over regional need of realisation, as is the case in Lübeck-Travemünde. The signers of a MoU that have the same interests can shorten the length of time usually needed to change an unwanted situation by this.

- There are binding minimum standards for the technical equipment on board ship (SOLAS, MARPOL 73/78). These standards are increased in some cases by regional or national regulations for ships sailing under the flag of these states or by e.g. personal engagement in shipping companies or in port companies. The different standards resulting from this for ships entering port can be coordinated more easily if all parties involved discuss this in a dialogue until a consensus is reached.

- A MoU can be adapted to different institutions (regional relation, agreements between states, public organisations and private organisations). This makes it easier to realise this quickly and increases the possibility to formulate an ambitioned standard in which not every "late-comer has to be taken on board". For this reason a *Best Available Technique* can be decided upon which really describes standards that are possible which are adapted to the possibilities of the most innovative participants. This standard describes a more future orientated plan of action.

- The procedures for reaching aims can be defined in cooperation with other signers individually. "Pragmatic" standards can be defined at first as voluntary commitments in order to provide a basis for further steps. More ambitioned aims can follow this later on. Together these aims can be defined and the procedure can be decided upon.

- The signers of a MoU can use this as proof for their special dedication for advertising by pointing out the high standards they keep to. By being voluntarily part of a MoU they go beyond the standards stated by the law and this is documented which increases the credibility. A commitment that is recognised by external parties (e.g. official offices) has more credibility than the "self-advertisement" currently in practise most often. Giving out a certificate to the signers shows appreciation for their responsible line of action and can be published effectively.

- MoU can be a first step to the introduction of legal drafts, meaning they can define standards that will have to be kept too sooner or later by all affected by this topic. By "proving the practicability" (including limits that have to be kept to, etc.) the legal rules can be influenced (EU/IMO).

9.2.2 Disadvantages resulting from a MoU

- Because of the voluntary nature of the MoU the progress in improvements in the environmental situation depends on the “good will” of the signers. Additionally, critics of the MoU say, that because the standards are based upon negotiations they turn out to be not very demanding. A MoU can also serve as a delaying tactic when trying to prevent more stringent regulations from coming into force while pretending to support improvement of environmental protection. This tactic is really used quite often by industry.

- A MoU is based upon trusting that standards are kept to. As long as the regulations are not inspected and sanctioned advantage can be taken from this trust until other mechanisms (legislation initiatives) come into force. This harms the MoU itself and the other signers.

- A MoU is focused on the “good ones”. The need to take action is actually lower here than with the real “polluters” (where it can however not be implemented – there would be no reason for a MoU if it was not so). From point of view of efficiency, it would thus be better to concentrate on the “polluters”. Additionally, this approach does not take the *Polluter Pays Principle* into account.

- Generally a MoU is organised in such a way, that no controls are carried out (by external parties or administrative bodies). Sanctions cannot be planned as it is not certain, who would charge and enforce these and what would happen with the “fines”. As well as this, sanctions could keep off possible signers as the risks would be difficult to calculate (dependence on customers, effect on the public, etc.).

9.3 The Memorandum of Understanding for a sustainable development of port and shipping companies in the Baltic

As the Memorandum of Understanding was to be integrated into the Agenda 21 process and was later to be discussed by the different interest groups of Lübeck-Travemünde and later in the Baltic area the MoU could not and should not be made contract-ready, within the scope of this project. The essential framework and the contents of a "MoU for a sustainable development of port and shipping companies in the Baltic" should however be formulated for possible participants of the Agenda 21 process within the scope of the project work. This path of action was seen as important for the implementation of this under the premises of the Agenda process and as efficient in connection with getting it accepted. The finished draft for this can be found in "background information", the "general conditions" and the "contents (appendix 1)".

The papers were discussed with representatives of the Federal Agency for the Environment, the Stadtwerke Lübeck-Travemünde as well as in meetings with representatives of the town of Lübeck-Travemünde, shipping companies and other parties. Not all objections could be considered in these discussions because of the different interests. As the goals aimed for cannot be reached with only one signer, namely the port of Lübeck-Travemünde, the final version of the MoU for a sustainable development of port and shipping companies in the Baltic will only come to pass with the participation of more signers in the Baltic area. The existing version of the MoU shall therefore serve as a foundation for possible signers in Germany and the other Baltic states.

9.3.1 Background information on the MoU

For processing the project *Implementation of the Agenda 21 in European ports with the example of Lübeck-Travemünde* supported by the Federal Agency for the Environment GAUSS drafted a

Memorandum of Understanding (MoU) for a sustainable development of port and shipping companies in the Baltic

Shipping is already the main cause for certain pollution in many ports. This is due increasing amounts of goods transported at sea and more restrictive legislations for traffic on land for the protection of the environment. Sulphur and nitrogen emissions are the main causes for acid rain (destroying of forests, erosion of buildings), other emissions are responsible for global warming and different health risks. The public is getting less willing to accept this, especially when additionally other interests are touched (e.g. tourist spending holiday on the beach, etc.). Thus the image of shipping could be harmed if measures for the reduction of pollution are not put into action.

The introduction of measures for the protection of the environment going beyond the legally binding ones is impeded by different obstacles. For example, according to UNCLOS, no demands can be made for the equipment on board foreign ships. For this reason, the effectiveness of possible measures is limited to own ships and is thus reduced drastically. From the national point of view and for national flags a conflict arises because of the strong competitive situation between coastal states which could provoke a migration of companies into less restrictive countries. For this reason also ports cannot do things single-handedly and shipping companies can also not install expensive new technology for the reduction of emissions caused by shipping because of the competitive situation.

This situation could be changed if shipping and port economy could decide on working together in order to find a solution to the problems. As basically both groups have the same interests – namely to continue shipping with other parties – it should be possible to create a basis for this. As especially in the Baltic area there are several ports and shipping companies who show a lot of commitment for the protection of the environment the conditions are promising in the here. This can be seen from the fact that, among others, several shipping companies are prepared to use low sulphur fuels and the initiative to provide incentives for environmentally sound shipping.

A certificate for the signers of the MoU acknowledges that they are actively committing themselves for the protection of the environment. Possibilities to make this commitment public are given in order to provide effective advertisement. Although no direct financial incentives are given for the signers at first, a development in this direction, based on a consensus in the discussions of the contents, is possible.

General conditions requirements of the MoU

The MoU consists of a general part (general conditions) and a content part (list of the requirements). The texts available are among others a synopsis from different international MoU and were roughly checked to begin with regarding possible legal mistakes. The final check is to be carried out after detailed commentaries have been inserted.

The contents of the MoU are based on what is possible for signers committed in the protection of the environment and in a second step the definition of the measures made possible by working together for future requirements. Another aim of the MoU is the development of common standards that are useful from the point of view of those affected (e.g. accepting waste in ports).

The drafts are handed out to the port and shipping companies asking them for their opinion. The question is raised whether the general conditions and the list of requirements can serve as suitable ground for discussion and – after it has been translated into English – if it can be handed out to potential signers in the Baltic area or if questions about the legal content, the general content or other objections remain open. Following backgrounds should be considered:

The text (general conditions and list of requirements) is to be seen as draft for discussion for potential signers. The general part is completed with the content part in which the requirements are described. Both should be discussed by the potential signers until a consensus is reached and then be developed further.

- Possible signers may be representatives from towns, ports, port companies, shipping companies and other parties in the Baltic but not the from the States or Federal States themselves
- The signers commit themselves to keep to the requirements voluntarily
- They are not to fall short of existing, legally binding conditions
- Official checks that the requirements are really kept to are possible. No sanctions are defined in case of violation. It is possible that a party could be excluded officially from the circle of users if violations of the requirements became known repeatedly (combined decision etc.).

After a consensus has been reached in the discussion among the potential signers is checked for legal validity (after translation into English).

The following questions are to be answered especially:

- Are there legal, formal or other objections against the wordings in the general part? If so, what should be changed?
- Are there objections about the requirements defined in the content? Which requirements should be changed? Which are feasible for the signers?
- Are there technical deficits existing which should be improved from the point of view of the signers (cooperation of the handling of waste in Baltic ports etc.)?
- Are there other technical improvements that should be included (e.g. recycling, use of large packages)?
- Do you have ideas for further supporting the initiative?
- Should this information be sent to other interested parties?

Please send your commentaries to:

GAUSS mbH

Werderstr. 73

28755 Bremen

Tel / Fax: 0421 5905 4850 / 4852

Email: gauss@gauss.org

Thank you for your cooperation!

GAUSS mbH / Chr. Bahlke

9.3.2 General conditions of the MoU

Joint declaration of intent

Memorandum of Understanding (MoU) for a sustainable development of port and shipping companies in the Baltic

This Memorandum of Understanding is focused on environmental pollution caused by shipping, i.e. by installations and engines in port and on board ship. With the implementation of the MoU the most important solid, liquid and gaseous pollutants are to be addressed and reduced considerably in cooperation with the premises of Agenda 21. The signers of this Memorandum of Understanding (MoU)

ARE AWARE that all parties using the marine environment of the Baltic are responsible for the conservation of this habitat.

ARE AWARE that the increasing public concern about emissions caused by port facilities and ships means that it is essential that port and shipping companies work together in order to reduce emissions.

INTEND to develop cooperate standards for the reduction of emissions and for the waste disposal in port, going beyond the binding standards already in force.

CONSIDER the different conditions in the different ports, especially because of

- the location of port facilities and residential areas
- the different services offered in ports
- the dependence of the economy on these services
- the availability of suitable reception- and disposal facilities and for example the offer of shore-side supply of electricity for ships.

ARE OF ONE MIND that

- this MoU is open to public and private users
- the MoU contains only voluntary self committing standards that go beyond the legally binding requirements, described under “self commitment of the signers of the MoU”
- the minimum standard described in “self commitment of the signers of the MoU” is realised by the time of signing
- the “goals for the protection of the environment of the signers of the MoU” are realised in a given length of time.

Article 1 Group of people to be addressed

Especially town administrations, port authorities, port operators and other port and shipping companies etc. are to sign the Memorandum of Understanding.

Article 2 Definitions

In context with this Memorandum of Understanding

a) *Are ship and port emissions all gaseous, liquid, solid and acoustic emissions, including vibration.*
b) *Are harmonised standards are the ones described in appendix 1.*

Article 3 General commitments

(1) *The signers commit themselves to keep to the harmonised standards named in appendix 1 under "self commitment of the signers of the MoU" from the time of signing.*

(2) *The signers commit themselves to keep to the harmonised standards named in appendix 1 under "goals for the protection of the environment of the signers of the MoU" from the time decided on in the procedure in article 8*[92] .

(3) *The signers agree to check the implementation of the harmonised standards for the reduction of emissions regularly*[93] *and to adapt the legal or technical development according to the procedure in article 8 if necessary.*

Article 4 General regulations (ports)

(1) *The signers agree to apply the harmonised standards to ports or parts of ports. This commitment is valid even if the port or parts of it are public or privately owned.*

(2) *The signers agree to supply suitable port reception facilities according to the harmonised standards described in appendix 1. No disadvantages are to come up by this for the signers as opposed to the non-signers.*

(3) *The signers commit themselves to make the port facilities for the implementation of the harmonised standards available to non-signers as well. They assure that by not using the facilities no advantages can be gained as opposed to using them.*

(4) *The signers commit themselves to develop a standard for a shore-side electricity for ships in their ports according to the international legislation in the procedure described in article 8.*

Article 5 General regulations (ships)

(1) *The signers commit themselves to keep to the harmonised standards for ships as described in appendix 1.*

[92] Periodical requirements should be defined (e.g. in connection with other regular audits like QM-System, ISM-System, classification renewal

[93] It should be defined who is responsible. It is possible that e.g. being an internationally recognised office the SeeBG takes this part or independent inspectors are employed for this (this is practised e.g. in the IATTO)].

(2) The signers agree to develop a standard for a shore-side electricity for ships in their ports according to the international legislation in the procedure described in article 8.

Article 6 Application on institutions, companies and persons that have not signed the Memorandum

(1) The signers commit themselves to encourage non-signers to keep to the harmonised standards

(2) Participants outside the Baltic are also welcome to the MoU.

(3) The signers intend to involve parties outside the Baltic to sign the MoU.

Article 7 Report duties

(1) The signers agree to keep each other informed on the implementation of the MoU according to article 8 [every 2 years].

(2) The signers agree to inform national and international institutions on the progress of the Memorandum.

Article 8 Updating the Memorandum

(1) The signers meet [every 2 years] in order to decide on updates of the MoU, lay down the deadline for the implementation of the "environmental aims of the signers of the MoU" according to appendix 1 and all other contents and organisational questions.

(2) Each signer has a voice.

(3) The decisions are made in consensus.

Article 9 Mutual acknowledgement of certificates

(1) A certificate is to be handed out to the signers about the implementation of the MoU which documents that the requirements described in appendix 1have been kept[94].

(2) The signers agree to acknowledge this certificate as proof that the signer has successfully realised the requirements given in appendix 1.

(3) *The signers agree to exclude any participant from the group if he has violated the standards named in the MoU repeatedly. The excluded signer may no longer use the certificate*[95].

Article 10 Signing, coming into force and ending

[94] It has to be decided who gives out the diploma/certificate

[95] This sanction is of course weak and is to be seen symbolically. Legal consequences might keep potential signers away and would also give the MoU a different status. The procedure might have to be regulated differently (with regards to hearing, correction, deadlines etc.).

(1) This Memorandum is available to the port and shipping companies for signing from the [1st of July 2005].

(2) The Memorandum is valid for all signers [6 months] after it has been signed by at least [3] parties.

(3) New signers inform the other participants on the time when the Memorandum will come into force for them.

(4) Ending the participation of the Memorandum can take place [30] days after the others have been informed.

Certificate

on the commitment for the environmentally sound and sustainable development of port and shipping companies in the Baltic

The Memorandum of Understanding (MoU) for a sustainable development of port and shipping companies in the Baltic is focused on environmental pollution caused by shipping, meaning the installations and engines in port and the pollution caused by the operation of ships. The most important solid, liquid and gaseous emissions are considered in the Memorandum and be reduced considerably according to the premises of the Agenda 21. The signers of the MoU commit themselves to continually inspect and improve the measures for the protection of the environment in their responsibility.

This certificate shows that the signer is keeping to the standards of the Memorandum of Understanding and is actively committing himself for the protection of the marine environment.

For this reason he is entitled to the title “Company for environmentally sound and sustainable development of port and shipping companies in the Baltic”.

The Memorandum of Understanding is implemented in version xy for [ship / shipping company / town council / port / terminal / company etc.].

Coming into force:

Signature: user | Signature: issuer of certificate

9.3.3 Textual content of the MoU (appendix 1)

Memorandum of Understanding (MoU) for a sustainable development of port and shipping companies in the Baltic

Following requirements are to be realised by ports, their port authorities and the shipping companies who are committed to the protection of the environment. The contents of the requirements are orientated at international / regional regulations (e.g. MARPOL 73/78) but go beyond these in some cases for a better protection of the environment. Signers of this Memorandum are supposed to have realised the standards for the protection of the environment legally in force and some additional ones under ***Self commitment of the signers of the MoU*** by the time of signing. As well as this they are to take on further improvements that go beyond those already in force under ***Goals for the protection of the environment of the signers of the MoU***.

Under ***general information*** important information is given in order to be able to assess the requirements described in ***Self commitment of the signers of the MoU*** and ***Goals for the protection of the environment of the signers of the MoU***.

The preconditions named under ***Self commitment of the signers of the MoU*** take up existing regulations that are in some cases not yet entirely realised, or planned regulations that are already in operation voluntarily in farseeing companies and public institutions. Additionally, requirements that have not yet been regulated but take up an immediate need of port and shipping company economy can be found here (e.g. coordination of requirements of different ports for the reception of waste from ships) and other measures for the protection of the environment that are up to date. Not the general, presently legal status quo is described in ***Self commitment of the signers of the MoU*** but a status to which the signers commit themselves voluntarily! Even if the requirements could be estimated as not very far reaching if viewed one by one, the sum of the different requirements adds up to an environmental standard that is above average.

The ***Goals for the protection of the environment of the signers of the MoU*** define further steps for the implementation of a sustainable shipping and port economy. These aims are based on the acceptance and further development of the binding part of the Memorandum and the possibilities of realizing further requirements in practise. For this a consensus has to be reached from the different groups of the same interest. Time limits should be given in which the aims are to be realised in order to ensure a constructive development of the requirements.

Textual specifications

1. Prevention of oil pollution

Self commitment of the signers of the MoU

General information:

Following requirements are binding today according to MARPOL Annex 1 and HELCON. It is however known, that there are ports that do not supply waste reception facilities yet and that some ships still discharge oily waste/sludge into the marine environment.

The discharge of bilge water is permitted according to MARPOL Annex 1 under certain conditions (e.g. keeping to 15 ppm). It is however technically and financially possible, as well as environmentally desirable, to discharge bilge water on land - many shipping companies already do this.

Binding for ports: Providing suitable[96] reception facilities for sludge*1 and bilge water*2.

Binding for ships: Discharge of sludge*1 and bilge water*2 on land.

Goals for the protection of the environment of the signers of the MoU:

General information:

Among others a deficit lies in the documentation of the disposal of waste. This is one reason for the low educational standard in environmental offences and the punishment of violations. Therefore, a complete documentation of the disposal of oily waste shall ensure that offences can be found out more easily and followed up.

The use of fuel in which the pollutants have been reduced means a substantial advantage for the environment. These fuels are however more expensive than "normal" HFO[97]. This is the reason, why ports (being the representatives of shore-side interests) should offer incentives for the use of low-pollutant fuel, e.g. following the rebates on the Swedish "*fairway dues*", which are given by Swedish ports.

Voluntary for ports: Verification about the appropriate disposal or processing*3[98].

Introduction of a harmonised "*no special fee*" system*2[99].

Voluntary for ships: Verification about the appropriate disposal*1[100].

Introduction of a harmonised "*no special fee*" system*2.

2. Pollution caused by liquid bulk goods[101]

Self commitment of the signers of the MoU

General information:

The requirements named in MARPOL Annex II are based on liquid cargo waste (cargo residues, slop from tank washing). International regulations already exist which, however are implemented only partially. These requirements are presently not relevant for target group of

[96] "Suitable reception facilities" means that the residues can be disposed of in due time and to the normal market conditions.
[97] MDO: Marine Diesel Oil, HFO: Heavy Fuel Oil.
[98] *3: has been realised in Germany, realisation for all Baltic ports is possible.
[99] *2: is not prescribed either according to MARPOL nor HELCON nor the EU port-reception facility regulation.
[100] *1: is prescribed worldwide by MARPOL, but deficits in the realisation exist
[101] These requirements are only valid for ports normally frequented by such ships.

the MoU, i.e. ferry operators and passenger shipping. For the desired spreading of the MoU to further ports or areas in the Baltic Annex II is to be listed here anyway

Binding for ports: Reception of wastes caused by cargo and cargo residues*1.

Binding for ships: Discharge of wastes caused by cargo and cargo residues in ports*1.

Goals for the protection of the environment of the signers of the MoU:

Voluntary for ports: Verification about the appropriate disposal or processing*3.

Introduction of a coordinated "*no special fee*" system*2.

Voluntary for ships: Verification about the appropriate disposal*2.

Introduction of a coordinated "*no special fee*" system*2.

3: Prevention of pollution caused by waste water

Self commitment of the signers of the MoU

General information:

MARPOL Annex IV has been in force since 27.09.2003. According to this, and the regulations stated in HELCON, untreated black and grey water may only be discharged into the sea further than 12 nm from the coast, or further than 4 nm if it has been treated mechanically and been disinfected, or always if the ship is equipped with a registered waste water treatment installation. Since the EU-port waste reception facility regulation had been introduced, ports in the EU have to offer reception facilities for waste water as well since 27.09.2004. This has only been partly realised yet. Disposing of black and grey water on land or treating it with demanding standards before discharge into the environment is especially desirable for passenger ships and ferries, as here great amounts are generated as well as it is technically and financially feasible.

Binding for ports: Providing of suitable reception facilities for black*4[102] and grey water*2.

Binding for ships: Discharge of black*2 and grey water*2 or use of treatment facilities on board that are better than the requirements given in MARPOL Annex IV by 50% and without use of chlorine as disinfectant.

Goals for the protection of the environment of the signers of the MoU:

Voluntary for ports: Verification about the appropriate disposal or processing*2.

Introduction of a coordinated "*no special fee*" system*2.

Voluntary for ships: Verification about the appropriate disposal*2.

[102] *4: is regulated by MARPOL, HELCON and the EU Port Reception Facility Directive

Introduction of a coordinated "*no special fee*" system*2.

4. Prevention of pollution caused by waste

Self commitment of the signers of the MoU

General information:

Because in former times the capacity of the sea was seen as infinite the waste from ships could be disposed of without limitation. This was only allowed for some kinds of waste after MARPOL Annex V (1988) came into force – e.g. the disposal of plastic was not allowed anymore. Other kinds of waste, e.g. tins and bottles, present a hazard for marine life forms and also affect the quality of beaches and ports adversely. This is why waste should be disposed of on land in any case. The unproblematic disposal of waste is however not given, because of hardly coordinated details in the regulation for the disposal of waste in Baltic ports. Following requirements are to solve this problem:

Binding for port: Implementation of the Directive 2000/59/EC from the 27th November 2000 about port reception facilities for waste and cargo residues (96) *5[103].

Coordinated declarations (EAK-numbers) and separation*2.

Coordinated standards for containers (boxes, sacks etc.)*2.

Binding for ships: Verification about the appropriate disposal*4.

Coordinated declarations (EAK-numbers) and separation*2.

Coordinated standards for containers (boxes, sacks etc.)*2.

Goals for the protection of the environment of the signers of the MoU:

General information:

By introducing the *no special fee*-system it is to be ensured that there is no incentive to dispose of waste on sea, as fees have to be paid in ports anyway – even if no waste is disposed of here. The realisation is hampered by the fact that the general conditions for the *no special fee*-system and possible reductions are different and not transparent in Baltic ports.

The introduction of recycling systems and big packages (food, other consumer goods – cleaning material, paint) reduces the amount of waste generated on board and so the need to dispose of this is reduced.

Voluntary for ports: Verification about the appropriate disposal or processing*3.

Encourage of the introduction of waste reducing measures *2.

Encourage of measures for the reduction of waste by giving reductions *2.

[103] *5 the realisation of the EU reception guideline has been regulated from the 1st January 2003.

Introduction of a coordinated *no special fee*-system*2.

Voluntary for ships: Encourage of the introduction of waste reducing measures *2 (separation, recycling, big packages etc.)*2.

5. Prevention of pollution caused by exhausts

Self commitment of the signers of the MoU:

General information:

MARPOL Annex VI comes into force in May 2005. With this, the (North- and) Baltic Sea turn into "Sulphur Emission Control Areas" (SECAs) in which special regulations are valid. The most important regulation is, that in this area only fuels with a sulphur content of 1.5% are allowed. This is a big step towards an improvement of the quality of the air in ports and coastal areas of the North- and Baltic Sea.

Binding for ports: Implementation of Annex VI (SECA)*1[104]

Binding for ships: Implementation of MARPOL Annex VI (SECA)*1

Goals for the protection of the environment of the signers of the MoU:

General information:

Although the reduction of the sulphur content in fuels to 1.5% according to MARPOL Annex VI is an important step towards an improvement of the quality of the air in ports and coastal regions it is still very high compared to the standards on land[105].Other legally binding requirements will follow.

Apart from this the supply of shore-side electricity can offer a further reduction of air pollution. This measure has already been introduced in some ports and is being examined for other ports.

An incentive system should be introduced in order to partly compensate for the higher costs arising from using low sulphur fuels.

Voluntary for ports: Implementation of the EU-Directive about the sulphur content in fuels for ships (COM (2002)595)*2

Development of harmonised standards for shore-side electricity for ships at berth*2

Development of incentive systems supporting the use of pollutant-reduced MDO or HFO (e.g. S<0.5%[106])*2

[104] is regulated according to MARPOL for SECAs on 20th May 2005-09-14

[105] Fuel for trucks in Europe = 350 ppm, from 2005 in the EU only 50 ppm, in Germany a fuel for cars with max. 10 ppm sulphur content will be offered.

[106] EU-REPORT from 10th November 2003: A European Union strategy to reduce atmospheric emissions from seagoing ships (COM (2002) 595 _ 2003/2064(INI)): 18. The European Parliament notes that the Commission urges the international bunker industry to make available significant quantities of 1.5% sulphur marine heavy fuel oils in states bordering SOx Emission Control Areas, but underlines that this request should be extended in

Voluntary for ships: Implementation of the EU-Directive about the sulphur content in fuels for ships (COM (2002)595)*2

Development of harmonised standards for shore-side electricity for ships at berth*2

Development of incentive systems supporting the use of pollutant-reduced MDO or HFO (e.g. S<0.5% (99))*2

Other requirements:

Following requirements not included in MARPOL I to VI should be considered additionally:

Input of unknown organisms through ballast water

Self commitment of the signers of the MoU:

General information:

The resolution A 868 (20)[107] is a guideline for the treatment of ballast water. Environmental-technically suitable requirements that can be realised nowadays are defined here.

Binding for ports: Implementation of Resolution A 868 (20) (7.2, 8.2)*2

Binding for ships: Implementation of Resolution A 868 (20)*2

Goals for the protection of the environment of the signers of the MoU:

General information:

The Ballast water-Convention was passed by the IMO in February 2004. One year after it has been ratified by at least 30 states with 35% of the world trade tonnage it will come into force. The requirements listed there can therefore be realised in the foreseeable future.

Voluntary for ports: Implementation of the Ballast water-Convention*2

Voluntary for ships: Implementation of the Ballast water-Convention*2

order to be able to meet demand for marine fuels also with a maximum 0.5% sulphur content in all Community sea areas; (section 6.5).

[107] Resolution A. 868(20), passed 27th November 1997: GUIDELINES FOR THE CONTROL AND MANAGEMENT OF SHIPS' BALLAST WATER TO MINIMIZE THE TRANSFER OF HARMFUL AQUATIC ORGANISMS AND PATHOGENS

10 Initiatives for pollutant reduction on ships /in ports

Because of missing or ineffective laws for the reduction of pollution caused by shipping increasingly initiatives for the voluntary realisation of more demanding standards for the protection of the environment are coming up. Generally the states that have ratified/will ratify the international regulations shown before have the possibility to introduce stricter regulations on the respective national level.

Some countries have already developed national regulations for the sulphur content in the bunker fuels sold in their ports. In Norway the allowed sulphur content in fuel is max. 1% as a general regulation, however in some Norwegian ports the limit is 2.5%.

In this context the Norwegian approach to fix an *Environmental Indexing* for every ship and to calculate the taxes and port-fees as well as the insurance premiums according to this system is interesting. It is the intention of Norway to initiate an economical incentive system in order to go beyond the internationally binding minimum level of the IMO in the interest of the marine environment.

In some federal states in the USA different regional specified areas in view of air pollution were already defined. This is the case for example for the Glacier Bay in Alaska, where only low sulphur fuels may be used, as well as in some Californian ports where e.g. a reduction of NOx of 70% is demanded. Ships often entering the port of San Francisco are mostly equipped with SCR-Catalysers for the reduction of NOx.

There are several other different possibilities and experiments to promote protection of the environment in shipping apart from the legal possibilities. More economical incentives are to be provided in order to fully use the relatively high potential of reduction in shipping in a cost effective way. According to Kageson the efficiency of the financial means invested in shipping for the protection of the environment is about six times as high compared to road traffic, a constellation that should be used from the economical point of view. It is being discussed at present if economical incentive systems or *Market Based Instruments* (MBIs) should be contrived for this, as legal measures are slow and possibly not as effective. As a rule, economical instruments offer a higher flexibility than regulating instruments. Single persons or companies adapt better to economical incentives than to administrative regulations.

Economical instruments are marked by the use of market forces (mainly the price) for reaching a goal. There are two groups of economic instruments: price-bound instruments (tax, duties and grants) and quantity-bound instruments (emission rights of certificates). To influence supply and demand in transport with the help of market forces offers an advantage when following up a sustainable transport policy: by using the price development as upholder for internationalising the actual costs the market distributional processes are not distorted. Only the use of the infrastructure is paid for by the traffic participants, meaning the costs of their mobility. These costs include creation of infrastructure and maintenance, harm to health and the environment. By connecting proof of quality (under the environmental point of view) and efficient advertisement another measure for supporting the protection of the environment is being tried out. The certificates of the classification companies are used increasingly for this and the Blue Angel for environmentally sound shipping is handed out for the realisation of especially high requirements.

10.1 Environmental initiatives predominantly related to shipping

Considering the fact, that the main and steadily increasing part of the pollution in ports is caused by ships, the first initiatives focused solely on ships for the improvement of marine protection. This made sense because an environmental legislation, in force for the operation of installations on land exists in many countries but not for shipping. The most resolute incentives for improving environmental standards in shipping have been realised in Sweden. The fact that a great part of the pollution of the forests and lakes was essentially caused directly by shipping called the most important stakeholders into action to put efficient measures in place.

The *Green Award*, known as one of the first initiatives for the voluntary improvement of the protection of the marine environment, is just to be mentioned here, mainly because it addresses tankers and the focus of the initiative to help reduce pollution caused by accidents at sea.

10.1.1 The Swedish system Differentiated Fairway Dues

Examinations by the Swedish maritime administration about ship generated emissions in Swedish ports were the reason for the implementation of the incentive system *Differentiated Fairway Dues*. These had shown that the share in harmful emissions (NOx and SOx) in the Swedish coastal regions and especially in Swedish ferry ports of ships had in some cases risen to up to 80%.

As the Swedish shipping administration did not expect that the harmful emission caused by ships could be reduced in future without incentive systems they assumed that a great part of the ships, especially the ferries, should be urged by means of economical incentives to install catalysers in order to reduce NOx. Additionally, the use of low sulphur bunker oil was rewarded. One aim of the Swedish shipping administration is to conclude appropriate agreements with all neighbouring states, especially those involved in ferry shipping with Sweden, and to advance the realisation of the planned measures between 1998 and 2003 with the help of incentives (reduction of fees). This initiative is based partly on the EU-Guideline for the realisation of a *Fair and Efficient Pricing in Transport* in which the political wish is expressed to rearrange transport (not only shipping) in the EU more environmentally friendly with the help of incentive systems.

In order to drastically reduce pollution of the air in Swedish ports, especially in ferry ports, the Swedish marine administration office, the Swedish port- and port worker-union and the Swedish Ship Owners Association introduced a *Tripartite Agreement* in April 1996.

The program was started on the 1st January 1998. The aim was to reduce the exhaust emissions (NOx and SOx) by 75% within five years. The Swedish initiators expressly point out that they support the IMO and HELCON initiatives about emissions into the air (MARPOL Annex VI) but that these regulations were not enough if the reductions of 75% are to be realised by 2003.

The initiators of the *Tripartite Agreement* have developed and specified the program in several publications. The provisional differentiated fee structures are pictured in the edition from 16th December 1997. According to this the new fees (*fairway dues/shipping route fees*) are divided into two parts:

- One part is based on the size of the ships, calculated in the *Gross-Tonnage*,
- The second part is based on the bulk of the cargo.

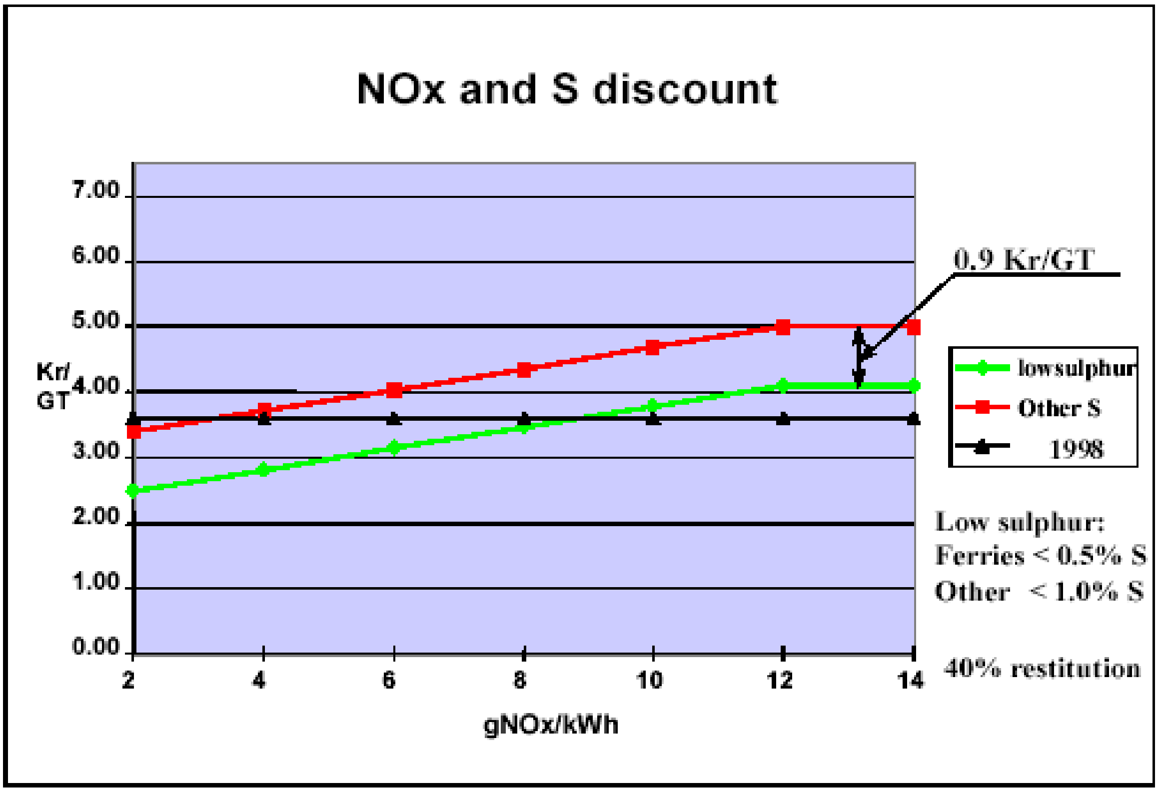
From the 1st January 1998 the first part is being gradually differentiated corresponding to the nitrogen oxide and sulphur emissions. The total sum of the fees is to remain unchanged to the present income as ships with higher emission values have to pay more now than before 1. Jan 1998. As from this date the fees relating to the cargo are 3.60 SEK or, for cargo of "little value", 0.80 SEK. Which cargo belongs into which category is stated in an appendix. The *Fairway Dues* are explained in tables according to the size of the ship (GT) and their NOx and SOx emission values.

In order to support the introduction of catalysers (SCR) the costs for the installation can be settled up to 40% within 5 years with the help of refunds from the *fairway dues* if the installation was carried out before the year 2000. After 2000 only 30% of the costs are refunded.

Additionally, a differentiated sulphur fee was placed on all ships as high running costs result from this for shipping companies. The cost for HFO, with the normal sulphur content, was about 130 USD/t in 1999. Fuels with a sulphur content of 1% were c. 10 USD/t more expensive, and fuels with a sulphur content of 0.5% were again c. 20 USD/t more expensive.

The ship based portion of fairway dues that reflect the NOx and SOx emissions are to be calculated maximal 12 times for freighters and maximal 18 times for passenger- and train ferries per year. The *fairway dues* are charged by the state. The Swedish port administrations were free to take part in the system with a reduction on port fees, which was actually done by some ports. The reductions however are very different from port to port.

Picture 40: Structure of costs for fairway dues and reductions



http://www.imprint-eu.org/public/Papers/IMPRINT_Swahn_sea.pdf.

Very soon there were different shipping companies that were obviously convinced that Sweden would use this program. Some had for this reason invested considerable means before to reduce the exhaust emissions above the binding limits stated in the international regulations in order to meet the Swedish requirements.

About 25 of the c. 52 Swedish ports are currently participating in this system; in the year 2002 1.043 ships were registered for the use of sulphur reduced fuel and in 2001 30 ships were registered for NOx reducing measures. According to Per Ekberg, *Administration's Manager for Maritime Policy and Public Affairs* c. 50.000 tonnes of SOx and c. 27.000 tonnes NOx emissions could be avoided per year[108] when looking back over the 6 years after the system was implemented.

It has repeatedly been tried to extent this system to the entire Baltic. The implementation of the Swedish system in other Baltic states is however not easy, as different countries have their own fee-systems. In addition in most countries are no comparable *fairway dues* charged for the use of the shipping lanes at sea, so that of course no reductions can be granted. The fee-structure is also so very different in the ports of the Baltic States that a comparable reduction-system ad hoc is very difficult to realise. This is a disadvantage inherent in the system. However, it is possible that the ports develop a temporary fee-system on a voluntary basis in cooperation with each other, which would offer the opportunity to give reductions. This is why it would be advisable to take the Swedish *Differentiated Reduction on Fairway Dues* as model for a *Baltic initiative*, which would be taken up by all member states to HELCON and implemented at least in the ports.

10.1.2 The EU-Port Reception Facility Directive 2000/59/EC

The approaches of the Directive 2000/59/EC about port reception facilities for ships wastes and cargo residues for the protection of the environment was already commonly practised long before it was legally binding in some ports – especially in Sweden and in some German ports. By adopting the Directive and the HELCON recommendations[109], the states in the EU also introduced the *no special fee*-system in order to prevent illegal discharge and dumping of dangerous residues (waste, oily residues) into the sea. However, the modalities, according to which the Directive is realised nowadays in different ports in the EU, can hardly be seen as an incentive for improved protection of the environment because they are very different in their effects. The fee-system includes having to pay for the reception and disposal of waste in port together with the normal port fees (or separate fees), no matter whether the ship actually uses the reception facility or not. The fee can be calculated from the type/size of ship as well as the number of passengers and crew. The aim of this system is to encourage ship owners to use port reception facilities by removing the economical advantage of disposing of ships´ waste at sea. The coordination and transparency of the procedure and fees in the ports of the EU are some preconditions for an efficient realisation of this system. The Directive is realised in Germany by the federal and regional laws. At present an efficient system for environmentally sound reception and disposal of ships´ waste and cargo residues has not yet been introduced in all EU-member states [I14].

The fact that the Directive has not been harmonised for all ports leads to problems on board ship as well as in some ports. While some ports take up to 100% of ships´ waste, meaning without the exception some kinds of waste or limiting the amount, other ports limit the amount of waste they have to take without charge. For this reason those wastes not belonging to the "*no special fee*-system" and for which the disposal is not free are brought to those ports

[108] Source: [I10] http://www.maritimetoday.com/more.cfm?ID=13466
[109] by the HELCON Russia, even as a non-EU country, must also realise the requirements.

that take all kinds of waste. This resulting in high disposal costs they would normally not have. Additionally it became known that on some ships the bilge water was not purified as partly the total amount was taken anyway. While sludge has a water content of only c. 20% after purification, a mixture of sludge/bilge water can consist of up to 99% water, resulting in a cost-intensive purification process on land.

However, these possibilities of disposing ships´ waste free of charge are important, because otherwise wastes could be disposed of again into the sea (not only normal rubbish, but also toxic waste). Examinations have shown that an increase of the illegal disposal of wastes at sea is generally connected with the introduction of fees for the proper disposal in ports. In addition to this, the ports only have to charge the disposing ships a "significant" part of the disposal costs in order to meet the requirements of the polluter pays principle. With this a share of at least 30% is meant. Ports that do not accept all kinds of waste without charge and also take just 30% of the costs gain an advantage (less costs) in competition with the other ports.

As well as this, taking the Gross tonnage as a basis for calculations is being criticised, as it is not a reliable indicator for the amount of waste created on board. The efficiency of the engine (for oily waste) or/and the number of persons on board and type of ship could be more reliable. And, lastly, a standardised registration and accounting system (e.g. relating to the duration of "free of charge" use of bunker boats) is being demanded so that the actual realisation of the Directive can no longer be disguised. When added up, the *no special fee*-system is seen by most experts as a suitable instrument for the reduction of marine pollution. Several improvements are being demanded, however, especially in the areas transparency and harmonisation.

10.1.3 The Bremen Bonus model for the promotion of environmental protection in shipping

Special measures for the protection of the environment usually create additional costs, meaning that shipping companies involved in environmental protection have a financial disadvantage compared to their competitors, so that such measures are only implemented in special cases. For this reason compensation for environmentally sound measures must be given to these shipping companies in order to support protection of the environment in shipping. On behalf of the Federal State of Bremen possibilities approaches were to be examined within the scope of a project. GAUSS and ISL developed an internationally applicable and integrative bonus with the aim to

- investigate a basis model of an economic incentive system that can be applied internationally with an integrative character
- consider additional factors like neutral competition, little administrational work and to bear in mind voluntary participation
- check practicability and the amount of administrative work needed for this basis model in test runs
- make statements about the ecological effects, the chances and perspectives of spreading it internationally and
- create a basis for making decisions for or against the introduction of the proposed incentive system.

In the project next to Bremen/Bremerhaven the ports of Brake, Emden, Wilhelmshaven and Lübeck-Travemünde participated.

In order to meet the requirements of the project an assessment of internationally acknowledged certificate and incentive systems was carried out to check the factual criteria for an internationally applicable bonus model. These were:

Table 47: Certifying and evaluation systems considered

American Bureau of Shipping	ABS	Marine Safety, Quality, Environmental Management
Chemical Distribution Institute	CDI	Safety and Quality Assessment System
Det Norske Veritas	DNV	Class Notation "Clean Design" and "Clean"
Germanischer Lloyd	GL	Environmental Passport
Green Award Foundation	GA	Seacure for Operations 2000
International Chamber of Shipping	ICS	Shipping and the environment – A code of practise
International Transport Workers´ Federation	ITF	Is there a better way to regulate shipping industry
Lloyds Register of Shipping	LR	Provisional Rules: environmental protection
Oil Companies International Marine Forum	OCIMPF	Vessels particulars questionnaire for bulk oil/chemical carriers and gas carriers
Registro Italiano Navale	RINA	Green Star Class Notation "Clean Sea", "Clean Air"
Swedish Maritime Administration	SMA	Environmental differentiated fairway and port dues

[33]: GAUSS / ISL: Development of a model for a integrative and internationally applicable bonus system *Quality Shipping*, results of the study, Bremen, January 2002.

From the results of the analysis a list of requirements was developed from which the environmental and safety management of shipping companies and ships could be evaluated. The list contained a total of 18 aspects in 3 main chapters. The proof of the compliance with the different requirements is given without exception by the according certificates thus administrational work is kept low

Table 48: Requirements to be realised for the Bonus Model

		Points	Σ	Proof e.g. by
Chapter 1	**Shipping company policy and -management**		**31**	
1.1	Pollution third party liability insurance	10		Insurance police
1.2	Quality management	3		ISO, ISMA, GA certificate
1.3	Environmental management	3		ISO, ISMA, GA certificate
1.4	Personnel management	< 16		ITF blue card, training record
Chapter 2	**Ships design, -construction and -equipment**		**45**	
2.1	Application of material on board	5		Material pass
2.2	Collision protection	10		Classification mark
2.3	Redundant systems	10		Classification mark
2.4	Hull stress monitoring	10		Certificate
2.5	Emergency Towing System	10		Certificate
Chapter 3	**Ships operational management and -technique**		**130**	
3.1	Gaseous emissions from air condition etc.	< 16		Installation Specifications
3.2	Sulphur dioxide emissions	< 21		Certificate
3.3	Nitrogen oxide emissions	< 21		Certificate
3.4	Soot- and particle emissions	10		Certificate
3.5	Solid waste (*waste*)	< 16		Waste diary
3.6	Black and grey water (*sewage*)	< 16		Certificate
3.7	Bilge water	5		Certificate
3.8	Antifouling	20		Specifications
3.9	Ballast water	10		Certificate, diary
		Σ	**206**	

[33]: GAUSS / ISL: development of a model for a integrative and internationally applicable bonus system *Quality Shipping*, results of the study, Bremen, January 2002.

Granting bonuses is based on a matrix for the evaluation of the environmental and safety practise according to a list of criteria. The hierarchy of evaluation followed the criteria

1. Measures with direct effect on the environment and safety
2. Innovative, precautionary measures
3. Documented and efficient QM-systems.

The aim of the evaluation was to realise a costs effective acknowledgement of a precautionary environmentally approach and safety related action. The model provides a bonus already when relatively few points have been earned, in order to have a signalling effect. Progression steps are planned to be able to consider over-proportionate expenses:

Share on total bonus	20 %	60 %	100 %
Points gained	35	70	110

A test run going on for several months was carried out in the participating ports with the help of questionnaires based on the list of criteria in order to gain information about the environmental and safety practices, and for the granting of bonuses.

The examination of the suitability of port fees for an internationally applicable bonus model was another focal pointing the project. Existing systems for the granting of incentives were checked first. The city of Hamburg had by then introduced a system in which reductions of 6% on port fees was provided for holders of an ISO 14001 or Green Award-Certificate and a reduction of max. 12% for harmful exhaust gas reduction (SOx and NOx) or the use of TBT-free paints was granted. A reduction of at least 50 German marks and maximal 12% of the port fees was given every time a ship entered the port. This system offered a score of advantages:

- It could quickly be decided upon and introduced on town/port administration level
- Quick modifications could be carried out in the testing phase
- Other ports could join this or a similar system
- The bonus was already counted positively into the settlement of accounts the first time the ship entered the port
- With these activities Hamburg was an example and promoted the discussion about environmentally sound shipping.

The traffic structure and the administrative organisation of the port of Hamburg offered good conditions for the introduction of the system. However, it was only partly possible to transfer the model to other ports. After the examination of the fee-structures of different ports it could be seen that often they are not suitable as the basis for granting similar bonuses. The most important results were:

1. From the several fees to be paid when entering port, port fees or pilot fees offer the best basis for the bonus-system, as these are often binding official tariffs, while the wages for private services are often negotiated. Port fees are however only a part of the costs connected with entering a port, so that a reduction on this does not lead to considerable amounts.
2. For many small ships in short sea-traffic a standardised reduction rate for all ships sizes can lead only to small absolute discounts as ships moving in European waters are often privileged because of the often low port fees that are paid per gross tonnage.
3. A standardised percentage rate is hardly sensible between the ports because of the variations in the amount of port fees in relation to gross tonnage. Higher reductions could disturb competition.
4. It is very important however that many ships are not touched by this as they do not have to pay port fees or at least only flat rates. Examples from the examined ports are:
    - The ferry service between Borkum and Emden makes up half of the shipping traffic in Emden. The shipping company pays a flat rate for this. How a bonus is to be calculated from this is uncertain.
    - The situation is similar in Lübeck and Travemünde where a great part of the traffic consists of ferries and RoRo-lines; a flat rate has been negotiated here, too.
    - The “NWO-pier” and the “Raffineriepier” in Wilhelmshaven are in private hands, the most important part of the tanker traffic is private as well. As it is a

kind of internal traffic, port fees are not demanded here. Instead, the pier operators take care themselves that their own environmental standards are kept to by a strict selection of the ships.

The environmentally conscious shipping company can profit from the Hamburg *Green Shipping* model, but the bonuses are financed by the taxpayers even though it would seem more sensible to burden the polluters with this. The ports can be the place where the bonuses are dealt with, but shipping itself ought to be relieved or burdened. These thoughts lead to the fact that bonuses should be calculated for the ships themselves and not based on the port fees. This would offer considerable advantages:

- The calculation of the accounts would be much easier if a central office were to state the right to receive a bonus e.g. only once a year
- The ship would profit from a reduction per year that is higher than the single bonuses would add up to as not all ports would participate. The yearly bonus should be high enough to be evaluated effective.
- The amount of money saved is calculable for the shipping company and does not depend on the often coincidental entries in the respective ports.

The introduction of a new environment fee that depends on the characteristics of the ship seemed to be the best solution. Ships not fulfilling any criteria for the protection of the environment would pay the full price, all others would get a reduction. Exemplary ships can get a reduction of 80%, a great part of the fees. An introduction should be tried on EU level, to ensure a broad application.

As the fee is calculated according to the ship, a yearly entry of the payment in the respective office where the data of the local ships register are kept would be possible. Here a plainly structured fee could be defined and a certificate about this would be kept on board. The Port State Control (PSC) could professionally define the height of the reduction. The advantages of charging ships´ fees from a central point are:

- The reference to the ship is fairer than taking reference to port fees (polluter pays principle).
- All ships are included, even those not paying port fees
- The reduction can be given at once and can easily be calculated by the shipping company
- Reaching the aims in environmental protection can be controlled better
- Individual measures like the Green Award or Green Shipping in Hamburg are not generally excluded
- It does not touch port competition
- Unlike in other incentives administrational work is relieved in ports
- The captain/ships operator is not burdened additionally.

The evaluation of a ship with the help of a point-system according to a list of criteria developed during the study is the basis for giving bonuses. With the help of the bonus-system and the gaining of points for defined measures the shipping company can see how much reduction is given for following up a criterion, meaning it can be calculated if a bonus is enough for an investment. This makes a certain control for the reaching of aims in environmental protection possible.

The technical data of the ship offer a basis for the calculation of the fees. Taking the turnover of goods as a basis does not seem sensible, as the pollution rate of a ship does not depend on how much cargo is transported. Especially non-freighters can not be calculated with the help of the cargo on board. The size of a ship, gross tonnage, is also not the best basis, as can be seen in the comparably strong pollution caused by RoRo ships, which have big enclosed space with little gross tonnage.

Therefore the fee could be calculated on the basis of the load capacity (tdw). According to this, tankers and bulk carries are burdened clearly depending on their size. General cargo-, container- and RoRo-ships pay a little less in relation to their gross tonnage. The calculation also contains a first ecological factor: those ships with the highest tdw-value have the deepest drought, resulting in the fact, that the routes have to be dredged, again resulting in the difficult disposal of dredged sands, etc. and a further interference in nature.

A further, even more important ecological factor can be included by considering the efficiency in kW of the engines installed as those ships with bigger engines cause more pollution. As general cargo ships and ships in regular service generally have a lower tdw-number but a higher efficiency than tramp- or bulk carriers, with this calculation the lower tdw-numbers are compensated again in the total evaluation. Higher fees are possible for these highly efficient ships because they usually transport higher quality cargoes at much higher costs. For ships not transporting cargo the gross tonnage number would have to be used, considering that this may have to be evaluated differently when comparing with the tdw as basis for calculations. The easiest way was suggested for the calculation of the fees on the basis of tonnage and kW at first:

$$\text{Fee} = (\text{tdw} + \text{kW}) * \text{Factor}$$

The factor depends on the sum of the fees to be deducted. If e.g. an environmental insurance would have to be paid from the fees for the loss of cargo, a higher factor for tankers could be possible because of the much higher environmental danger.

The proposed bonus model was discussed with the BMVBW, UBA, the Association of Shipowners, shipping companies, other officials etc. in a workshop. The approach was, in general, seen as suitable, but an immediate realisation was judged to be not possible at present because of the different fee structures in the different federal states, and even more so in the different countries and ports of the EU. The Bremer bonus model can continue to serve as a basis for further discussion since the EU generally intends to make the traffic participants pay themselves for the costs of environmental protection (*polluter pays principle*).

10.1.4 The Blue Angel Award for Environmentally Conscious Ship-Operation

The initiative to create the *Blue Angel Award for Environmentally Conscious Ship-Operation* is bound to a project that was worked out by the GAUSS for the Federal Agency for Environment. The tasks of the research project were to quantify emissions caused by shipping, to investigate potentials for reduction and to define a *Best Available Technique* standard.

Several commendable approaches were found for environmentally sound operation in shipping, in single improvements as well as in the total operating of ships. In order to strengthen these positive approaches it was decide find a way to honour the commitment of such shipping companies in public. Although it was known that international regulations would be preferable in shipping, for reasons of a quick and efficient implementation the eco-label *Blue Angel Award* was chosen as incentive for environmentally sound shipping especially as it is a label of the UNEP (United Nations Environment Programme) that is available to potential applicants worldwide.

The analysis of different international evaluation- and certifying systems (incentive systems, classification societies, etc.) were the basis for the list of criteria for the *Blue Angel Award*. The procedures and criteria of other initiatives were also included in order to be able to offer options for a future harmonisation. The overall aim of this was to reach an common agreement on realistic and ambitious environmental requirements in shipping.

The requirements were modified and evaluated in workshops in which representatives of all the important stakeholders involved in shipping were included. The elaborated criteria, twenty in all, go far beyond all other existing approaches. Applicants successfully fulfilling all these criteria can rightly count themselves among the shipping companies leading worldwide in environmental protection. According to the tasks following requirements are to be fulfilled in the definition of the requirements:

- Best possible and effective protection of the marine environment
- Reliable and credible proof about the realisation of the criteria
- Little administrative work on land and on board
- Applicability by shipping companies in commercial competition.

A positive example for a responsible and committed behaviour for marine protection and safety in shipping should be given with the handing over of the eco-label *Blue Angel Award for Environmentally Conscious Ship-Operation shipping*. The requirements that have to be fulfilled in order to get the eco-label *Blue Angel Award for Environmentally Conscious Ship-Operation shipping* are divided into three groups that represent different aspects of environmental protection in shipping:

- Policy and management of shipping companies and ships
- Ships´ design, construction and equipment,
- Operational management on board the ships.

The different requirements of the three groups are closely connected, so that they can only be realised in combination with each other (e.g. policy of shipping company or instruction of the crew in connection with the operation of the ship for the reduction of emissions).

Safety and environmental protection at sea can only be realised effectively if the shipping company on land acknowledges these aims as an original commitment. The deficit caused by a lack of *Commitment from the top* on one hand and the crew's loss of identification with the shipping company or the ship on the other hand, led to a deterioration of the standards in safety and environmental protection that became more and more pronounced, so that ways had to be found to stop this. With systematic management instruments, including the ISM-Code, ISO 9001:2000, ISO 14000 as well as a more intensive management of personnel, this problem was to be dealt with. While the ISM-Code was already legally binding for all sea going vessels, the realisation of ISO9001:2000 and ISO 14000 is not mandatory. They are being implemented increasingly by committed shipping companies anyway, either because contract partners want this in order to get transparency about the respective management of the company, or because some components are not covered by the ISM-Code. This is the reason why these instruments, as well as aspects of the management of the personnel, are defined as requirements for obtaining the eco-label *Blue Angel Award.*

Requirements for ships´ design, construction and equipment reflect that an effective protection of the environment always depends on the safety of a ship as well as from other things. Some of the most serious pollutions taking place in a defined area and time were caused by shipping accidents, which were again caused by few reasons. Apart from the main causes, *human element* or *human fatigue*, problems that have to be solved by measures in the management of the personnel, there are collisions and stranding as well as the breaking apart of a ship in high seas followed by a loss of cargo.

The requirements for collision protection and redundant ships´ propulsion take these circumstances into account. Collision, stranding, engine break down and loss of cargo can be avoided effectively by technical means which are nowadays available. In order to avoid, or recognise in time, stress and bending of the ships hull and to be able to react accordingly a *Hull-Stress-Monitoring-System* on board was considered as requirement as well as an Emergency Towing System, in order to be able to quickly help a ship in distress situations. When working out the requirements for environmentally sound shipping the fact that still a lot of pollution in the environment is caused by repair works and the scrapping of ships. For this a list of material used on board was recommended as a suitable measure to protect the environment.

The most extensive packet of the criteria is the requirements about ships emissions caused by the regular operation of ships. The requirements defined here for solid, gaseous and liquid emissions in some cases go far beyond those limits defined in international and national regulations.

The gaseous emissions caused by ship´ operations are probably the most critical. On land the emissions caused by traffic have been reduced with great effort by reducing the pollutants in the fuel so that by now sulphur-free fuels are available. This procedure could not be realised for fuels used in shipping yet. On the contrary: ships are seen as the disposal units for residues of refineries, resulting in the fact that all those substances forbidden in fuels on land are burnt on ships by using heavy fuel oil. Thus in coastal waters and ports shipping traffic takes place, a great part of the local emissions is already caused by shipping.

Therefore, considerable measures for reduction must be implemented in this area for ships that are to carry the eco-label *Blue Angel Award*. This means having to reduce the emission of sulphur dioxide and nitrogen oxides in the exhaust of the ship as well as reducing the use of coolants, meaning the emissions from air condition and cooling units. Measures of reduction are also seen as important for soot and particle emissions in the exhaust, but up to now no limits could be defined as practicable proof for this is not available. As there are still ships using the highly harmful fire extinguishing measure Halone the decision was made that this medium will have to be replaced by a more environmentally sound one.

For liquid emissions caused by ships requirements for black, grey water and ballast water were considered for the *Blue Angel Award*. Because of the fact that passenger ships create great amounts of sewage and grey water, and that they often frequent sensitive waters, stricter regulations have been implemented on the discharge of these pollutants than for other ships with less persons on board. As the best solution for the environment protection the disposal on land was favoured, as was the case with bilge water and waste.

Bilge water, meaning condensed water and water from leakages, is often contaminated with oil and other pollutants as it comes from the engine room and the cargo holds. In some areas of the sea, e.g. the Baltic, a disposal on land can be carried out as a rule. If this is not possible it is permitted, under consideration of the international regulations and by keeping to the requirements, to discharge into the sea. When aiming for the eco-label *Blue Angel Award* the demands for this are raised to 1/3 of the internationally valid limitations (meaning to 5 ppm oil content in the effluent). The transport of foreign organisms in ballast water into a foreign environment and the dangers connected to this is also a subject for the handing out of the eco-label. Measures for reducing or solving the problem are being prepared internationally, which are taken up by the requirements for the Blue Angel Award.

The disposal of wastes created on board and ashes from the incineration of waste as well as the input into the environment of TBT from the hull (*Antifouling*) are considered in the area of solid emissions. Waste disposal on land is the best method for the environment in industrialised countries with functioning disposing facilities. This may, however, cause pollution in far-off areas without an adequate infrastructure. This is why it seemed better to take the possibility of burning waste on passenger ships into consideration, as a lot of waste is created here. It must be remembered, however, that no toxic wastes or PVC may be burnt in order to prevent the forming of Dioxin and Furan.

Almost all ships´ emissions are covered when the ships´ operations are considered in total for awarding the eco-label. Additionally, the fact that effective protection of the environment also depends on the motivation and instruction of the crew is reflected upon. As the ships of environmentally conscious companies fulfil many important requirements, but none fulfil all those criteria considered to be important, it was decided to demand the most important requirements for the protection of the environment and to leave the realisation of a certain number of requirements to the companies so that these could be realised optionally. This procedure has following advantages:

- Binding requirements have to be fulfilled; they are inalienable from the environmental point of view. To this belong, among others, education of the crew about environmental protection, the reduction of sulphur dioxide and nitrogen oxide emissions as well as the emission of green house gases, e.g. coolants. The use of certain pollutants is to be banned completely (Halone, TBT)
- The options describe criteria, which are not, as a rule, classified as not inalienable (e.g. the implementation of ISO 14000, the reduction of the soot and particle emissions, considering the problems connected with ballast water, use of materials on board)
- The options can consider new and existing ships, offering the opportunity to address requirements that can be fulfilled only in new ships or ships under construction (e.g. use of redundant drives)
- The options can consider different types of ship (e.g. use of Hull-Stress-Monitoring-Systems for large ships)
- The shipping companies can commit themselves according to the specific requirements for their ships or shipping routes (e.g. the ballast water problem)
- Because more than the minimum of the options can be fulfilled the basis for awarding remains to be dynamic: the ship that has fulfilled most options is the most environmentally sound one
- The system is flexible and uncomplicated (no extra ships types etc.).

At present, concrete statements about the reduction of emissions that have to be realised can only be made relating to single ships. Trying to add these statements up in order to cover entire areas or fleets would only result in a rough estimate because of the insufficient data that is available, e.g. the duration of stay in the respective area, the actual efficiency of the engine, the size of the ship etc. However, ships spend a lot of time in coastal waters so that with the increasing acceptance of the eco-label the quality of the air would be improved in those areas where the pollution is noticed most, i.e. in coastal waters and in ports.

According to an investigation carried out by *Lloyds Register of Shipping* the share of the total emission of sulphur caused by international shipping is worldwide 7%, which is c. 10 million tonnes per year. The yearly emissions in the North Atlantic are c. 1.37 million tonnes sulphur dioxide. Each ship with the “Blue Angel” reduces its own emissions by 50% (binding) or even 85% (optional).

The share of the NOx emissions worldwide caused by international shipping is estimated to be 11% to 13%, 9.3 million tonnes NOx per year (c. 1.94 tonnes in the North-east Atlantic). This is reduced by individual ships by 20% (binding) or more than 50% (optional).

Substances harmful to the ozone layer are still in use on board many ships. Estimates have shown that of these coolants about 50% of these substances on board are emitted during the lifespan of the cooling and freezing units and a further 15% are emitted during repairs and maintenance of these units. And lastly, great amounts of CFC are often set free when the ships are scrapped. For ships with the *Blue Angel Award* the use of Halone is forbidden. The substances used on ships with the *Blue Angel Award* have an ozone-depleting-potential of maximal 0.05 (binding) or 0 (optional), the value for global warming potential (GWP) is limited to 1650.

Comparable values exist for other kinds of emissions: bilge water may only be discharged if the oil content is at 33% of the values that are internationally in force at present (binding) or it is being disposed of on land (optional).

The aim of awarding the eco-label *Blue Angel Award for Environmentally Conscious Ship-Operation* was to honour the observance of defined and high standards with an internationally introduced predicate. With this it is to be made possible for ship builders, shipping companies, charters and others to commit themselves in the protection of the environment and also to use this in an economically effective way, also for publicity reasons.

10.2 Environmental initiatives predominantly related to ports

Ports have increasingly come to public attention, meaning between the order to take over important transport functions and the concerns of the residents who feel that their right to be able to live in a clean environment, the protection from noise etc. is impeded. For this reason there are already attempts to settle these conflicts of interest. Although most of these impairments are caused by the ships, the ports are being criticised as the indirect source of this pollution. There are, as a fact, several possibilities here, too, to integrate environmental protection into the operation or to help reduce deficits in shipping.

10.2.1 European Sea Ports Organisation: The ECO-Port Project

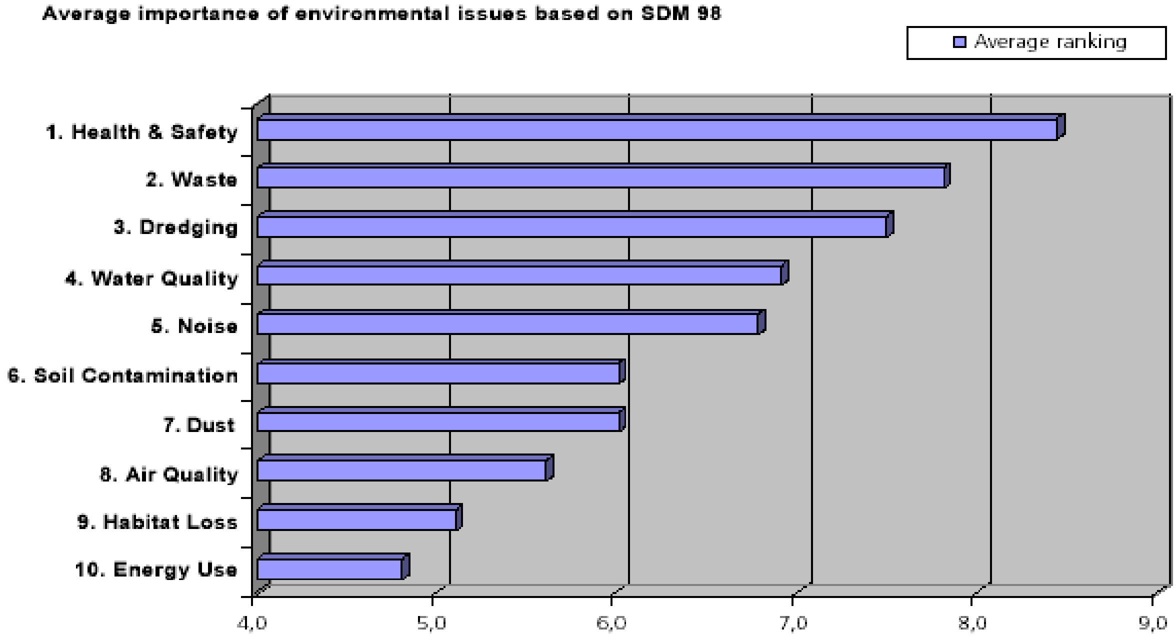
The ESPO (European Sea Ports Organisation) was founded in 1993 in order to give port economy a platform to support their interests. The organisation represents port authorities, port administrations and port companies with contacts to c. 800 ports in Europe. The ESPO understands itself as being the motor for development of port economy and, among others, analyses the situation in ports, works out ideas for improvements and supports the implementation of new regulations etc. A *Code of Practise* was published, among others, by the ESPO in which the most important strategic-environmental aims ports should to realise are described[110]. The aims are summarised in ten points:

1. As ports play an important role in the Trans-European network, a contribution is to be made for the development of a sustainable chain of logistics
2. Extensive dialogues and cooperation between port administrations and the people affected by this (port users, the public, non-governmental organisations) are to be encouraged in order to find a balance in the near future between the different interests and reach an acceptance for port projects from the local residents
3. Development of new knowledge and sustainable technologies in order to combine environmentally friendly effects and cost efficiency. Self-regulation and an approach starting from the bottom are to be aimed at for this. The existing self-regulating instruments developed from the ports in everyday practise will form a basis for European environmental policy also if the EU decides to suggest environmental regulations or guidelines. This way it will support and implement EU legislation
4. Improved cooperation between port administration in the area of environment and making the exchange of experience and the implementation of model practices easier in order to avoid unnecessary work and to share costs in the development. This can be realised by working together with the port authorities in a network that is being coordinated by the ECO-port foundation
5. Strengthening of the awareness for the environment and integration of sustainable development into the strategies of the ports by encouraging the port authorities to publish environmentally strategic guidelines describing their strategies and the methods they use for reaching their aims. This would contribute to create common social responsibility for the port
6. Encouraging the port administrations to carry out tests on the environmental friendliness of port projects and strategically suitable audits on the environmental friendliness on port development plans in order to be able to decide early on how harmful influences on the environment can be reduced
7. Boosting continuous improvements in the environment around the ports and the port environment management by promoting environmental managements information systems (as for example environment audit, environment report, environment management systems, support systems for decisions, internet instruments for port users as has been developed by the ECOPORTS foundation
8. Promoting monitoring based on eco-indicators, as was advised in the ESPO report 2001 so that developments in port practises related to the environment can be measured objectively
9. Promoting that environment reports be written as means of showing environmentally sound behaviour for those affected and institutions in Europe, according to the suggestions in the ESPO report 2001
10. Better communication about the improvements for the environment that have been implemented by the ports in order to create a better understanding for the role of ports and their efforts for a sustainable development.

[110] http://www.espo.be/publications/Env%20Code%202003.asp

The queried ports were asked to give their assessments on a scale from 1 to 10 of the importance of different aspects in the areas safety, health- and environmental protection. 32 ports answered and the summary of the assessments gives following picture:

Picture 41: Importance of different facts in environmental protection



[21]: ECO-Port: ECO-information in European Ports, Final Report for Publication.

The problems that result from port operations can apparently be compared in part to the situation in Lübeck-Travemünde according to an analysis in the ECO-ports. Ambitious and detailed regulations for health and safety management are, in some cases, currently in force and guaranteeing the needed water-depth is an essential regulation for a port, but there are environmental problems right next to this, that have to be solved.

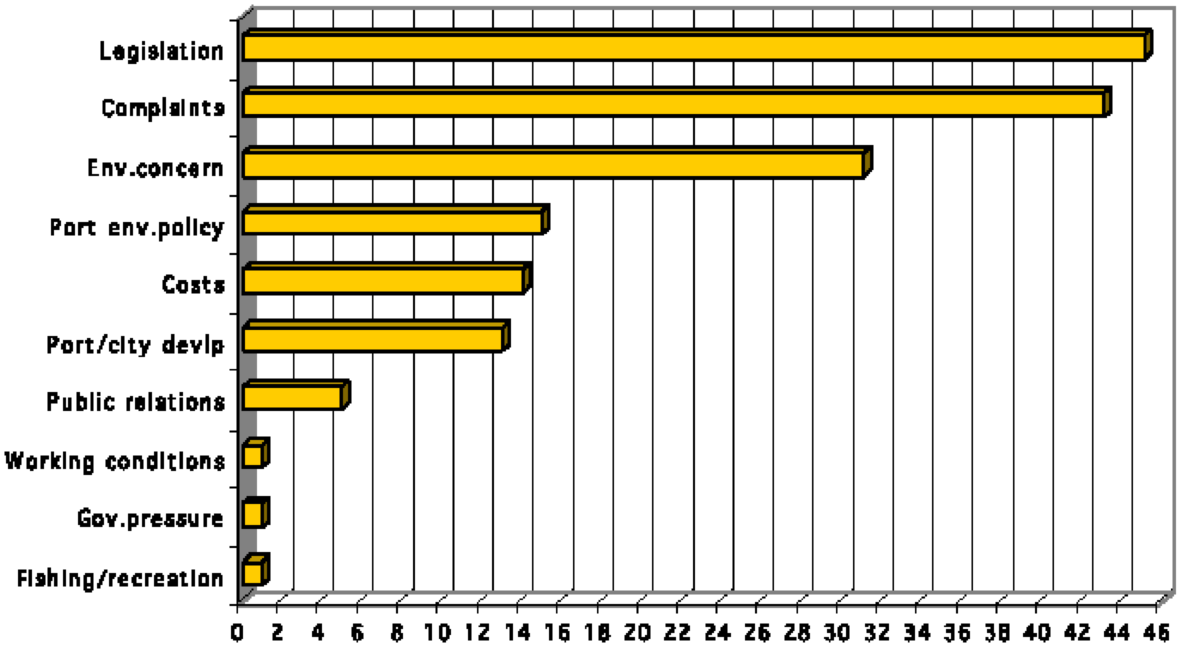
Table 49: Description of the situation in the ECO-ports

Current port activities are most affected by:	Port development plans are most affected by:
1. Health & safety management	1. Health & safety management
2. Dredging	2. Dredging
3. **Noise**	3. **Soil contamination**
4. Waste management	4. Noise

[21]: ECO-Port: ECO-information in European Ports, Final Report for Publication.

There were different reasons for the reactions to, or reductions of, the problems mentioned above. First of all, these were legal conditions that had to be kept. More reasons were the complaints of the persons that are affected, showing either increasing pollution affecting the residents and customers or an increasing sensibility of those people.

Picture 42: Reasons for the implementation of measures for environmental protection



[21]: ECO-Port: ECO-information in European Ports, Final Report for Publication.

This is why the problems are mirrored also in the initiatives for the reduction of the deficits. The waste problem is therefore the first in line and the emission of noise is already in third place.

Table 50: Measures for the reduction of pollution

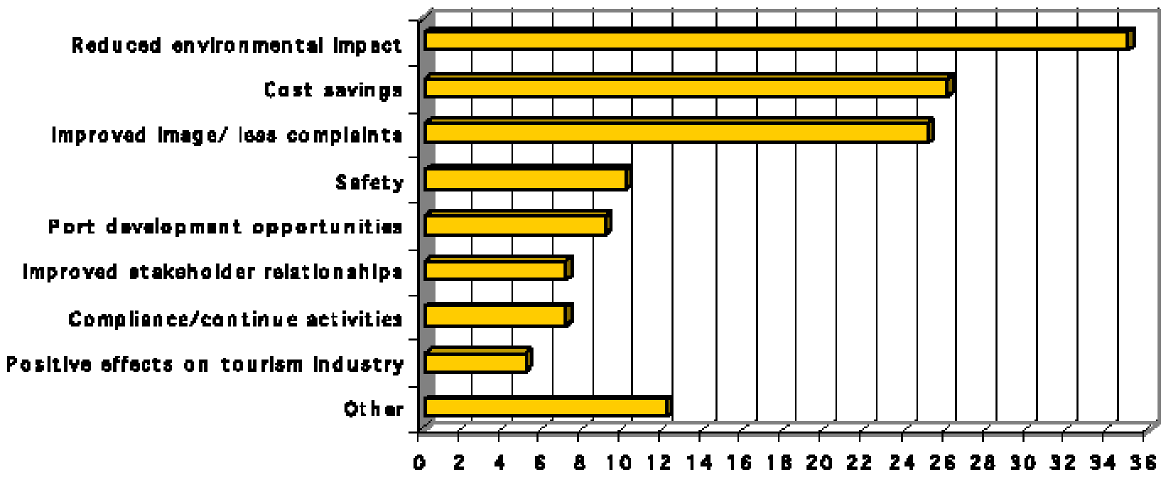
Issue	Management programs dedicated to issue at present (% 'yes' response)
Waste management	6
Dredging	6
Noise	5
Water quality	4
Soil contamination	4
Health & safety management	4
Air quality	3
Dust	1
Habitat loss	1
Energy use	0

Based on SDM sample, encompassing ten ports.

[21]: ECO-Port: ECO-information in European Ports, Final Report for Publication.

An important result of the query and analysis in the study is, that there are actually advantages to be gained by the implementation of measures for the protection of the environment that were at first not expected in this way. 27 % of the measures resulted in cost reductions for the port apart from the effect that was hoped for, namely protecting the environment. When the ports were asked on the cost/benefit relation, of the 19 ports that had answered 94% said that the use was good and only 6% that it was low. The costs were given as high with 68% or medium and with 34% as low. It was concluded in the evaluation that the use of an introduced measure for the protection of the environment is higher as a rule than the costs connected to this.

Picture 43: Effect of realised measures for the protection of the environment



[21]: ECO-Port: ECO-information in European Ports, Final Report for Publication.

Strengthened by the positive results additional measures were introduced by the partners as a reaction to existing problems in order to further improve the performance. The most important are shown in the following table:

Table 51: Progress in environmental management 1996-1999

Progress in Port Environmental Management *1996-1999*	
More ports:	
• carry out environmental monitoring	(+13%)
• have an Environmental Plan	(+17%)
• involve community and other stakeholders	(+17%)
• designate environmental personnel	(+18%)
• aim for environmental 'Compliance Plus'	(+28%)
• encourage internal and external env. awareness	(+45%)

[21]: ECO-Port: ECO-information in European Ports, Final Report for Publication.

10.2.2 The IPSEM-Code

The *Bureau Veritas* has worked out the so-called IPSEM-Code (*International Code for Safety and Environmental Protection management in Port*) in order to improve safety and protection of the environment in ports. This code is a guideline and a model for certificates that offers the management directions for proceedings, to increase safety in port and its surrounding areas especially, to lower insurance premiums and also to improve the reputation of the port.

The weak points in safety and management of a port or a terminal can be analysed with the help of the IPSEM-Code, and it is also to support the solving of the problems by giving advice. It focuses on the company policy as well as on the infrastructure, the equipment, communication and waste disposal. International standards, like ISO 14000, OHSAS 18001, APELL and ISO 9001 are being considered and integrated if possible. After the audit of the system the port office/port department is given a certificate that is valid for five years. The validity is confirmed in annual inspections.

10.3 Port/ship-initiatives for an improved protection of the environment

Although ships cause most of the local emissions in ports but the possibilities of taking influence are greater with the servicing companies and the operators of the fleet of vehicles etc. in port than on international shipping, several initiatives have been introduced in order to succeed in lowering the emissions in both areas.

10.3.1 The initiative *Green Ports* in the USA

The Green Ports initiative was founded by the *Environmental Protection Agency* (EPA) of the United States. For the main report about the state of the art for the realisation of environmentally relevant topics in US ports 21 ports and 44 projects were evaluated more intensively after a preliminary examination of about 110 ports and 177 different projects for the initiative. Aspects for the examination were among others:

- Air pollution
- Dredged matter and contaminated sediments
- Endangered species
- Water pollution caused by port operation
- Oil pollution
- Observance of regulations
- Waste from ships and ports
- Redevelopment of living space
- Improvement of the attractiveness of ports
- Treatment of old deposits.

Exemplary projects were described, e.g. for the reduction of emissions caused by tugs by the use of modern technology in Los Angeles or the creation of new living space with by-products/wastes in front of the Houston coast. As it was pointed out in the summary[111] the ports become increasingly aware, and act accordingly, to their eco-political responsibility:

> "Ports are facing up to their responsibility to protect and clean up the environment. They are doing this for economic and ecological reasons, aesthetics and safety, and to improve integration and compatibility with the surrounding community. In some cases, these activities are undertaken in response to environmental regulations but, increasingly, ports are initiating projects and programs voluntarily."

[111] Green Ports: Environmental Management and Technology at U.S. Ports, by the independent Urban Harbours Institute at the University of Massachusetts in Boston
http://oceancommission.gov/meetings/nov13_14_01/Nagle_testimony.pdf

The reference project that is known most widely is the port of Los Angeles, especially because of the initiative to offer ships shore-side electricity (see chapter 7.1). Additionally, there are attempts to electrify as many installations on land as possible in Long Beach or, if this is not possible, to run these with bio-diesel or to use other techniques with pollution lowering potential.

Within the scope of this initiative official representatives of the town have signed a contract with the town Shanghai to cooperate in, and coordinate the environmental protection in the ports.

10.3.2 Port of Los Angeles: No net increase of air emissions

A study with which, among other things, ships emissions were to be quantified was ordered by representatives of the port of Los Angeles in October 2001. The background for this was, that it could be foreseen that the port must expand in order to be able to receive the expected increase of cargo, especially in container transport, and that on the other hand the public was no longer prepared to accept the pollution caused by shipping and port operations without complaint. To avoid this foreseeable conflict measures for the reduction of pollution were to be introduced on the basis of a sound analysis. The ambitioned aim was to keep the emissions on the same level as in the year 2001, in spite of the increase in traffic. After the situation had been analysed following measures were suggested, of which some have already been put into practise:

Alternative Maritime Power (AMP) *Program*

The most known approach is the *AMP-Program* that was to supply ships during time at berth in Terminal 100 with shore-side electricity. For the purpose of the realisation extensive examinations were carried out in order to prove the feasibility and efficiency. Different types of ship were analysed which showed, depending on different factors (type of ship, age, efficiency etc.), a more or less favourable cost/benefit relation. The feasibility was also confirmed and seen as suitable under the existing requirements for some containerships taking the cost/benefit into consideration, especially as ships are the most significant source of harmful emissions in port. 10 % of the ships are to be supplied with electricity by the year 2020; by the year 2025 it is to be 25% of the ships.

Emulsified Diesel Fuel Use in Port Terminal equipment

The port implemented an incentive system with which the operators were to be motivated to use clean fuels for the vehicles used in port. These are trucks, mobile cranes, forklift carriers etc. Proformix™ was used as fuel, with which nitrogen oxides could be reduced by 14% and particles by 60% for the vehicles which used about 400.000 litres were per year.

Retrofit of Port Terminal Equipment with Diesel Oxidation Catalysts

It was agreed to eventually equip all engines in port with catalysts. The first aim was to reduce the emission of particles in port by 25%. 500 units had already been installed by the year 2003. Reduction rates of 20% can be reached for nitrogen oxides when the catalysts have been installed, and 50% for particle emissions.

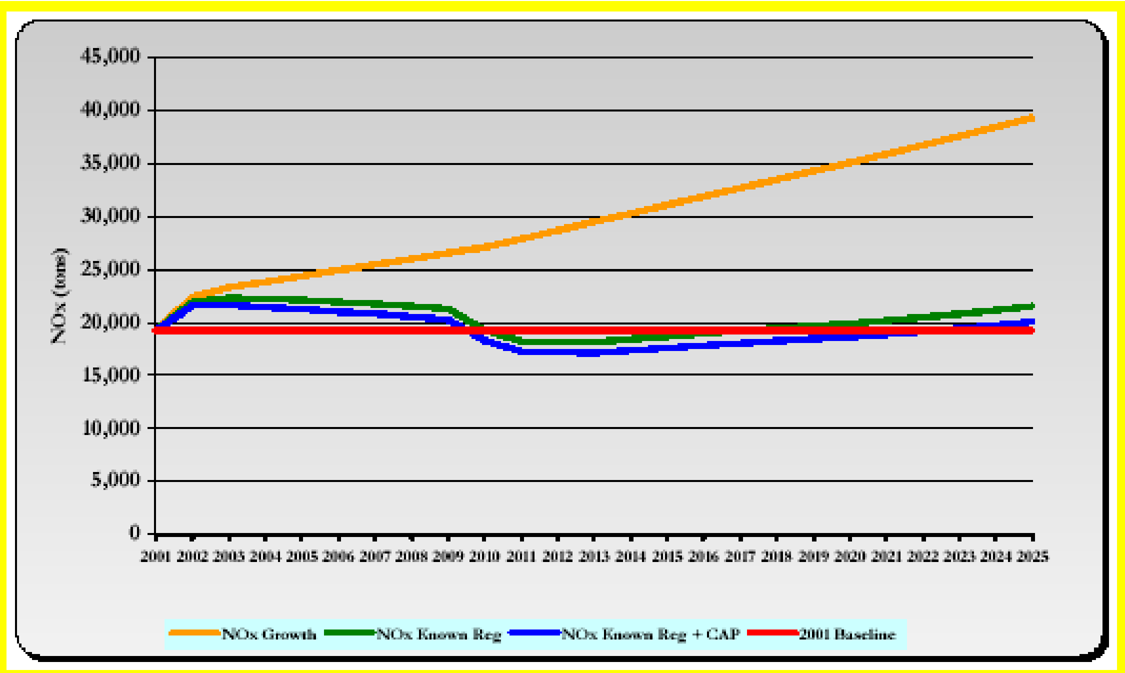
Switch Locomotive Fleet Replacement Program

The outdated locomotives are to be replaced in the course of the project. For this a fund was to be issued in cooperation with other stakeholders and financial means, among others from the *Carl Moyer Program* (3.2 million USD). By this the emissions are to be reduced by 50% and transportation is to be improved.

Vessel Speed Reduction Program

On a voluntary basis a Memorandum of Understanding was agreed on between the port of Los Angeles, the U.S. EPA, CARB[112], SCAQMD[113] and the shipping industry, in order to achieve a reduction of the speed of ships and so a reduction of emissions in the proximity of Los Angeles. According to reports the speed of ships is being checked from land and a calculation of the generated and avoided emissions takes place automatically.

Picture 44: Development of the NOx emissions under consideration of different preconditions



[I13] www.portoflosangeles.org/publicnotice/portoflapublicnotice96421021_07072004.pdf.

10.3.3 The Interreg III-B-Project "New Hansa of Sustainable Ports and Cities"

In the course of the project *Implementation of Agenda 21 in European sea ports with the example of Lübeck-Travemünde* for several reasons it became clear that it would not be possible to arrange the Memorandum of Understanding with the most important Baltic ports and shipping companies ready for signature. That is why it was decided that only the draft of the MoU was to be drawn within the scope of the project. This draft can be decided upon between the most important Baltic towns, ports and ship owners and then be signed by them in a following

[112] California Air Resources Board
[113] South Coast Air Quality Management District

project. This following project is the “New Hansa of sustainable Ports and Cities”, initiated by the town of Lübeck and sponsored with the Interreg-B-support. The project “New Hansa of sustainable Ports and Cities” was named by Baltic 21 as one of three chosen “lighthouse-projects”.

As already mentioned sll sea going vessels, no matter of which nationality, answer to international law, which had started as regulations that had been introduced by the International Maritime Organisation (IMO) (e.g. MARPOL) and then became international law. Towns have no legal possibilities to influence shipping companies and ships in view of emissions, water pollution, noise and vibrations. No coordinated technical or organisational solutions exist in the ports, here the Baltic ports, despite the agreements of MARPOL. Therefore it was deemed necessary to start with voluntary agreements which are available as instruments for action. In February 2002 a meeting with representatives of important Baltic towns and ports within the scope of the project *Implementation of Agenda 21 in European sea ports with the example of Lübeck-Travemünde* was carried out.

The most important Baltic towns are members of the Union of the Baltic Cities (UBC), which was then chosen as the level for action for the project. It was agreed on this level that solving of the problems is to be continued in a following project. The town of Lübeck applied for support from the BSR-Interreg-III-B-Program *New Hansa of sustainable Ports and Cities* for the following project in March 2003. BSR-Interreg-III-B is a part of the European fund for regional development. The applied support was granted by the international guidance committee in June 2003. The project *New Hansa of sustainable Ports and Cities* started as stipulated in July 2003. However, the actual work only started in February 2004, as some practical questions about the support had to be settled. Following partners participate in the project *New Hansa of sustainable Ports and Cities*: Stadtwerke Lübeck GmbH (main responsibility as lead-partner), Hanseatic town of Lübeck, Baltic Energy Forum association, Port development company Rostock mbH, Port of Kolding, Denmark, Town of Malmö, Sweden, Town of Stockholm, Sweden, Port of Stockholm, Sweden, Town of Mariehamn, Finland, Town of Pori, Finland, Town of Turku, Finland, Town of Helsinki, Finland, Port of Turku, Finland, University of Turku, Finland, Shipping company Finnlines, Finland, Port of Szczecin, Poland, Port of Swinoujscie, Poland, Union of the Baltic Cities (UBC).

The total costs of the project amount to 1.049.498 € and it is supported by the European Union with 542.793€. The project ends by the end of the year 2005. The aims of the project are basically the same as in the basis project, namely the reduction or avoidance of exhaust, waste water, wastes, noise and vibrations as well as reaching an agreement and the signing of the MoU draft introduced in the basis project. The goal is that the coordinated MoU will be signed by all mayors of the most important towns in the Baltic at the general conference of the UBC in Turku in October 2005. Additionally, this MoU is to be signed by representatives of Baltic port administrations and operators as well as from shipping companies.

11 Summary

The aim of the research project is the examination of different possibilities to record and then work out suggestions for the reduction of emissions into the air, pollution of the environment by waste water, waste and oil as well as impairments caused by noise and vibrations from ships in the ports of Lübeck-Travemünde within the scope of the implementation of the Agenda 21 process. The Agenda 21 office of the Hanseatic town of Lübeck and the GAUSS in Bremen were part of the project as well as the municipal works of Lübeck. The Federal Agency for the Environment commissioned and supported the project.

Several studies, which were commissioned by the European Union and other well known institutions, show that the different emissions caused by shipping are increasing more quickly than the emissions caused by traffic on land. This can also be confirmed for some pollutants in Lübeck-Travemünde. Projections show that the sulphur and nitrogen oxides caused by shipping will surpass the emissions from land if environmental legislation does not change in the near future. Contrary to public opinion shipping does not mainly take place on the high seas; 50% of all ships´ traffic takes place closer than 200 nm to the coast, which means that above all the emissions concern the coastal areas, rivers and especially the ports. Apart from the harm to the environment, climate, buildings etc. the fact that 75% of all Europeans live near the coast increases the relevance of health aspects.

Background

The developments shown here lead, as is also the case in Lübeck-Travemünde, to tension in the population because the people living near the coast no longer accept this development without complaint and also, fishing and tourism industry are affected adversely when confronted with the results of the partly outdated environmental legislation in shipping. One consequence of this could be for example that the coastal region suffers a loss of image so that the tourists stay away. This is being feared if a town like Lübeck-Travemünde suffers a loss of image because the given limitations for air pollution have been exceeded, or if investors stay away because leisure and wellness facilities can only be run with little chance of success with the argument that the ambience, a healthy and clean environment, could be questioned by potential customers.

The project *Implementation of Agenda 21 in European ports with the example of Lübeck-Travemünde* was carried out in front of this background. The immediate aim of Agenda 21 is to consider ecological and social interests and to promote a sustainable development for the well-being of all while guaranteeing the economical interests. Answers should be worked out on the basis of the analysis of the existing situation in order to follow this approach up.

Results

Some kinds of emissions caused by shipping dominating the air pollution in port turned out to be an urgent problem. It could be confirmed that shipping is responsible for over 95% of the total pollution in port, especially for sulphur dioxide, nitrogen oxide and diesel soot, after the traffic situation in the ports of Lübeck-Travemünde had been recorded and blended with the technical data of the ships. This is not really surprising considering that legislation for the protection of the environment on land has become stricter over the last few years and that legislation for shipping, which orientates itself on the requirements that are internationally recognised, has changed little or not at all. The coming-into-force of MARPOL Annex VI for the limitation of gaseous emissions caused by shipping on 19th May 2005 has little effect, as the limits stated there are already outdated in some cases. An exception can in some cases be found in the regulation for specified areas, to which the Baltic Sea belongs, according to

which a maximal sulphur content of 1.5 % in the fuels may not be exceeded. Some shipping companies in the Baltic could be affected by this, but many shipping companies go beyond the requirements on a voluntary basis in any case, e.g. because a company participates in the incentive system in Swedish waters (Differentiated Fairway Dues), according to which reductions are given on some tariffs if special requirements are being kept to.

It must be pointed out, however, that there are several elements of uncertainty to the determined values on environmental pollution caused by shipping. While official statistical values could be used for determining the times at sea and at berth, this could only partly be done for the technical equipment on board as only some of the data could be taken from official publications. Data on the number and efficiency of the main engines, and to a certain extent for the auxiliary diesels on board, could for example be determined. This was, however, seldom the case for the auxiliary boilers which mainly operate in port. Assumptions had to be made for these which are different according to the types of ship. It was the same for the actual capacity of the main engines, auxiliary diesels and auxiliary boilers. For this, wholesale approaches that were used in the EU calculations were made that could, in some cases, be completed by asking the shipping companies in written or oral form. The information on the sulphur content in fuels, although critical in the effects on the environment, can seldom be found in publications, meaning that assumptions have to be made that are not as reliable as proper data. In order to follow up a conservative approach the average value of 2.7% was assumed if it was not possible to gain concrete statements. Concrete data was used in those cases where it was available. Also, assumptions had to be made relating to the distribution of the load factor of the units on board for time in coastal waters, while manoeuvring and time at berth. Following results are to be noted:

- The emissions in the survey area are influenced mainly by the Skandinavienkai. The part in the emissions lies at c. 80 to 85 % for nitrogen oxides, sulphur dioxides and soot, at c. 70 % for CO_2 and Benzole as well as 60 % for particle matter (PM_{10}). In this the emissions produced during time at berth are decisive with c. 60 to 80 % compared to shipping movements to/from the Skandinavienkai (20 to 40 %). Relating to the total emissions in the survey area the part during time at berth at the Skandinavienkai is c. 50 to 65 %, for particle matter c. 40 %.

- Emissions at the Ostpreussenkai can be ignored in the total balance, but they can lead to an increase of harmful imissions locally because of the close proximity to high density areas

- Shipping movements on the river Trave to the other ports in Lübeck cause about 18% of the sulphur dioxide, 16% of the diesel soot and 12% of particle matter emissions. The amount of other harmful emissions created here is under 10%.

- Road traffic in the surveyed area contributes 18% to the benzole and 25% to the particulate matter (PM_{10}) emissions to the yearly emissions. NOx and diesel soot emissions are relatively low at below 7%. The proportion of CO_2 emissions is about 22%. The sulphur dioxide emissions caused by road traffic can be ignored.

Following assumptions were made relating to measures for the reduction of emissions caused by shipping:

<u>Concept for reduction 1:</u> exemplary concept for reduction in order to prove the maximally possible potential for reduction when creating a shore-side supply of electricity for all ships at berth at the Skandinavienkai.

1a: capacity of the auxiliary boilers as in case of analysis 10%,

1b: auxiliary boilers not in operation, capacity at 1%.

Concept for reduction 2: in the second exemplary concept for reduction a limitation of the sulphur content in fuels to maximal 1% is assumed for all ships in the survey area.

Concept for reduction 3: during times at berth only fuels with a sulphur content of maximal 0.1% (MGO) may be used in port (according to the EU Directive[114]).

Reductions of about 40 to 45% of the total emissions of carbon dioxide, sulphur dioxide and benzole can be expected under consideration of Concept for reduction 1a/1b. Slightly higher reductions of just 60% can be expected for nitrogen oxides. Particle matter (PM_{10}) and diesel soot emissions are reduced by c. 25 to 35%. When comparing the concepts for reduction 1a/1b (operation of auxiliary boilers during times at berth with 10% or 1% capacity) it can be seen, that reductions worth mentioning can only be expected for the sulphur dioxide emissions when operating at reduced capacity (c. 10%). The reductions for the other pollutant components are c. 5% and less.

Considerably higher reductions can be noted for the emissions from the Skandinavienkai, especially at the berths: reductions of 40 to 70% of the emissions caused by operations at the Skandinavienkai (shipping movements and times at berth together) result. When considering only times at berth, considerable reductions between 70 and 90% can be expected.

The use of Concept for reduction 2 only results in reductions worth mentioning for sulphur dioxides. A reduction of about one third of the total yearly emissions in the survey area can be expected.

When summarising the facts, the supply of shoreside electricity turns out to be an effective measure for the reduction of emissions into the air especially as the improvements take place in close proximity to those areas with the highest pollution level. The limitation of the sulphur content to maximal 1% is also a suitable measure to considerably reduce the emission of sulphur dioxides.

The development for the state of prognosis 2010 after the extension of the Skandinavienkai was calculated taking the pollution level from the analysis 2003 (without extension of the Skandinavienkai) into consideration. The increase in ships´ traffic was calculated on the basis of the evaluations for the project approval procedure for the extension of the Skandinavienkai. According to this, about 28 ships additionally per week can be expected. The pollutants CO_2, NOx, SO_2, benzole, particles and soot were calculated for the analysis and the prognosis without the concepts for reduction and then three exemplary idealised concepts for reduction were tested on the basis of this in order to show the possible potential for reduction.

The calculations of the total emissions in the survey area that were carried out for the year of prognosis 2010 result in following picture:

- As opposed to the analysis considerable increases of the total emissions were forecast in the survey area. The reasons for this are the additional shipping movements and times at berth. The increases amount to 70 to 80% for the carbon dioxide, nitrogen oxide and sulphur dioxide emissions and 35 to 40% for the benzole, particle matter and diesel soot emissions.

- As in the analysis, the main cause for emissions in the survey area is the Skandinavienkai. About 80 to 85% of the nitrogen oxides and sulphur dioxides, 75% of the CO_2, benzole and diesel soot as well as 60% of the particle matter are emitted here. In this the emissions caused during times at berth are decisive with about 65 to 80% as opposed to the shipping move-

[114] Amended proposal for a Directive of the European Parliament and of the Council amending Directive 1999/32/EC as regards the sulphur content of marine fuels̃ Political agreement

ments to/from the Skandinavienkai (20 to 35%). The emissions during times at berth at the Skandinavienkai are c. 50 to 65%, for particle matter c. 40% from the total emissions.

- The emissions at the Ostpreussenkai can still be ignored in the total balance, but are of interest locally.

- Ships´ movements on the river Trave to the other ports in Lübeck contribute between 10 and 20% to the total emissions, according to the different pollutants.

- The contribution to the total emissions per year from road traffic in the survey area is highest for particle matter (PM_{10}) emissions at c. 22%. Benzole, NOx and diesel soot emissions are relatively low at 6% and less. CO_2 emissions are at about 15%. The sulphur dioxide emissions caused by road traffic can be ignored.

According to these results, also in the prognosis, the greatest potential for reduction can be seen through a limitation of the emission of pollutants during times at berth at the Skandinavienkai. Following results are to be noted for the different concepts for reduction:

Concept for reduction 1 (shore-side electricity): Reductions of about 40 to 50% of the total emissions of carbon dioxide, sulphur dioxide and benzole can be expected under consideration of Concept for reduction 1a/1b. Slightly higher reductions of just 60% can be expected for nitrogen oxides. Particle matter (PM10) and diesel soot emissions are reduced by c. 25 to 35%. When comparing the concepts for reduction 1a/1b (operation of auxiliary boilers during times at berth with 10% or 1% capacity) only slight differences can be seen of up to 6%. Considerably higher reductions can be noted for the emissions from the Skandinavienkai with the concepts for reduction 1a/1b, especially at the berths: reductions of 45 to 70% of the emissions caused by operations at the Skandinavienkai (shipping movements and times at berth together) result. When considering only times at berth, considerable reductions between 70 and 90% can be expected.

Concept for reduction 3: reductions worth mentioning resulting from the limitation of the sulphur content during times at berth to maximal 0.1% are only achieved for sulphur dioxides. Here a reduction of the yearly total emissions of about half can be expected in the survey area. The other pollutants are reduced by 5% and less.

Concept for reduction 1a+3: combining the concepts 1a and 3 leads to reductions similar to those in concept 1a alone, with the exception of the sulphur dioxide emissions. These are reduced by 12 % points as opposed to concept for reduction 1a, so that a reduction of c. 60% results when compared to the state of prognosis without measures for reduction.

Concept for reduction 1b+3: only slight further reductions of up to 3 % points can be expected when compared with the combination 1a+3 as opposed to the prognosis. When summarising, it can be seen that the continuous operation of the ships´ units during times at berth at the Skandinavienkai contributes a great deal to the pollution in the survey area, emission and imission wise. For this reason, measures for reduction like the supply of shore-side electricity are concepts with high potential for reduction. Especially the sulphur dioxide and nitrogen oxide pollution can be reduced by this. The reductions can even be noted in areas further away from the Skandinavienkai.

The limitation of the sulphur content affects only the sulphur dioxide emissions. A reduction of the sulphur dioxide pollution that can be measured in a wide area can be achieved with a limitation to 1%. Limiting the sulphur content to 0.1% during time at berth also leads to a reduction worth mentioning only for the sulphur dioxide emissions. Only slight further improvements can be expected in combination with the supply of shore-side electricity, because the ships´ engines are basically not in operation during time at berth. However, the reduction of the sulphur content in fuels is a suitable measure to at least reduce the emission of sulphur dioxides considerably as long as not all ships use shore-side electricity.

Supplying ships with shore-side electricity brings a whole range of further advantages when compared to the limitation of the sulphur content in fuels. By this, all emissions of harmful substances are reduced as electricity is used instead of fuels. These emissions are particles, hydrocarbons and heavy metals etc. apart from SO_2, NOx and CO_2. As well as this, other pollution caused by the ships´ engines, noise and vibrations, are also avoided.

The shipping companies used to be rather sceptical in the past regarding shore-side supply of electricity for their ships. Firstly, the technical feasibility was questioned. However, by an initiative in Los Angeles[115] it seems possible to continue with this idea as the feasibility was proven for container shipping as well (other exceptional cases were already known, e.g. in the Navy or in cruise shipping). The supply of shore-side electricity can also bring certain advantages for the shipping companies. Apart from offering more time for the maintenance of the engines, a longer lifespan of the units and a reduction of noise and vibrations, the consumption of fuels and substances needed for the operation of ships´ engines can be reduced considerably.

The possibilities for shore-side electricity are not given in all ports or on all ships. The cost/benefit situation can be very different, depending on the spatial possibilities for the connections in port and the technical requirements on board. The structure of shipping using the berths is of special importance (regular service, ferry or tramp shipping, frequency of use, length of time at berth etc.).

According to calculations made in America the investment on board can amortize in a few years under favourable conditions and depending on the price of the supplied electricity from land – especially if the measures required for this were already considered when the ship is under construction, as is being increasingly done. Because of this, further projects were started in order to prove the feasibility relating to the concrete individual situation in ports, e.g. the New Hansa-Project for the Baltic or a project proposed for Hamburg with regard to cruise shipping.

However, the legal situations often prove to be an impediment for the realisation of efficient measures for the protection of the environment. National rules can only regulate the situation on own ships, but not on those sailing under a foreign flag. For this reason they have little influence on international shipping. It is not possible, according to national law, to commit foreign ships to have higher technical standards on board than those that have been agreed on in international law.

An indirect commitment of ships sailing under a foreign flag could only be realised with the help of regulations from the port operators, who would make load and discharge operations only possible if the higher standards are being kept to on these ships. As far as that goes, the possibility to influence foreign ships is given in international law. However, these would have to be port related regulations.

Coastal states are not bound by law to admit foreign ships access into their internal waters or their ports, but, as a rule, due to competition they refrain from requiring outstanding standards. Exceptions can only arise, when there is no other possibility for the ship anyway (e.g.

[115] AMP: Alternative Maritime Power is the result of a groundbreaking effort to reduce emission at the Port. Instead of burning diesel fuel while at dock, AMP ships "plug in" to shore side electrical power - literally an alternative power source for maritime vessels [http://www.portoflosangeles.org/environment_amp.htm].

when a regulation is passed for the entire USA) or if special interests have to be considered (passenger shipping in Alaska).

If an overall interest for changing the existing conditions can be assumed but these cannot be implemented legally ambitioned standards can only be realised when all persons involved work together voluntarily. For this reason a *Memorandum of Understanding* was formulated in which the most important circumstances that are to be changed in Lübeck-Travemünde (and in many other ports in the Baltic and worldwide) are being identified and in which suggestions are given for improvements that can be afforded by the ports and shipping companies. The analysis of the given problems and the examination of the organisational and technical possibilities for reducing pollution of the environment were the basis for formulating these requirements.

The contents of the *Memorandum of Understanding for a sustainable development of port and shipping companies in the Baltic* are to give examples and lead to international standards, as was the case in the Stockholm agreement for the safety of RoRo ships for the Baltic. As a rule, a MoU does not at first have legally binding character and therefore it cannot have legal authority. A voluntary commitment, meaning committing oneself to higher standards implemented by the ports or shipping companies/ship owners within the scope of a MoU, however, can be the fastest way to solve regional problems. The requirements are divided into two different premises:

- Definition of basic preconditions. Before taking part in a MoU these basic preconditions have to have been actually realised.
- Definition of aims that go beyond the preconditions. These are more ambitioned and are determined by the participants within the scope of further cooperation.

The Basic Requirements, which generally can be realised by environmentally aware companies, were formulated in order to include potential interested parties. Regulations which are legally binding anyway but of which it is known that they have not yet been realised (probably also in some Baltic States) are stated here. Apart from this, relatively simple needs of harmonisation in different areas (e.g. relating to the kind of waste separation) on different ships or in different ports are formulated here. And lastly, it is about requirements that ought to be considered by environmentally aware companies anyway but which are not regulated (e.g. ballast water management according to the IMO guidelines) partly, because their legal implementation can be foreseen.

The Aims take up problems which can only be realised in cooperation, organisationally, technically or financially. These include measures in which a further need for coordination is stated (e.g. development of an incentive system for environmentally sound shipping) or technical projects which have to be coordinated (e.g. the realisation of shore-side electricity for ships). The most important basic requirements and aims can be found in the areas

- Prevention of pollution caused by exhausts
- Prevention of pollution caused by waste water
- Prevention of pollution caused by waste
- Prevention of oil pollution.

Measures for the development of a financial incentive system for environmentally sound shipping and a coordinated *no special fee system* for ports were suggested in connection with the requirements stated above. The incentive system is to give committed shipping companies a compensation for the costs of special pollution-prevention measures, as by prevention of more pollution they cost the society less in the long run. The different measures for the protection of the environment cause a distorted competitive situation between ports which is to be cured by introducing a harmonised *no special fee system*[116].

The measures formulated here were expressly defined as suggestions which are feasible, but which can also be modified under consideration of individual circumstances. For this reason the qualitative demands of the final version of the MoU will surely be more or less high depending on the number of the parties interested in joining.

Following advantages would result from using a MoU in order to improve environmental protection, apart from compensating non-existing legal possibilities of intervention:

- In some cases the regulation of problems is “forbidden”; these can be dealt with by using a MoU. Voluntary agreements can be made in coordination with each other in order to achieve the wanted changes.

- A consensus on combined procedures, meaning a MoU, can decrease the competitive situation between the different parties concerned.

- A MoU can be adapted to different institutions (regional concerns, agreements between states, public corporations). A *Best Available Technique* can be used in which actually feasible standards are described, which have been adapted to the possibilities of the most innovative participants.

- MoU can be the first step to new laws, which means they can define standards which will have to be kept to sooner or later by all persons involved in this topic. Laws can be influenced (EU/IMO) by “proving the feasibility” (including limitations etc.). The time usually needed to react on deficits is shortened considerably when all signers of the MoU have the same interests.

- The procedures for reaching aims can be decided upon individually in cooperation with other signers. “Pragmatic” standards can be formulated as voluntary commitments at first, in order to provide a basis for further steps.

- The signers of a MoU can use this as proof for their special commitment for advertising reasons, by pointing out the high standards they are keeping.

There are actually several different MoU in shipping already in use, which are about safety or environmental protection. To the most important of these count the *Memorandum of Understanding on Port State Control*, which has been made legal in many regions worldwide, several MoU between cruise shipping companies and different Federal States of the USA for the protection of coastal waters as well as a MoU introduced a short while ago between the port of Los Angeles and several shipping companies with the aim of supporting the introduction of shore-side electricity for ships at berth, so as to reduce noise and the pollution caused by exhaust from the auxiliary diesels.

Some questions in the project could not, as had been expected, be dealt with because of external circumstances. From this – and from the results of the study – some areas in which re-

[116] Ships are burdened financially for waste disposal by the “no special fee system”, no matter if the waste reception unit in port is being used or not. Shipping is to be motivated by this to dispose of their waste in port, as saving costs by disposing waste at sea is no longer possible because the disposal will have to be paid for anyway. The different procedures in the ports (e.g. amount and kind of the waste stated in “no special fee”) leads in some cases to “unfair” financial burdens for the ports.

search is needed could be determined, which are to be shown here shortly as problem or suggestion for a further project.

Problem 1: Quality of the data and their comparability for finding out the pollution caused by sea-going vessels.

The situation in connection with the availability of reliable data for the calculation of the pollution level has proved to be an extreme obstacle. The information's normally provided by official institutions serve to help calculate port fees and other duties. They relate to ships´ data only so far as necessary for this. The necessary data for determining the pollution level cannot be gained in this way. This is especially critical for shipping, as ships, unlike vehicles on land, can be seen as individual units, (although the situation is comparatively harmless in the typical ferry port of Lübeck-Travemünde up to now), meaning that binding limitations are given less often for ships than on land, resulting in the fact that there is a far higher element of uncertainty in wholesale assumptions. Presently there is a series of different attempts for finding out the pollution level which lead to various results.

This deficit is proving to be a great hindrance in other areas, too. For example, the survey of the present condition regarding environmental pollution of coastal waters caused by shipping needed within the scope of the EU legislation on water-purity cannot really be realised. In addition it can be foreseen that vehicles will increasingly be expected to pay for the use of common goods (air, water etc.) and for this data on the actual pollution of individual ships will be needed sooner or later.

Suggestion 1:

Suitable parameters have to be identified for showing the environmental pollution (solid, liquid, gaseous) caused by shipping. The existing estimates have to be compared in order to have reliable information so as to be able to plan measures for the future.

Problem 2: Supplying ships with shore-side electricity in order to reduce exhausts caused by ships in port.

Shore-side electricity for ships at berth was identified as an efficient measure to reduce pollution of the environment, and so also the local residents, caused by ships. The technical and financial feasibility, regarding the temporary replacement of main- and auxiliary engine with a shore-side electricity connection at the berths was to be examined within the scope of a project so as to reduce health risks and pollution. Gaseous emissions (SO_2, NOx, CO_2, soot and particles etc.), noise and the transmission of vibrations can be reduced substantially by the use of shore-side electricity.

Regenerative, environmentally friendly electricity generated with wind-power in the coastal areas (c. 25% of the energy in Schleswig-Holstein is wind-generated) can effectively replace the highly polluted exhausts from ships. Perhaps ships will, after all, be able to sell the avoided CO_2 emissions in the future in the planned emission-trade, refinancing a part of the investments for the reduction by this. As well as this, other advantages for the shipping companies could be gained from the external supply of their ships with shore-side electricity. The fuel and lubrication oil consumption would go down, more time for maintenance and repair works of main and auxiliary engines and other units, longer intervals between maintenance of the engines, reduction of personnel costs because of these longer intervals and improving their image as an environmentally sound company could result.

Suggestion 2:

Supplying ships in port with shore-side electricity seems feasible especially for ferry ports as here some aspects come together which make the realisation easier. To these belong: close proximity to city centres, making a reduction of emissions especially desirable. The berths in these terminals are frequented often and regularly, so that the electricity connections are used often, and the ships always berth at exactly the same place because of the ramps. For this reason the connection points can be installed at exactly the right place. Ferries in the Baltic are in general relatively modern ships, making the technical realisation on board comparably easy and the relatively young average age of the ferries allows a current adaptation of new ships to the required installations for the reception of shore-side electricity.

Problem 3: Quantitative and qualitative assessment of boiler emissions and possibilities for their reduction.

Considering the emissions from the (auxiliary) boilers have proved to be especially critical. Technical data was, in most cases, available for the other units on board, but data on the auxiliary boilers was hard to get (efficiency, capacity). For this reason correlation factors had to be used in most cases for calculating the emissions. Additionally, it was even more difficult than with the other units on board to determine the kind of fuel used. All this leads to the fact that the amount of the emitted pollutants is difficult to determine for sure.

Suggestion 3:

A project should be carried out in which the relevance of the boiler emissions is determined in a definite case. Because of the fact that the (ferry) traffic-patterns are relatively well known in Lübeck-Travemünde and can be assessed easily, and because they cover c. 95% of the emissions caused by shipping, relatively accurate results could be gained here. It should be tried to calculate the emissions on the basis of an on-the-spot investigation of the operational data and to verify the results with the help of random checks. This procedure would give important knowledge for evaluating other surveys and make future calculations more reliable.

Problem 4: Measures for the reduction of particle emissions caused by shipping.

Measurements and calculations have shown that about 15% of the global pollution is caused by particles emitted from ships diesels. The most efficient medium speed engine from MAN B&W emits c. 136.000kg exhaust per hour, about 11kg of which are soot and particles[117]. More than 260.000t of soot and ashes were emitted worldwide by ships´ diesel engines in the year 1994. Ports with regular ferry services are affected most by this. Because of the health risks and the environment pollution, particle emissions are increasingly coming to public attention. This is being verified by campaigns of eco-organisations and the pressure on vehicle manufacturers, some of whom already offer particle filters in series while others still do not. Pollution caused by particles emitted in shipping must be seen as more critical than those generated on land. Because of the high sulphur content in ships´ fuels much more particles are emitted here with a flow rate being enormous. For this reason there is a great but unused potential for reduction potentials in this area which would probably result in a far better cost/benefit relation compared to other sectors.

While the main and auxiliary diesels could probably be turned off in port with the help of shore-side electricity, auxiliary boilers have to remain in operation as they supply the ship with heat and not with electricity. So purification procedures would still have to be carried out in this case. As the EU is planning to reduce the sulphur content in the fuels that are used in

[117] Horst W. Köhler: Weiterer Kampf um den Dieselruß und die NOx- Reduktion; Schiff & Hafen 9/ 2001

port to 0.1% anyway, filters normally used on land can be installed. They would have to be adapted to the flow rate however and perhaps to other parameters as well.

Suggestion 4:

Introduction of different approaches that are in practise at land but need an adaptation to the conditions in shipping.

- Use of soot filters on board ships operating on high sulphur fuels: shipping is greatly interested in this because it must be feared that the sulphur content in fuels will be lowered by law sooner or later, if, for example, emissions cannot be reduced by installing new equipment (see MARPOL Annex VI, EU sulphur-Directive).

- Adapting the filters to higher amounts of exhaust: soot filters for engines with up to c. 1.500kW are already on offer for special cases (mega yachts). In some cases the ships used for ferry traffic in the Baltic already operate on low sulphur fuels, although the engines have, as a rule, a higher output, meaning that the soot filters would have to be adapted to the conditions in commercial shipping. Especially the Scandinavian countries want to lower emissions even more.

- Use of filters for auxiliary diesels and auxiliary boilers: from 2010 ships at berth are to operate on fuels with a sulphur content of no more than >0.1%, according to the EU Directive. Filtering the exhaust in order to come to the same results is permitted.

- Use of filters for auxiliary boilers: supplying ships with shore-side electricity is being accepted more and more (Los Angeles, Gothenborg). The boilers on board can not be replaced by this, however, meaning that the exhaust will have to be filtered.

Problem 5: Noise emitted in port and ships´ operations.

In the course of the project it became clear that local residents do no longer accept the noise emitted from shipping and turnover operations in city-near ports. These noise emissions include acoustic signals from ships and port vehicles, normal engine noise as well as noise caused by ventilation and hydraulic systems etc. Noise caused during the turnover operations were considered as being particularly troublesome, meaning the taking up and setting down of containers, trailers etc. The ship-side effects considered as being the most negative are caused by the vibrations from 1 to 100 Hz.

Suggestion 5:

It should be examined and evaluated within the scope of a project how far-reaching the effects of the noise and vibrations caused by shipping are on ports, local residents, buildings, etc. Measures should be investigated which are suitable to reduce these problems. These measures could be of organisational and technical nature.

Conclusion

The project should address the implementation of the requirements of the Agenda 21 for port and shipping companies. Different interested parties were included in the project work in workshops and presentations, in order to find supportable solutions to the problem of health risks caused by pollution and environmental pollution in ports. It could be proved in general that shipping does not meet the requirements stated in Agenda 21 in some areas, because it would impede a sustainable development of other interested parties because of the wanted and forecasted quantitative growth. This situation gains special importance because presently no effective rights of intervention exist in international shipping to take any corrective measures.

Technical and operational measures were identified, but their realisation is only possible when other local and, in some areas, over-regional partners reach a consensus. In order to bind the different partners to a common procedure a Memorandum of Understanding for a sustainable development of port and shipping companies in the Baltic was developed for solving these problems, which can serve as a basis for cooperation, as is already being practised e. g. in the port of Los Angeles.

The project was briefly presented when the Minister for the Environment made a visit to Lübeck-Travemünde in 2005, who took an interest in this topic. The BMU suggested in the discussions of the results to develop a second initiative, apart from following up the approaches of a MoU, in order to aim for solutions for these problems within the scope of a legally binding EU directive.

12 List of Abbreviations

AVV	Abfallverzeichnisverordnung (Waste register)
BAT	Best Available Technique
BOD	Biological Oxygen Demand
BRZ	Bruttoraumzahl (gross register)
CLC	International Convention on Civil Liability for Oil Pollution Damage
COW	Crude Oil Washing
CO_2	Carbon Dioxide
DNV	Det Norske Veritas
DOT	U.S. Department of Transport
EEA	European Environmental Agency
EPA	U.S. Environmental Protection Agency
ETS	Emergency Towing System
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GL	Germanischer Lloyd
GWP	Global Warming Potential
HFO	Heavy Fuel Oil
HNS-Code	Hazardous and Noxious Substances Code
HSC	High Speed Craft
ICS	International Chamber of Shipping
IMO	International Maritime Organisation
ISL	Institute of Shipping Economics and Logistics
LMIS	Lloyd's Maritime Information Services
MARINTEK	Norwegian Marine Technology Research Institute
MDO	Marine Diesel Oil
MEPC	Marine Environmental Protection Committee
nm	nautical mile
NOX	Nitrogen Oxides
NMVOC	Non-Methane Volatile Organic Compounds
ODP	Ozone Depleting Potential
OECD	Organisation for Economic Co-operation and Development
OPA 90	Oil Pollution Act, 1990
PSC	Port State Control
ppm	Parts per Million
SMS	Safety Management System
SOLAS	Safety of Life at Sea
SO_2	Sulphur Dioxide
SRÜ	Seerechtsübereinkommen (SRÜ/ UNCLOS)
TBT	Tributyltin
Tdw	Tonnes Deadweight
TEU	Twenty Feet Equivalent Unit
TSS	Total Suspended Solids
UBA	Umweltbundesamt (Federal Environmental Agency, Berlin)
UNCLOS	United Nations Convention on Law of the Sea
UNEP	United Nations Environment Programme
VOC	Volatile Organic Compounds
UZ 110	Umweltzeichen 110 (eco-label 110)

13 List of Pictures

14 List of Tables

15 Bibliography

[1] UNO: Rahmenbedingungen der Agenda 21

[2] Lloyds Register: Marine Exhaust / Emission Research Programm, Croyden Uk, 1995

[3] NN: Safer Cleaner Ships, Drewry Consulting London, September 1996

[4] Ball, J.: Feasibility Study on the application of a pollutant release and transfer register to the shipping industry, University of Wales/Cardiff 1996

[5] August, Michael: Hafenentwicklung und Schiffsverkehr im Wandel, Geographisches Institut der Universität Kiel Mittelseminar: Die Ostseeregion im Wandel,2004

[6] Statistical Analyses of the Baltic Maritime Traffic, Customer: Finnish Environment Institute, Ministry of Traffic and Communications, RESEARCH REPORT NO VAL34-012344, 30.09.02

[7] Det Norske Veritas Industry: The North Sea a special area, Horvik 1994

[8] Det Norske Veritas Industry: The contribution from ship emission to acidification in the north sea vountries, Horwik 1994

[9] National Swedish Maritime Administration: Summary of a proposal to the Swedish Government concerning environmentally differentiated shipping dues, Norköping 1966

[10] Kaps, H.: Entwicklung eines Kriterienkataloges für die Vergabe des Prädikates „Um weltfreundliches Schiff“, UBA F+E-project 102 04 416, GAUSS, Februar 1998

[11] Oftedahl, S u.a.: Air pollution from sea vessels, Brüssel 1996, T&E 96/9

[12] Hadler, Neddenien: Schadstoffemissionen im Schiffsverkehr, Schlussbericht GL-Hamburg, 1994

[13] Otten, C.: Umweltschutz auf Schiffen der Bundeswehr, Wehrtechnischer Report, 5, 1995

[14] Kittelmann, B. u. a.: Entwicklung umweltverträglicher Entsorgungskonzepte für die Schiffahrt (Vorstudie), GAUSS, 1997

[15] Kanerra, M.: A revolution in RoRo-Shipping, Deltamarine, Raisio 1994

[16] International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78)

[17] Magnusson, K.: The handling of sewage and grey water on passenger ships in Baltic Sea Area, Report No. 7153-2. SSPA Consulting, Schweden, 1994

[18] Bahlke, Chr.: Übertragung von Standards auf dem Gebiet der Umwelttechnik auf die Schifffahrt zur Reduzierung der Emissionen sowie für eine umweltgerechte Entsorg ung an Bord von Seeschiffen, UBA F+E-project 102 04 416, GAUSS, Februar 1998

[19] Ø. Endresen and E. Sørgard, DNV, Norway: Emission from international sea transportation and environmental impact, JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 108, NO. D17, 4560, doi:10.1029/2002JD002898, 2003

[20] Hartung, O.: Durchschnittlicher Anfall fester Abfälle auf Fährschiffen, Auswertung von Fragebögen „Schiff“ für die Schwachstellenanalyse Schiffsmüllentsorgung, Bre men, 1997

[21] ECO-Port: ECO-information in European Ports, Final Report for Publication, 15.11.1999

[22] Bailey, D., Plenys, T., Solomon, G., Campbell, T., Ruderman, G., Masters, J., Tonko nogy, B.: HARBORING POLLUTION, The Dirty Truth about U.S. Ports

[23] Statistisches Amt in Hansestadt Lübeck

[24] Fleet, D.: Untersuchung der Verschmutzung der Spülsäume durch Schiffsmüll an der deutschen Nordseeküsten, Umweltbundesamt Berlin, FKZ 202 96 183

[25] N.N.: Swedish Maritime Administration: Summary of a proposal to the Swedish Government concerning Environmentally differentiated shipping dues. Norköping, 13. Jan. 1997

[26] N.N.: Swedish Maritime Administration: Information on new environment differentiated fairway dues being implemented on 1 Jan. 1998, Norkoping

[27] Swahn, H.: Environmentally differentiated fairway charges in practice – the Swedish experience, (for the) Department for Maritime Policy and Public Affairs at the Swedish Maritime Administration

[28] Deutscher Wetterdienst Wetteramt Schleswig: Amtliches Gutachten über die Luftqualität in Lübeck-Travemünde“, Schleswig, 23. November 1994

[29] Isensee, J: Schiffs-Hilfskessel: Größe – Eigenschaften – Umweltbelastung, Hannover 16.12.2003

[30] Hansestadt Lübeck: Indikatoren im Rahmen der Lübecker Agenda 21, Agenda 21-Büro, Lübeck im Mai 2001

[31] Ministerium für Umwelt und Verkehr Baden-Würtemberg (et. Al.): Forschungsvorhaben zur Erstellung eines Leitfadens für Indikatoren im Rahmen einer lokalen Agenda 21, Juli 2001

[32] ENVIRON International Corporation for Port of Long Beach, Long Beach, California: “Cold ironing cost effectiveness”, Volume I Report, California, March 30, 2004

[33] GAUSS / ISL: Entwicklung eines Modells für ein integratives und international einsetzbares Bonussystem *Quality Shipping*, Ergebnisse der Studie, Bremen, Januar 2002

[34] Mühr, Ortwin: Darstellung technischer Konzepte zur Reduzierung von exotischen Spezies im Ballastwasser von Seeschiffen, Diplomarbeit an der Hochschule Bremen, Fachbereich Nautik, 05.12.2000

[35] MARINTEK, Trondheim: Study of Greenhouse Gas Emissions from Ships, Final Report to the International Maritime Organization, Norway, March 2000

[36] SMA: THE BALTIC STRATEGY, A report on the progress of the Baltic Strategy for Port Reception Facilities for Ship-generated Wastes and Associated, issued April 1999

[37] D. Bailey, T. Plenys, G. Solomon, T. Campbell, G. Ruderman Feuer, J. Masters, B. Tonkonogy: HARBORING POLLUTION - Strategies to Clean Up U.S. Ports, August 2004

16 Internet Addresses

[I1] http://www.oilspilltaskforce.org/docs/meeting_notes/SummaryNotesCruiseshipRt2.pdf

[I2] http://www3.telus.net/cruise_watch/enviro.htm

[I3] http://www.HELCOM.fi/HELCOM/convention.html

[I4] Vapour recovery when loading vessels in the port of göteborg: www.portgot.se

[I5] http://www.ecoports.com/pdfdb/ECOConference_Proceedings.doc

[I6] http://www.HELCOM.fi/a/proceedings/bsep50.pdf

[I7] http://www.HELCOM.fi/proceedings/bsep86.pdf

[I8] Finnish Environment Institute: Statistical Analyses of the Baltic Maritime Traffic: http://www.vtt.fi/tuo/projects/seastat/balticstatfinal20021.pdf

[I9] ESPO Environmental Code of Practise: http://www.espo.be/publications/ENVIRONMENTAL_Code_of_p.pdf

[I10] http://www.maritimetoday.com/more.cfm?ID=13466

[I11] http://www.hwwa.de/Projekte/Forsch_Schwerpunkte/FS/Klimapolitik/PDFDokumente /Bode,%20Krause,%20Michaelowa%20(2002).pdf

[I12] http://www.eceee.org/latest_news/2003/swedeepa3.pdf

[I13] www.portoflosangeles.org/publicnotice/portoflapublicnotice96421021_07072004.pdf

[I14] http://landesregierung.schleswighostein.de/coremedia/generator/Aktueller_20Bestand /StK/Hintergrund/PDF/Kieler__Vorschl_C3_A4ge__deutsch,property=pdf.pdf