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REVIEW OF MARPOL ANNEX VI AND THE NO_x TECHNICAL CODE

Development of Standards for NO_x, PM, and SO_x

Submitted by the United States

SUMMARY

Executive summary: This document outlines proposals to establish emission standards for Particulate Matter (PM), Sulphur oxides (SO_x), and Nitrogen oxides (NO_x) emissions from ships. The emission standards may be met through the use of low-sulphur fuel or the application of specific technologies, or both. This approach also allows the shipowner or operator to determine what mechanism is the most cost-effective means for meeting the specified emission standard. The proposed standards, if adopted, will constitute significant reductions in harmful air emissions from ships and should ensure a predictable and stable regulatory environment for the maritime industry

Action to be taken: Paragraph 24

Related documents: BLG 11/5, BLG 10/14/9, BLG-WGAP 1/2/5, BLG-WGAP 1/2/8 and MEPC 53/4/4

Introduction

1 At the fifty-third session of the Marine Environment Protection Committee, the Committee instructed the BLG Sub-Committee to consider future emission limits for marine diesel engines and their fuels. The Sub-Committee was tasked with examining available and developing techniques for reducing NO_x and recommending future NO_x emission limits. The Sub-Committee was also instructed to consider PM controls, as well as the need for further limits on sulphur content in marine fuels. The Committee requested that the Sub-Committee consider NO_x and PM limits for existing engines as well.

2 In this document, the United States puts forward a number of proposals which offer the opportunity to address the serious and growing air quality problems associated with marine vessels engaged in international commerce. The proposals are designed to offer substantial reductions in the most problematic emissions from ships while allowing the shipowner to decide what technologies or fuels offer the most cost-effective means of compliance. The PM and SO_x standards, as well as the Tier III NO_x standard, would be applicable in a limited area of the sea to be defined as [200] nautical miles (or some other appropriate distance) from shore, in co-operation with neighbouring countries that share air basins and ocean resources on a regional or continental level.

Background

3 Air pollution from ocean going vessels (OGVs) is a significant source of damage to human health and welfare on a global scale, and its overall contribution is rapidly growing. In the 15 years since the MEPC began formal discussions on air emissions from ships, only limited progress has been made toward reducing these emissions. While the sulphur content of marine fuel oil has been capped at 45,000 parts per million, the vast majority of in-use fuel never exceeded that level and the global sulphur cap has resulted in little, if any, reduction in sulphur emissions. In addition, this fuel sulphur cap is set at a level 3,000 times higher than what is commonly now used in land-based mobile transportation sources in many nations. The NO_x standards contained in the existing MARPOL Annex VI were originally conceived by IMO to result in a 30% reduction in new engine NO_x emissions. However, information gathered in the past decade indicates that the actual reduction will be significantly smaller, perhaps on the order of 15 – 20% by 2030 due to the long transition time required for new engines to enter the fleet. In addition, the current MARPOL Annex VI standards do not address particulate matter emissions. Particulate matter from diesel engines is now widely understood to be a serious health hazard and a significant cause of premature mortality.

4 In this same period of time (the past 15-20 years), air pollution from other transportation sources have been reduced significantly around the world. Emission limits in the European Union, Japan, the United States and other countries for passenger vehicles, commercial trucks, locomotives, in-land waterway vessels, and farm and construction equipment have been established and, in many cases, strengthened numerous times. The use of advanced engine and catalyst technologies is now common place, and new engines are typically 90% or more cleaner than they were 10 to 20 years ago. On-land gasoline and diesel fuel properties have also been addressed, including the removal of lead from gasoline, as well as substantial reductions in the sulphur content of both gasoline and diesel fuel. In Japan, Europe and the United States, diesel fuel used for highway vehicles is now required to be 10 to 15 ppm sulphur or lower. Off-highway diesel fuel is also being substantially reduced, and in the United States, all land-based transportation diesel fuel, as well as marine distillate fuel, will contain a maximum of 15 ppm sulphur by 2012. While there have been questions about the feasibility of applying advanced emission reduction technologies to large marine diesel engines, recent experience demonstrates that any technical problems have been or can be resolved with adequate lead time, proper maintenance and monitoring, and maritime industry support.

5 The consequence of OGVs achieving only modest improvement in their air emissions, while all other transportation sources are making continued improvement, is that OGVs are now one of the largest anthropogenic sources of air pollution on a relative basis. Recent estimates by some in the scientific community indicate OGVs represent approximately 18-30% of the world's NO_x pollution and 9% of global SO_x emissions[1]. The impact of ship emissions on worldwide air quality is expected to grow as marine transportation grows. The United States Environmental Protection Agency estimates that by 2030 marine diesel engines on OGVs will account for 28% of United States mobile source NO_x emissions, about 20% of United States mobile source direct PM emissions, and about 83% of United States mobile source SO_x emissions. Based on more recent studies, we now believe these values may be significantly underestimated, and the total tons of NO_x and PM emissions may be higher by a factor of 2-3.[2] Other countries

[1] Corbett, J.J., and Koehler, H. 2003. Updated Emissions from Ocean Shipping. Journal of Geophysical Research, Vol. 108.

[2] Corbett, J.J., et. al., May 2006. Estimation, Validation, and Forecasts of Regional Commercial Marine Vessel Inventories.

with large marine transportation activity are likely to see similar impacts. These emissions prevent many areas in the United States and other countries from attaining ambient air quality levels that are protective of human health and the environment. In addition, vessels that use marine diesel engines are used in ports that are often located in or near urban areas, and significant numbers of people are exposed to these emissions. The contribution of these engines to air pollution is substantial and is expected to grow in the future.

6 As discussed many times in this forum, the Member States and industry stakeholders generally agree that global regulation of ship emissions through the IMO is the best vehicle for addressing air emissions from ships due to the international nature of maritime shipping. However, the environmental problems caused by ship emissions and the lack of adequate international standards are leading some governments or local authorities, like the State of California, to set their own requirements for OGVs that enter their ports[3]. More of these programmes can be expected if the result of the current deliberations at IMO is limited to modest, incremental improvements. The pressure for substantially improved standards can be expected to increase as more governments begin to recognize the serious health and welfare impacts from ship air pollution.

7 To achieve meaningful reductions in air pollution and to ensure a predictable regulatory structure for the international shipping industry, the next tier of standards adopted by IMO must be sufficient to address the serious air pollution problems faced in many areas of the world and should reflect technology advances to ensure that the standards adopted are not already outdated before their respective implementation dates.

8 As noted in MEPC 53/4/4, engine manufacturers and technology companies continue to make significant progress in the development and application of advanced emission control technologies to all types of marine diesel engines, from small engines used in harbour craft to large engines used in OGVs. As a result, many countries have already adopted standards to reduce emissions from the engines in their inland waterway fleets, including the United States and the European Union, and others are considering such standards. In addition, the United States is developing a proposal for a new tier of standards for marine diesel engines up to 30 litres per cylinder displacement. This proposal, which will apply to both distillate and residual fuelled engines, is based on improvements in engine-out emissions and the application of catalyst technology, including particulate filters and urea-based selective catalytic reduction.

9 IMO Member States now hold a unique opportunity to revise the MARPOL Annex VI engine and fuel standards in a manner that will provide a long-term solution to the significant air emissions generated by ships. The remainder of this document identifies specific proposals for future standards, as well as recommendations which require additional deliberations.

Proposal for performance-based PM and SO_x standards

10 As discussed in paragraphs 5 and 6, OGVs are a significant source of PM and SO_x emissions in many areas of the world and these emissions are a source of significant public health and welfare concerns. A long-term solution to these serious issues is critical to the mission of IMO, the Member States, and the industry.

11 The use of residual fuel is the primary reason for the extremely high levels of PM and SO_x associated with OGVs. Around the world, land-based petroleum fuel (both diesel and

[3] See http://www.arb.ca.gov/regact/marine2005/appa.pdf

gasoline) has been steadily moving to lower and lower values of sulphur. This has been done not only because sulphur contributes to acid rain, but primarily because it contributes significantly to PM pollution as well as regional haze and a host of serious human health and environmental concerns.

12 In order to achieve meaningful long-term reductions in both PM and SO_x from OGVs, two basic approaches have been discussed to date. One is a tightening of the sulphur limits applicable in existing SO_x Emission Control Areas (SECAs); the second is a reduction in the global fuel sulphur standard. The first approach, as discussed at the first intersessional meeting of the BLG Working Group on Air Pollution in Oslo in November 2006, focuses on the sequential tightening of sulphur requirements in SECAs. The second approach, as described in the recent proposal by INTERTANKO (BLG-WGAP 1/2/5), would result in a long-term reduction in the global cap for fuel sulphur of nearly 90% (from 4.5% to 0.5%), and the elimination of residual fuel from the marine market. This approach would achieve substantial reductions in both SO_x and PM on a global basis. The United States believes that the use of distillate fuel will provide significant public health and welfare benefits, and the proposal from INTERTANKO should be evaluated by the Sub-Committee.

13 The human health and environmental impacts associated with PM and SO_x emissions from vessels require a stringent international standard, but we also believe that ship operators should choose what mechanism is the most cost-effective for meeting a given standard. Consequently, the United States believes that a performance-based standard that allows for different compliance mechanisms may be the most cost-effective way to address these issues. In addition to evaluating a global switch to distillate fuel as proposed by INTERTANKO, the United States believes we should also consider uniformly defined, geographic-based PM and SOx standards beginning in 2011 for all ships operating within [200] nautical miles of land. It is not envisioned that these requirements would apply to those waters adjacent to all land areas on the globe, but to a specific set of coastal waters defined in the current amendment process. Future expansion or amendment of the defined areas would follow a process similar to that specified for SECAs.

14 Ships operating within the defined coastal areas (such areas would include the United States and other coastal areas defined in the negotiation) could meet specified emission standards through the use of low-sulphur distillate fuels or the use of exhaust gas cleaning technology, or both. Vessels operating within these defined coastal areas would need to meet a SO_x standard of [0.4 g/kW-hr] or use a distillate fuel with a sulphur level not exceeding [0.1]%. PM limits could be defined as follows:

- [0.50] g/kW-hr for engines with a per-cylinder displacement of 15 liters or more;
- [0.27] g/kW-hr for engines with a per-cylinder displacement of 5 liters but less than 15 liters; and
- [0.20] g/kW-hr for engines with a per-cylinder displacement of less than 5 liters.

15 The PM and SO_x standards specified in paragraph 14 are achievable through the use of seawater SOx scrubbers or with the use of low sulphur distillate fuel. Recent demonstration projects have shown scrubbers are capable of reducing SO_x emissions on the order of 95% and can achieve substantial reductions in particulate matter as well. The United States is supportive of the continued development of stringent waste discharge limits for SO_x scrubbers by IMO. The implementation date proposed in paragraph 13 (2011) should be considered in parallel with the size and number of the defined geographic regions and the availability of low sulphur distillate for marine applications in that timeframe.

Proposal for Tier II and Tier III NO_x limits for new-built vessels

16 The United States offers the following proposal for revising the Annex VI standards applicable to new-built engines:

.1 ***Tier II NO_x limits:*** All engines on board any vessel constructed on or after 1 January 2011, whose main propulsion engine(s) have a per-cylinder swept volume displacement of 30 liters or more, would need to meet a NO_x limit [15-25%] below the current limits (as given by the formulae in paragraph 3(a) of regulation 13 of MARPOL Annex VI); and

.2 ***Tier III NO_x limits:*** Beginning in 2016, all engines on board any new vessel constructed on or after 1 January 2016, whose main propulsion engine(s) have a per-cylinder swept volume displacement of 30 liters or more must meet a NO_x limit 80% below the proposed Tier II limits described above.

17 The Tier III NO_x limits described in paragraph 16 should be based on a geographic approach, whereby the applicable control technology is employed only when vessels are operating within the coastal areas defined through the amended Annex VI. Such a geographic approach would utilize the same boundaries as the PM and SO_x standards outlined in paragraphs 13 and 14. A similar geographic NO_x concept has been suggested by Japan in documents BLG 11/5/13. BLG 10/14/9 and BLG-WGAP 1/2/8.

18 *Rationale for proposed Tiers II and III NO_x limits*. The United States believes a distinction between engines with per-cylinder swept volumes above and below 30 liters is appropriate. Vessels propelled by larger, slow-speed engines are typically engaged in long-distance trans-oceanic commerce, while vessels propelled by smaller engines are not. As discussed in previous submissions from the United States and other countries, emission control technology has progressed substantially in recent years. The proposed Tier II NO_x limits can be achieved by a range of technologies, with little or no impact on overall vessel performance. For low-speed two-stroke engines, these technologies include traditional engine-out controls based on the use of electronically controlled fuel systems and exhaust valves, improvements in turbo-machinery, and compression-ratio changes, exhaust gas recirculation, and/or water-based technologies. Four-stroke engines can achieve these reductions using similar technologies.

19 The proposed Tier III emission limits can be achieved with the use of urea-based selective catalytic reduction (SCR). While some parties have raised questions concerning the practicality of SCR after-treatment systems, discussions with the major engine and after-treatment manufacturers indicate that such questions have been successfully addressed. More than 300 SCR systems have been installed on marine vessels, some of which have been in operation for more than 10 years and have accumulated 80,000 hours of operation. SCR systems are capable of reducing NO_x on the order of 90% to 95%. A NO_x reduction of 80% from the proposed Tier II levels is achievable throughout the life of the vessel, and provides a clear opportunity for improved fuel consumption. While low sulphur distillate fuel would be a benefit for achieving these limits, it is not a requirement. Urea SCR systems have been used on marine vessels operating on residual fuel, with sulphur levels as high as 2.5% to 3%.

Proposal for NO_x limits for existing engines

20 Due to the very long life of OGVs, and the availability of known within-cylinder technical modifications that provide significant and cost-effective NO_x reductions, the Sub-Committee is invited to consider the following proposal for NO_x limits for existing engines.

21 For all engines with a per-cylinder swept volume displacement of 30 liters or more on board a vessel built between [1985] and 2000, a NO_x reduction of 20% would be required by the year [2012]. Alternatively, the standard may be expressed as a specified action (e.g., injector change) that would be known to achieve a particular reduction, but verification would be limited to the completion of the action as opposed to measuring a specified emission reduction.

22 In order to simplify the compliance demonstration and record keeping requirements, the Sub-Committee is invited to consider mechanisms which will simplify the certification of in-use engines to these new standards. The United States suggests that consideration be given to:

.1 simplified certification for any engine for which a parent engine of the family has already received certification to the exiting IMO NO_x limit, provided the in-use engine employs the same emission control hardware and calibration;

.2 allowable use of portable emission measurement equipment for certifying in-use engines, with appropriate consideration for any necessary deviations in the engine test cycle;

.3 broad use of the engine family concept for in-use engines, to enable in-use engines to use the same or similar hardware and calibration requirements as other similar engines in order to minimize and where appropriate eliminate emissions testing requirements; and

.4 development of alternatives to the NO_x Technical File to simplify the certification burdens for existing vessels while ensuring that the modified engines and/or emission components may be surveyed and inspected.

Summary of the United States proposal

23 The following table provides a summary of the proposal described in paragraphs 10 to 21 above.

Summary of Key Elements of the Proposal
NO_x standards for new build engines with a cylinder displacement greater than 30 liters: a) Tier II: 15-25% reduction effective in 2011; and b) Tier III: 80% reduction for engines on vessels applicable only in defined areas (x miles from shore) effective in 2016.
PM & SOx: Limits applicable to all vessels operating in defined areas [x miles from shore] effective in [2011]. Shipowners may choose to comply through the use of low-sulphur distillate fuel and/or the use of scrubbing technology.
NO_x standard for existing engines: 20% reduction applicable to pre-2000 large-displacement engines with exceptions to be defined for certain engines where the reduction is impractical. Reduction to be met through in-cylinder changes and simplified certification procedures by [2012].

Action requested of the Sub-Committee

24 The Sub-Committee is invited to consider the proposals outlined above and take action as appropriate.