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REVISION OF MARPOL ANNEX VI, THE NOx TECHNICAL CODE AND RELATED GUIDELINES

Appropriate standards to reduce air pollution from ships

Submitted by the Friends of the Earth International (FOEI)

SUMMARY	
Executive summary:	This document summarizes the rationale for stringent new international limits on emissions of air pollution from ships, and urges the adoption of such limits as amendments to regulations of MARPOL Annex VI. This document was produced by a coalition of environmental NGOs.[1]
Action to be taken:	Paragraph 21
Related documents:	BLG 10/14/13; MEPC 53/4/1; MEPC 53/4/8; MARPOL Annex VI

Introduction

1 The BLG Sub-Committee agreed at its 10th session to further consider amendments to the regulations under MARPOL Annex VI. BLG will continue its review of potential international control of air pollution from ships at its intersessional meeting in Oslo during November 2006.

2 This document summarizes the need to reduce air pollution from ships and potential approaches to do so. In view of the serious and increasing public health and environmental impacts of shipping emissions, substantial reductions are required sooner rather than later. Ships remain one of the last major sources of air pollution on the planet to be controlled, a situation that makes reductions from ships less costly than additional land-based reductions. It is no longer acceptable for the shipping industry to transfer the cost of its pollution to society at large; rather, it must accept responsibility for its air emissions and substantially clean them up. Stringent regulation at the international level via amendments to MARPOL Annex VI is the most effective way to accomplish this. Otherwise, the industry will likely face in the near future a growing patchwork of local and regional regulations around the globe, as ports and port States mandate the necessary reductions themselves in order to protect their natural environment and the health of their citizens.

[1] Clean Air Task Force, Bluewater Network-a division of Friends of the Earth-US, European Environmental Bureau, European Federation for Transport and Environment, North Sea Foundation, Seas at Risk and Swedish NGO Secretariat on Acid Rain.

3 In April 2005, Friends of the Earth International (FOEI) submitted to MEPC 53 a background document (MEPC 53/4/1) demonstrating that shipping emissions of air pollution have a substantial impact on human health and the environment, and that feasible and cost-effective means are available to reduce those emissions. A submission by Finland, Germany, the Netherlands, Norway, Sweden, and the United Kingdom (MEPC 53/4/4) made similar points, and proposed the initiation of the present review of Annex VI emissions. In January 2006, FOEI submitted a supplemental document (BLG 10/14/13) that provided additional information, focusing on several significant subsequent developments.

4 Other parties have also submitted a variety of documents regarding potential amendments to MARPOL Annex VI to both MEPC 53 and BLG 10. In addition, a number of parties, including FOEI, have submitted responses to certain questions regarding potential amendments to Annex VI; these are summarized in the 26 September 2006 report of Correspondence Group A established by BLG 10 (BLG-WGAP 1/2/1).

5 This document summarizes FOEI's position on appropriate standards to reduce air pollution from ships and the rationale therefore. This document does not repeat the more detailed information provided by FOEI in MEPC 53/4/1, BLG 10/14/13 and in its Correspondence Group A responses, but rather is supported by (and in some cases supplements) the information previously provided.

Summary

6 To summarize the main points of this document:

.1 Emissions of nitrogen oxides (NOx), sulphur oxides (SOx) and particulate matter (PM) from ships cause and contribute to severe onshore human health and environmental impacts.

.2 Air pollution from ships is substantial and growing, and most of it is emitted within transport distance of land.

.3 Shipping emissions remain largely uncontrolled, unlike most land-based sources. As a result, ships have higher rates of emissions than most other sources, and will produce an increasingly large share of the world's pollution burden-in some areas overtaking land-based sources as the primary emission sector.

.4 Cost effective approaches to substantially reduce shipping emissions exist today, or can be developed from land-based applications within the near future. It is now less costly to reduce emissions from ships than to require additional reductions from most land-based sources.

.5 Amendments to Annex VI should require reductions of NOx and SOx emissions in the 70-90% range for both new and existing ships as soon as possible, but no later than 2015:

- interim reductions in the 40-50% range should be required by 2010, and

- substantial PM reductions are also needed, but the co-benefits of NOx and SOx reductions should be considered. In the event BLG cannot agree on significant reductions at BLG 11, then MEPC or BLG should establish/continue a process to review the impacts of, and control measures to reduce, PM emissions and to recommend specific PM standards no later than 1 January 2009.

Air pollution from ships is causing substantial human health and environmental damage and must be reduced

7 Emissions of NOx, SOx, PM and other toxic pollutants such as polyaromatic hydrocarbons (PAHs) produce-by themselves and in combination with emissions from land-based sources-substantial human health and environmental impacts. These impacts include:

.1 Fine particles (emitted directly and formed via secondary atmospheric reactions of NOx and of SOx) are associated with premature death and a variety of heart and lung problems, including heart attacks and lung cancer as well as atherosclerosis, stroke and permanent respiratory damage.

.2 Ozone (formed by secondary atmospheric reactions of NOx) causes a host of respiratory problems, up to premature death.

.3 Diesel exhaust contains many other toxic materials such as metals, formaldehyde and PAHs, many of which are carcinogenic.

.4 NOx and SOx emissions contribute to acid rain, eutrophication of coastal and inland areas, crop damage, visibility impairment and regional haze.

.5 NOx emissions (e.g., via ozone formation) and black carbon emissions contribute to climate change.

8 There is no evidence that shipping emissions are any less of a health and environmental threat than other diesel emissions. This is obvious for NOx and SOx, but also true for PM. A recent examination of this issue by the California Air Resources Board (ARB) staff concluded:

> "[P]articulate matter emissions from ocean-going vessel diesel (compression ignition) engines operating on marine gas oil (MGO), marine diesel oil (MDO) or marine heavy fuel oil (HFO) constitute "diesel particulate matter" emissions. As such, the cancer potency factor and chronic reference exposure level for exhaust emissions from diesel-fueled engines, approved by the Scientific Review Panel and adopted by the ARB in 1998, are applicable to exhaust emissions from ocean-going vessel diesel engines using MGO, MDO or HFO."[2]

Nor is there evidence that PM emissions from ships using marine fuels are likely to consist of larger particles than those emitted by diesels using land-based diesel fuel. Rather, both the existing evidence and the physics of combustion suggest that marine diesels produce particulates that are primarily in the fine particle (2.5*u*m or less) range.[3]

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[2] California Air Resources Board (2005). "Staff Report: Initial Statement of Reasons for Proposed Rulemaking-Proposed Regulation for Auxiliary Diesel Engines and Diesel-Electric Engines Operated on Ocean-Going Vessels within California Waters and 24 Nautical Miles of the California Baseline," at pp. II-5 - II-7.

[3] *See e.g.,* Lyyranen, J., Jokiniemi, J., Kauppinen, E. and Joutsenaari, J. (1999). "Aerosol Characterisation in Medium-Speed Diesel Engines Operating with Heavy Fuels," J. Aerosol Sci. Vol. 30, No 6, pp. 771 - 784 (finding a size distribution of particulates emitted from a large medium-speed engine using HFO that indicates that most are fine particles less than 2.5*u*m). Given the high temperatures and pressures characteristic of low-speed marine diesels, the physics of combustion would suggest that these engines also produce mostly fine particulates.

9 International shipping emissions are significant and projected to grow even more in the future. At the same time, emissions from most land-based sources and some inland marine engines are being dramatically reduced. In fact, shipping emissions in European waters are projected to exceed all land-based European emissions in the next decade or so.[4] This is also the case for a number of areas along the California coast of the United States.

10 This is largely the result of the huge discrepancy between emission standards applicable to international shipping and to land-based sources:

.1 Emissions of NOx and PM will be reduced to 0.27 to 3.5 g/kWh (NOx) to 0.01-0.04 g/kWh (PM) for all new land-based mobile sources over 75 hp in the United States between 2007 and 2015. This represents a reduction of over 90% from current levels.

.2 The sulphur in all mobile distillate and diesel fuels in the US must be reduced to 15 ppm by 2007 for highway fuels, 2010 for most nonroad fuels and 2012 for locomotive and distillate marine fuels. The reduction of sulphur in fuel to ultra-low levels not only reduces emissions of SOx and PM, but also permits the effective operation of highly efficient catalyst-based emission control devices.

.3 In the European Union, emission standards are similar-for new heavy trucks (EURO V-2008), 2.0 g/kWh for NOx and 0.02 g/kWh for PM.; and for nonroad engines between 75 and 750 hp, 0.4 g/kWh for NOx and 0.025 g/kWh for PM by 2014.

.4 By comparison, IMO limits for NOx range from 9.8 to 17.0 g/kWh-orders of magnitude higher than land-based standards-while IMO has no PM standards at all. The IMO's sulphur in fuel limit is 45,000 ppm globally, and 15,000 ppm in the Baltic and North Sea SECAs-1000 to 3000 times higher than US land-based sulphur limits.

11 Almost 70% of global ship emissions occur with 400 km (~250 miles) from shore, well within transport distance of land (recent ICARTT studies demonstrated NOx transport over oceans of up to 1000 km).[5]

Cost-effective measures to substantially reduce air pollution from ships are or will soon be available

12 There are a variety of technologies to reduce shipping emissions of air pollution that are or will likely be available by the time new emissions standards become effective. Such technologies include in-engine modifications, water-based technologies such as humidification and emulsified fuel, after-treatment technologies such as selective catalytic reduction (SCR) and seawater scrubbing, and improvements in fuel quality.

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[4] *See, e.g.*, Amann, M., Bertrok, I., Cofala, J., Gyarfas, F., Heyes, C., Klimont, Z., Schöpp, W., Winiwarter, W. (2004) Baseline scenarios for the Clean Air For Europe (CAFE) Programme. Final report to the European Commission, DG Environment, in October 2004. Contract B4-3040/2002/340248/MAR/C1. (http://www.iiasa.ac.at/rains/index.html).

[5] *See. e.g., http://www.al.noaa.gov/ICARTT/factsheets/neuman.pdf.*

13 We have discussed these technologies in greater detail in our prior submissions and will not repeat that information here, except to summarize the results from the recent Entec report to the European Commission estimating the costs of NOx and SOx reductions from ships and comparing the cost-effectiveness of those shipping reductions to additional reductions from land-based sources.[6] Those results are:

.1 For NOx emissions from medium- and large-sized engines –

Measure	**NOx Reduction**	**Cost (new) (euro/tonne NOx)**	**Cost (retrofit) (euro/tonne NOx)**
Basic Internal Engine Modifications (IEM) (2-stroke only)	20%	9	15-24
Advanced IEM	30%	19-33	Variable
Direct Water Injection	50%	345-360	Variable
Humid air motors	70%	198-230	263-282
SCR	90%	313-563[a]	358-612[a]

[a] SCR operating costs depend on the fuel burned, increasing with fuel sulphur content.

.2 For comparison purposes, the marginal estimated NOx abatement cost for existing power and district heating plants was over 4000 euro/tonne, while that for heavy-duty trucks and buses was over 8000 euro/tonne (over *13 times* the cost of the *most costly* shipping abatement measure).

.3 SOx emissions

Measure	**SOx Reduction**	**PM Reduction**	**Cost (euro/tonne SOx)**
Seawater scrubbing	75%	25%	350 (new) 535 (existing)
Low-sulphur (1.5%S) HFO fuel	44%	18%	1230-2050
Low-sulphur (0.5%S) HFO fuel	80%	20%+[a]	1438-1690

[a] Entec's estimated PM reduction is quite conservative, and is likely higher.

.4 Estimated shipping SOx emissions abatement costs were lower than that of almost all other land-based SOx sources; this is especially the case for seawater scrubbing.

14 The use of cleaner marine fuels – by replacing HFO with lower sulphur marine distillate fuels – could produce substantial environmental benefits immediately. United States EPA has estimated that the use of 0.5% sulphur distillate fuel rather than HFO (containing 2.7% sulphur) could reduce PM emissions by about 63%, and the California ARB has estimated that such use could produce PM reductions of 75%. Furthermore, the use of such fuels will facilitate

[6] Entec UK Limited (August 2005), Final Report for European Commission Directorate-General-Environment, "Service Contract of Ship Emissions: Assignment, Abatement and Market-based Instruments" (EC Ship Emissions Report), available on the Internet at: http://europa.eu.int/comm/environment/air/transport.htm.

application of advanced pollution control devices such as SCR, which operate more effectively on engines using fuels with lower sulphur content.

15 Finally, there are no significant technical impediments to more widespread use of low sulphur fuel in ships. Generally, no engine modification is required. In fact, because low sulphur fuel is cleaner and of higher quality, its use results in reduced engine wear, maintenance, and lubricating oil use, thereby increasing engine performance and reducing the risk of operating problems. These quality advantages can partially offset the higher cost of lower sulphur fuel.

16 A number of parties have raised questions in past IMO submissions about the use of after-treatment technologies. For example, it has been stated that SCR use may be limited by high sulphur fuel content, low exhaust temperatures and storage of consumables. While ship and engine designers will need to pay attention to these issues, none are insurmountable. This is especially true considering that such requirements will not likely be in place until the 2015 time period-almost a decade from now, giving vessel and ship manufacturers substantial time to address any problematic issues. Both SCR and scrubbers (flue gas desulphurization) are established, proven technologies and have been used with great success in a wide variety of land-based applications-on combustion sources both smaller and larger than marine engines. In fact, SCR has been successfully used on many marine vessels already, including container ships, ro-ros, tankers and ferries.[7]

17 While more difficult issues may be faced when applying after treatment controls to existing ships, again, these issues are not insurmountable and should be overcome in most cases.

Recent port State regulatory actions

18 Recently, port States have begun to take action to reduce emissions of air pollution from marine engines, primarily focusing on inland and coastal vessels. For example:

.1 After treatment-based emissions standards for new inland and coastal marine diesels in the United States are likely to be required later this year.

.2 Ocean-going ships visiting California ports must reduce emissions within California waters from their auxiliary engines by using marine fuel with a 0.5% sulphur limit by 2007 and a 0.1% sulphur limit by 2010. The State is also initiating a process beginning in 2007 to develop similar standards for main engines.

.3 In Europe, a 0.1% sulphur limit will be required for fuel used by inland vessels and seagoing ships at berth in EU ports starting in 2010.

Recommended International Standards for Shipping Air Emissions

19 In view of the serious and increasing health and environmental impacts from shipping emissions, IMO must establish emission standards for both new and existing ships at levels that reflect application of the best technology to control emissions likely to be available when such standards go into effect. The standards must anticipate tomorrow's technology-and must not be based on yesterday's solutions. The innovation and creativity that has made shipping the predominant carrier of the world's good must be harnessed to make shipping a low polluting mode of transportation as well.

[7] Munters alone has installed its SCR system on about 200 marine engines. See: http://www.munters.dk/home.nsf/FS1?ReadForm&content=/home.nsf/ByKey/CKIL-5ZCKSL.

20 The following are recommended for consideration by BLG:

.1 Amendments to Annex VI should require reductions of NOx emissions in the 90% range for both new and existing ships as soon as possible, but no later than 2015 –

- this can be accomplished through the use of SCR, in-engines controls and water technologies, as well as other approaches.

.2 Interim NOx reductions in the 40-50% range should be required by 2010 –

- this can be accomplished through the use of in-engine controls and water technologies, as well as other approaches.

.3 Reductions of SOx emissions in the 70-90% range should be required for both new and existing ships as soon as possible, but no later than 2015 –

- this can be accomplished through the use of low sulphur [distillate fuels], as well as seawater scrubbers (once the sludge and wastewater disposal issues have been appropriately resolved).

- the worldwide limit for the sulphur content of marine fuel should be substantially lowered - interim targets could be for example maximum 1% by 2010 and 0.5% by 2015; the sulphur content of fuels used in SECAs and in sensitive port and harbour areas may need to be lower still.

.4 Substantial PM reductions are also needed, but the co-benefits of NOx and SOx reductions should be considered. In the event BLG cannot agree on significant reductions at BLG 11, then MEPC or BLG should establish/continue a process to review the impacts of, and control measures to reduce, PM emissions and to recommend specific PM standards at a later date, but no later than 1 January 2009.

Action requested of the Intersessional Meeting of the Working Group

21 The Intersessional Meeting is invited to consider the above comments during the ongoing Annex VI revision process and to recommend to MEPC stringent limitations for air emissions from ships.

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