AIR EMISSIONS FROM SHIPS

WORKING PAPER TO INFORM MEMBER STATES' DISCUSSIONS IN RELATION TO THE REVISION OF MARPOL ANNEX VI

WORKSHOP ON AIR EMISSIONS FROM SHIPS

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1. INTRODUCTION

The aim of the workshop is to provide opportunity for Member States to discuss and exchange views on the different options for the revision that will be discussed at IMO level later this year. The interested industries (INTERTANKO, EUROMOT and EUROPIA/IPIECA) will present position and proposals of their respective activity sector. This working paper has to objectives. The first is to provide background information about the magnitude of ship emissions and their impacts on health and the environment. The second is to assist in the preparation of a coordinated EU position on proposals to amend Annex VI of the Marine Pollution Convention (***MARPOL***) relating to air pollution. The paper does not address emissions of carbon dioxide or policy options to address them as these are not related to the process to revise Annex VI.

2. INFORMATION IN RELATION TO AIR POLLUTION & SHIP EMISSIONS

Outlook for growth in shipborne trade

Between 1970 and 2004 world seaborne trade increased from 10.65 to 27.6 trillion tonne-kilometers. During the same period the absolute mass of cargos transported rose 170% from 2.5 billion tonnes to 6.7 billion. Figure 1 depicts the evolution in seaborne trade differentiated by cargo type and shows that the biggest growth has been in dry cargoes.

In 2004, the average age of vessel in the world fleet was 12.3 years[1] but a substantial part of the fleet was 20 years or older. Figure 2 shows the world fleet gross tonnage broken down by vessel type and age. It is clear, for example, that 56% of general cargo vessels and 30% of bulk carriers are over 20 years old. Moreover, most bulk carriers are in service for at least 20 years and a significant proportion can serve for up to 50 years before being retired[2]. The age of the fleet has implications for the timescale over which the expected benefits of measures applied to new ships would materialise.

Impacts of air pollution in the EU

Currently in the European Union, air pollution is associated with approximately 370,000 premature mortalities from exposure to fine particulate matter ($PM_{2.5}$) and ground level ozone. With current policies this is only expected to reduce to around 290,000 premature deaths per annum in 2020. The natural environment is also at risk and it has been estimated that, on the basis of current policies, 150,000 square kilometres of ecosystems will be at risk from acid rain, 590,000 km^2 of ecosystems

will be at risk from excess nitrogen deposition and 760,000 km^2 of forest at risk from elevated levels of ozone in 2020.

Outlook for ship emissions and impacts in the EU

Ongoing analytical work performed for the European Commission[3], shows that emissions of sulphur dioxide, nitrogen oxides and primary $PM_{2.5}$ from international shipping in EU seas are expected to increase from their 2000 levels by 40%, 45% and 55% to 3186, 4828 and 396 kT per annum respectively in 2020, even with effective implementation of the IMO and EU's current regulatory requirements. Abatement measures have been applied progressively to land based sources and air emissions from these sources are expected to decline significantly over the next ten to fifteen years as measures on vehicles, industrial installations and fuels take effect. In fact, it is expected that by 2020 emissions of sulphur dioxide (SOx) and nitrogen oxides (NOx) from ships in European sea areas will be of the same size as those from land based sources in the EU.

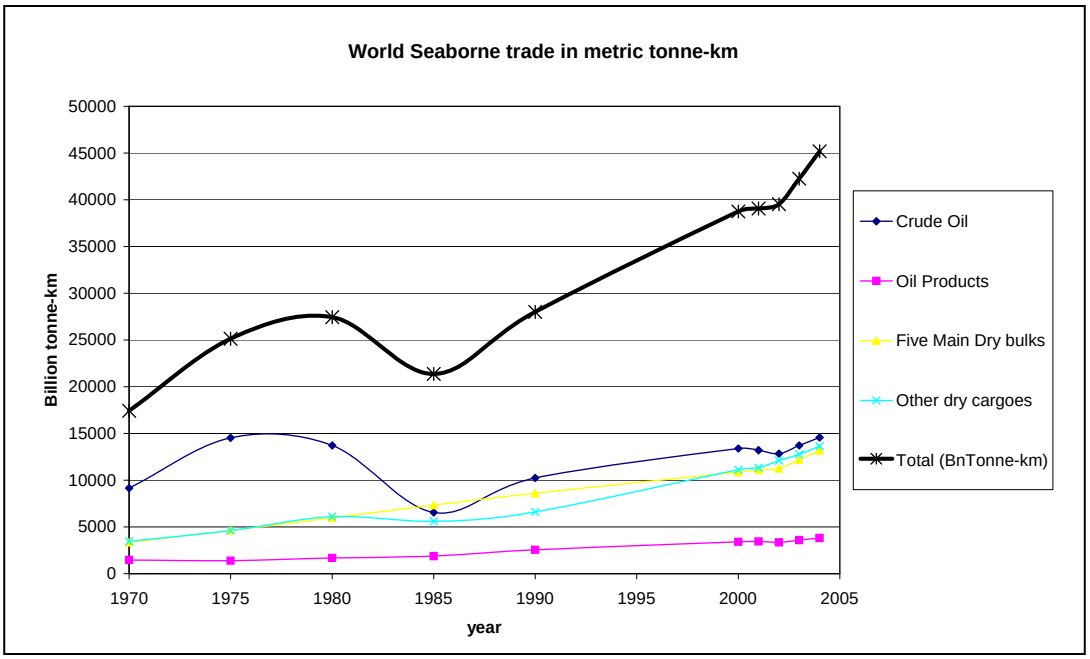

Figure 1. World seaborne trade 1979 to 2004 expressed in metric Tonne kilometers

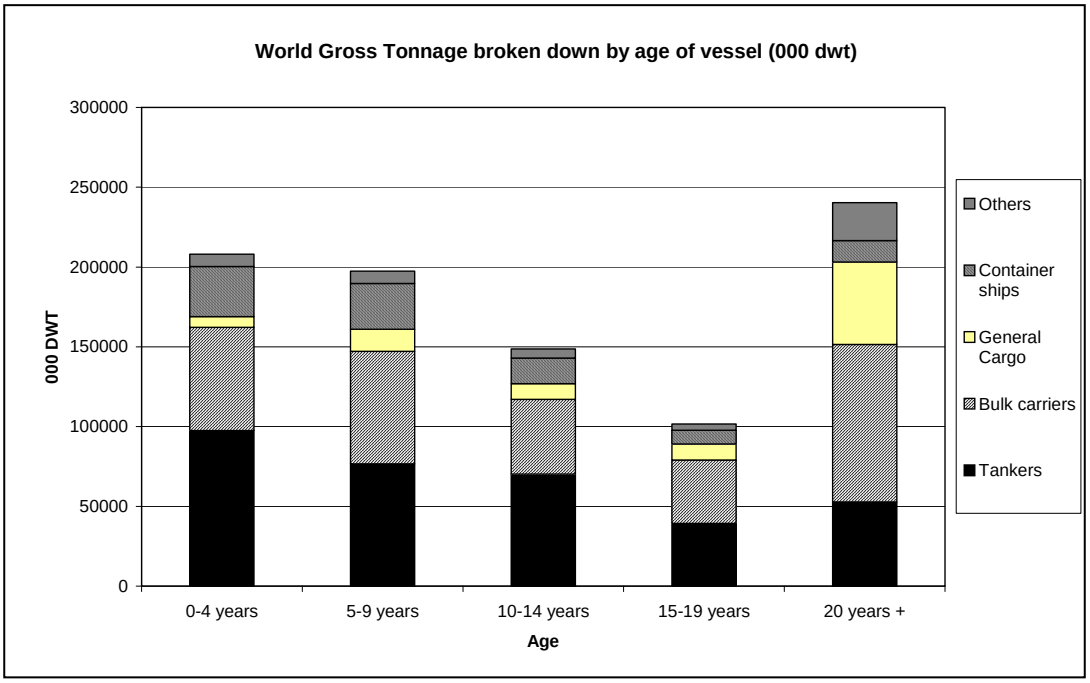

Figure 2. World fleet tonnage disaggregated by age and vessel type (as of 1 January 2005)

The vast majority of emissions in EU sea areas are emitted from cargo ships over 500 GRT. About 45% of all emissions come from EU-flagged ships and approximately 20% of emissions are emitted within the 12 mile limit of territorial seas.

Health and environmental impacts are determined by the magnitude of emissions sources, their location, the position of sensitive ecosystems and people and the prevailing wind patterns. This means that some maritime emissions have less health and environmental impacts than land-based sources because they are released far from populated areas or sensitive ecosystems. However, in harbour cities ship emissions are in many cases a dominant source of pollution and need to be addressed when considering compliance with legally binding air quality objectives. Moreover, emissions from ships are transported over hundreds of kilometres and can thus contribute to air quality problems on land even if they are emitted at sea. This is particularly relevant for the deposition of sulphur and nitrogen compounds which cause acidification of natural ecosystems and threaten biodiversity through excessive nitrogen inputs.

In respect of human health, ships' emissions contribute on average more than 10% of all adverse impacts in the EU from exposure to fine particulate matter. Though this can be much higher for countries such as Denmark (>20%), Ireland (>20%), Malta (>30%) and Spain (ca. 20%). Analyses also suggest that ships' emissions are currently responsible for around 10 to 20 per cent of sulphur deposition in coastal areas. This contribution is expected to increase to more than 30 % by 2020 in large areas of Europe especially in the UK, Ireland, Sweden, Denmark, France, Germany, Netherlands, Belgium, Spain, Italy and Greece. In many coastal areas, ships are expected to be responsible for more than half of all sulphur deposition by 2020.

3. POLICY RESPONSE SO FAR

In 2002, the European Commission adopted a strategy to tackle air pollution from ships[4]. Following the publication of this strategy, the Council of Ministers urged the Member States of the European Union to submit concrete proposals to the International Maritime Organization to introduce stricter standards for NOx emissions from ships' engines and invited the European Commission to investigate the feasibility of Community measures should action at the IMO fail to deliver new standards by the end of 2006[5]. Directive 2005/33/EC amending directive 1999/32/EC introduced parallel requirements in the EU to those in MARPOL Annex VI in respect of the sulphur content of marine fuels. In addition, it also introduced a 0.1% maximum sulphur requirement for fuels used by ships at berth in EU ports from 1 January 2010. This directive is to be reviewed in 2008 and this review should address the potential for further reducing the sulphur content of marine fuels and fuels used by land-based sources.

The Thematic Strategy on Air Pollution was adopted by the European Commission in September 2005[6]. This Strategy proposed new health and environmental objectives to be attained by 2020 as well as a range of new measures to bring about their attainment, including new engine NOx emissions standards for ships. More recently, the Council's conclusions[7] and the European Parliament's resolution[8] concerning the Thematic Strategy on Air Pollution also supported further action to reduce emissions from ships.

The thematic strategy on air pollution is currently being implemented and will lead to the implementation of a series of new measures to abate emissions from land based sources such as cars, trucks, small scale combustion plant and intensive agriculture. In addition, a new directive proposal on national emission ceilings is expected in mid-2007 that will impose new national limits on Member States' emissions from land based sources. Given that both land-based and sea based emissions sources affect health and the environment in the Member States, then the magnitude of ships' emissions naturally has consequences for the level of emissions reductions that will be required of the Member States. The Commission has undertaken work to look at the relative cost-effectiveness of measures to tackle ship emissions versus those focused on land-based emissions sources. It is clear from the interim report already published that ship based measures can be substantially more cost-effective[9][10].

4. ISSUES TO BE ADDRESSED AT THE BLG & MEPC

Ships emit nitrogen oxides, sulphur dioxide and particulate matter all of which contribute to local air quality. Nitrogen oxides and sulphur dioxide contribute to the regional problems of acidification and eutrophication of ecosystems as well as to the formation of secondary particulate matter. Furthermore, nitrogen oxides and volatile hydrocarbons contribute to the formation of ozone which can travel between continents and is known to be the third most important greenhouse gas. Any revision of MARPOL Annex VI must therefore face the difficult challenge of addressing several air pollution problems that occur on very different geographic scales.

The IMO has established a process whereby a new protocol may be adopted to revise Annex VI of the MARPOL Convention. Technical options are to be

developed by the Committee on Bulk Liquid & Gases (BLG) and its air pollution working group. Procedurally, at the next and 11th meeting of the BLG (April 2007), it is foreseen that firm proposals will be adopted and these will be submitted to the decision making forum of the IMO's Marine Environment Protection Committee (MEPC) in July 2007. In order to ensure unity of EU representation at the IMO and to increase the EU's effectiveness, it is preferable that the Member States attempt to develop coordinated positions before these meetings on the issues related to emissions of sulphur dioxide, nitrogen oxides and primary particulate matter.

5. SULPHUR DIOXIDE EMISSIONS

5.1. BLG options

The BLG is likely to propose the following three options to the Parties of the IMO:

(1) Leave unchanged the current regime comprising the Sulphur Emission Control Areas (maximum 1.5% Sulphur in fuels or technological equivalent) and the global sulphur cap of 4.5% sulphur in fuels;

(2) Reduce the maximum permitted sulphur content of fuels used in Sulphur Emission Control Areas from 1.5% to 1% to 0.5% in two stages, possibly in 2012 and 2015 but subject to fuel supply considerations;

(3) (a) Oblige all ships to use marine diesel fuels rather than residual fuel oil and reduce the sulphur content of this fuel to 1% and 0.5% in two stages possibly in 2012 and 2015 but subject to fuel supply considerations; or

(b) Permit the use of abatement technologies and continued use of residual fuel oil but obtain the same environmental result as in 3(a).

5.2. Discussion of options

Various options will be available to fuel suppliers in the EU if required to respond to stricter requirements on the sulphur content of fuels. The choice will depend upon the desired level of sulphur (e.g. 1% or 0.5%) and also the amount of low sulphur fuel which must be supplied (e.g. all fuel produced or just proportion that is used in sulphur emission control areas). The options include desulphurisation, conversion to distillates, blending and exporting excess high sulphur product.

The costs associated with desulphurising all residual fuel oil down to 0.5% are similar to the costs of converting that residual fuel oil to higher value distillate fuels, but the much higher market price for distillates could make this a much more attractive option. Refiners could also export excess high sulphur fuels to other parts of the world if this option is permitted. Alternatively, different components could be blended together to meet the required specifications though only limited amounts of low sulphur residual fuel oil are likely to be able to be supplied by such an approach.

Option 3(a) was proposed by the Independent Tanker Owners Association (INTERTANKO). It would establish global standards and obviate the need for sulphur emission control areas. It has safety benefits in that it would mean fewer fuel changeovers and fewer engine breakdowns due to fuel blending incompatibilities. The specific energy content would also be increased leading to improved fuel economy. It would however, force the oil refiners to invest in additional refinery processing equipment to convert residual fuel oil into higher quality middle distillates. This would also lead to increased energy use and carbon dioxide emissions at refineries. Concawe has estimated[11] that the additional costs of reducing the sulphur content from 1.5% to 0.5% would be around €35-40 per tonne of residual fuel oil converted/desulphurised with an increase of around 5-10% in refinery CO_2 emissions (7-15 MT per annum). Work undertaken for the Commission indicates lower additional emissions of CO_2 in the range of 5-10 MT[12].

It is likely that the permitted use of scrubbing technologies to achieve the same environmental result, would reduce the required amounts of low sulphur fuels. This would also provide greater flexibility to fuel suppliers and reduce refinery costs. Similar arguments are also relevant to restricting the requirement to use lower sulphur fuels within sulphur emission control areas.

6. EMISSIONS OF NITROGEN OXIDES

It is clear from the discussions in the IMO that there is a clear potential to reduce further the emissions of nitrogen oxides from both new and existing engines. What is unclear is the desired ambition level of any emission reduction and whether and how to include existing engines.

The options so far discussed are as follows:

(1) Introduce new engine standards in 2010 based only on the potential of "in-engine" measures to reduce emissions by up to 20% from current engine exhaust gas limits.

(2) Introduce a second and stricter tier of engine emission standards (from say 2015) that could reduce emissions by between 50-90% from current levels by deployment of after treatment technologies.

(3) Introduce engine emissions limits for existing engines installed before 1 January 2000 or require, where appropriate, the retrofit of certain abatement technologies to these engines.

6.1. Discussion of options

Land based sources of nitrogen oxides in the EU will decline by around 60% between 2000 and 2020 as a result of existing polices and measures and following the implementation of the Thematic Strategy on air pollution. Legally binding emission reduction targets for each Member State will be established by a revision of the national emissions ceilings directive 2001/81/EC foreseen by mid-2007.

Ships' emissions of nitrogen oxides in ports can also contribute to exceedences of Community air quality standards for nitrogen dioxide. These standards enter into force on 1 January 2010 and it is expected that several Member States will experience difficulty to comply.

There is predicted to be a growth both in seaborne trade and in ships' emissions to air of between 40-50% between 2000 and 2020. Moreover, it is clear that cargo ships are the dominant source of emissions in EU seas and that these ships are in service for up to 50 years.

The Community already regulates the emissions from compression-ignition engines using diesel fuel and installed in inland waterway vessels[13]. These engine limits are the same as US Tier 2 limits and enter into force from 1 July 2007. They cover engines over 18 kW (and in excess of 560 kW) and the pollutants carbon monoxide, hydrocarbons, particulate matter as well as NOx. Engines used in marine applications and designed for use with marine distillates are the same engines as those regulated by this European Community legislation.

The chairman of BLG has asked parties to submit specific proposals on how to amend Annex VI in order to advance the discussions on policy options for reducing emissions of NOx. Indeed, the Council in its conclusions of 2002 also urged the Member States to do likewise.

7. EMISSIONS OF PRIMARY PARTICULATE MATTER

7.1. Options at BLG

No concrete options or proposals have been discussed at the BLG for the time being. The chairman of BLG has asked parties to submit specific proposals on how to amend Annex VI in order to advance the discussions on policy options for reducing emissions of primary particulate matter.

7.2. Discussion

Emissions of primary particles from ships' engines are in the size fraction that is important for human health. These particles are also known to travel significant distances in the atmosphere and may be transported over hundreds of kilometres. In addition, emissions from ships whilst in port can contribute to local air quality problems such as exceedences of legal air quality limits for nitrogen dioxide and particulate matter such as PM_{10}. There are currently exceedences of the PM_{10} air quality standards in many Member States of the European Union including the Netherlands, Belgium, Italy and Germany. Such Member States will be under increasing pressure to ensure legal compliance over the next five years or so.

Reductions of the sulphur content of marine fuels could have a significant impact on emissions of primary particulate matter. This has previously been identified in work undertaken for the Commission[14]. As a further example, the Auto-Oil programme showed that for road diesel vehicles, a reduction of the sulphur level from 0.2% to 0.05% could reduce particulate emissions by 13%. In 2010 ships at berth will have to use fuel with a sulphur content of

less than 0.1% following implementation of Directive 1999/32 as amended by 2005/33/EC. In addition, it is also probable that the use of flue gas desulphurisation (scrubbers) will also lead to significant reductions in emissions of primary particulate matter.

QUESTIONS TO BE DISCUSSED AT THE WORKSHOP

Sulphur

1. What should be the maximum permissible level of sulphur in fuels used by ships?

2. What timescale should be established for the introduction of low sulphur fuels?

3. Should the use of marine distillates with a lower sulphur content be made compulsory?

4. Should technologies such as flue gas desulphurisation ("scrubbers") be permitted as alternatives to low sulphur residual fuel oil and/or marine distillates

5. Should the use of lower sulphur fuels apply globally or be restricted geographically to Sulphur Emission Control Areas?

6. Is there a need to develop a more precise fuel quality specification for residual fuel oil and marine distillates?

Nitrogen oxides (NOx)

7. Given the Council's conclusions and the thematic strategy on air pollution, what should the aim be of new IMO standards for emissions of nitrogen oxides? (e.g. stabilisation, reduction, slowed growth of emissions in EU sea areas)

8. Should existing engines be retrofitted to reduce emissions?

9. What level of emission reduction should be required of existing engines and by when should this be implemented? Does the level of sulphur in fuel affect what can be achieved?

10. What emission limits should be applied to new engines and on what timescales?

11. Should existing Community legislation (and US standards) be applied to new ships' engines designed to use marine distillates (directive 97/68/EC)?

Particulate Matter

12. Should additional measures be pursued in addition to lower sulphur fuels and/or the use of scrubbers?

13. Should engine certification automatically cover emissions of primary particulate matter as is done for non-road machinery and on-road vehicles?

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[1] Review of Maritime Transport 2005, Report by the secretariat of the United Nations Conference on Trade & Development, United Nations New York and Geneva 2005; Tables 8, pp. 23.

[2] Propulsion trends in Bulk carriers, MAN B&W A/S, Copenhagen 16.3.2006; page 6. http://www.manbw.com/article_005479.html

[3] http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/thematic_strategy/contract_emissions&vm=detailed&sb=Title

[4] European Union strategy to reduce atmospheric emissions from seagoing ships (COM(2002) 595; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52002DC0595:EN:HTML

[5] Conclusions of the Council of Ministers of the EU of 22 December 2003;
http://ec.europa.eu/environment/air/pdf/031222_ship_emissions_council.pdf

[6] Communication on a Thematic Strategy on Air Pollution COM(2005) 446;
http://eur-lex.europa.eu/LexUriServ/site/en/com/2005/com2005_0446en01.pdf

[7] Conclusions of the Council of Ministers of the EU of 9 March 2006;
http://ec.europa.eu/environment/air/cafe/pdf/council_concl_them_strategy.pdf

[8] EP Resolution of 26 September 2006 on the Thematic Strategy on Air Pollution;
http://www.europarl.europa.eu/registre/recherche/NoticeDetaillee.cfm?docid=203998&doclang=EN

[9] http://ec.europa.eu/environment/air/transport.htm (see reports at this web site from ENTEC UK)

[10] http://forum.europa.eu.int/Public/irc/env/cafe_baseline/library?l=/thematic_strategy/contract_emissions&vm=detailed&sb=Title

[11] Techno-economic analysis of the impact of the reduction of the sulphur content of residual marine fuels in Europe, Report N° 2/06, Concawe Brussels, June 2006.
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[12] Advice on Marine Fuels: Potential Price premium for 0.5% marine fuel; Particular issues facing fuel producers in different parts of the EU; and Commentary on marine fuels market. Bececip-Franlab, October 2003 (Contract ENV C1/SER/2001/0063).

[13] Directive 97/68/EC as amended by Directive 2004/26/EC

[14] http://ec.europa.eu/environment/air/pdf/task2_so2.pdf