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PREVENTION OF AIR POLLUTION FROM SHIPS

Environmental effects of new emission limits in the amended MARPOL Annex VI

Submitted by Norway

SUMMARY

Executive summary:	This document summarizes the environmental impact of possible options to reduce sulphur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter (PM) emissions from ships, as documented in MEPC 57/4/23. The document furthermore compares the results with the impact of the various options in MEPC 57/4. Special attention is given to the environmental benefit of including NO_x emission control in ships, which was not considered in the MEPC options analysed before.
Strategic direction:	7.3
High-level action:	7.3.1
Planned output:	7.3.1.1
Action to be taken:	Paragraph 16
Related documents:	MEPC 57/4, MEPC 57/INF.6 and MEPC 57/4/23

Introduction

1 This document provides comments on document MEPC 57/4/23 and is submitted in accordance with paragraph 4.10.5 of the Committees' Guidelines (MSC-MEPC.1/Circ.1) and the relaxed deadline for comments documents on the air pollution item to MEPC 57 with prior authorization of the MEPC Chairman following consultations with the Secretariat in line with paragraph 4.12 of the Committees' Guidelines. The purpose of this document is to present environmental effects on some of the options for new emission limits presented in document MEPC 57/4/23.

2 The environmental impacts of ships emissions are considered here with respect to human health and ecosystems. The indicators used to establish the health impact are the air concentrations of fine particulate matter (PM2.5) and ozone measured as the Sum of Ozone Means Over 35ppb (SOMO35), following the recommendations from the World Health Organization (WMO). For ecosystems, total deposition of sulphur and nitrogen compounds are

used as indicators of the emission impact. The study is centered in the European region. The study has been carried out by the same teams (ENTEC and Met.no) and follows the same methodology as it was used to evaluate the environmental impact of options R1, R3, R4, B, B1, B2 and C for the Scientific group of Experts (SGE) as reported in document MEPC 57/4. Therefore, results are presented also as comparison with these options, in particular, the Business as Usual scenario, R3.

Assumptions for the evaluation of the new emission scenario

3 The evaluation presented in this document is on the proposal by Finland, Germany and Norway (MEPC 57/4/30) on a total package of new requirements for the emissions of Nitrogen Oxides (NO_x), Sulphur (S), Particulate Matter (PM) and Fuel Oil Quality for the amended MARPOL Annex VI. A main challenge to evaluate the environmental impact of the proposal is to determine how the proposed measures will change the emissions of these pollutants to the atmosphere. This study provides an estimate of emissions in 2020 based on the technical proposal from Finland, Germany and Norway. The assumptions used to determine this new emission scenario are documented below, and may be commented upon as they are assumptions on a future situation.

4 The new 2020 scenario has been determined for SO_2, PM and NO_x emissions from the cumulative effect of the proposed policies in MEPC 57/4/30 as compared to the Business as Usual (BAU) for 2020 developed by Entec on behalf of the IMO SGE. The BAU scenario included no SECAs or EU measures and assumed a growth rate of 165% from 2000 to 2020. This scenario was further referred to by the IMO as R3 - 2020 Reference Scenario.

5 The reference R3 scenario for the IMO study (MEPC 57/4) followed recommendations of the IMO expert group, and it assumed that the fuel consumption was split as follows: 84% for Heavy Fuel Oil (HFO), 5% for Marine Diesel Oil (MDO) and 11% for Marine Gas Oil (MGO). In addition, it assumed that the average sulphur content was 2.7% in HFO, 1% in MDO and 0.2% in MGO. To determine the emissions of particulate mater (PM), an emission factor for PM was associated to different average sulphur contents in fuel. So, for sulphur content of 2.7%, 1%, 0.5% and 0.1%, the associated emission factors for PM recommended by the IMO expert group were respectively 6 kg/ton of fuel, 3.9 kg/ton of fuel, 1.5 kg/ton of fuel and 1.0 kg/ton of fuel. The same assumptions have been used here.

6 The estimation of the reduction in NO_x emissions is more complex than for fuel based emissions such as SO_2 and to a certain extent, PM, mainly because the emissions are dependent on the type of engine. For the combined 2020 scenario, each of the three tiers of NO_x regulation proposed by Finland, Germany and Norway (Fi/Ge/N) are assumed to be in place and the following assumptions have been made by Entec:

Tier I (Global = Inside and Outside SECAs) – ("2000-2011 engines")
NO_x emission reductions from 2020 BAU, have been calculated by assuming a 17% reduction in NO_x emissions for new engines entering service from the year 2000, at a replacement rate of 4% each year (with a constant fleet size).

Tier II (Global = Inside and Outside SECAs) ("2000-2016 engines")
To estimate the likely emission reductions from the Fi/Ge/N Tier II proposal of reducing NO_x emissions globally by 2.5 g/kWh below Tier I from 2011, a weighted percentage emission reduction has been calculated assuming an engine mix of 5% High Speed Diesel (HSD), 30% Medium Speed Diesel (MSD) and 65% Slow Speed Diesel (SSD) with corresponding emission reductions from Tier I to Tier II of 26%, 22% and 15% for HSD, MSD and SSD engines respectively. The weighted percentage reduction for Tier II is therefore 17% beyond Tier I for all new engines installed from 2011.

Tier IIIa (Regional = Inside SECAs)
In existing SECAs new engines installed after 1 January 2016 would need to comply with emission limits of 80% below the Tier I requirement. All other vessels operating inside SECAs would need to comply with their Tier I or Tier II requirement, respectively.

Tier IIIb (Global = Inside and Outside SECAs)

It has been assumed that 70% of the fleet will need to comply with Tier I under the Fi/Ge/N proposal (i.e., 70% is assumed to be large 2-stroke and large 4-stroke (engines existing engines proposal)). A 17% reduction in emissions to 70% of fleet that do not already meet Tier I has therefore been applied. As explained under Tier II, engines installed after 1 January 2011 but prior to 1 January 2016 will need to comply with Tier II requirements inside SECAs, but outside the SECAs the Tier II requirements applies after 1 January 2016 as well.

7 The resulting percentage emission reductions in 2020 with respect to the BAU scenario (IMO R3) are given in Table 1, for different pollutants and different sea areas. For all pollutants analysed, the emission reductions envisaged as a consequence of the implementation the Fi/Ge/N proposal are more stringent than for any other of the IMO scenarios. The closest emission reduction is that of proposal C (change to distillates) but the proposal has no associated control of NO_x emissions.

Table 1. *Percentage emission reductions from 2020 R3 BAU scenario used in this study*

Environmental impact of the proposal by Finland, Germany and Norway

Sea area	SO2	PM	NOx
SECAs	96%	82%	34%
Global (exc. SECAS)	80%	73%	22%

8 The proposal by Finland, Germany and Norway results in a general reduction of particulate matter levels in Europe, very much in line with the reductions derived from IMO options B1 and C. All over Europe the average reduction would be of about 12%, while in coastal areas the reduction would be of the order of 20%. In existing SECAs, the North Sea, the Baltic Sea and the English Channel, the environmental effect of the Norwegian proposal is more beneficial than for the other proposals by about 5-10%, a significant reduction. In countries like the Netherlands or the United Kingdom, the introduction of the proposal by Finland, Germany and Norway would imply significant additional reductions of the 2020 PM atmospheric levels.

9 For sulphur deposition, the proposal by Finland, Germany and Norway results in a general reduction of sulphur deposition levels by 19% with respect to the BAU scenario in 2020. This reduction in sulphur deposition is comparable to the effect of option C – switch to distillates in the study by MEPC for the sea areas outside existing SECAs. In SECAs and neighbouring land areas, the effect of the Fi/Ge/N proposal to reduce sulphur emissions results in a significantly larger reduction of sulphur deposition levels. The reductions are comparable to those in option B1, the US proposal. The Fi/Ge/N proposal results in the largest benefits for ecosystems in Scandinavia, in the Baltic States, in countries with coastal lines along the North Sea and the English Channel and in the British Isles.

10 The control of NO_x emissions is an additional element in the Fi/Ge/N proposal that was not considered in the previous IMO option study. NO_x control has an effect on ozone, nitrogen deposition and on particulate matter concentrations.

11 The control of NO_x emissions by the Fi/Ge/N proposal results in a small general reduction of ozone levels in Europe. SOMO35 values are generally reduced by 5-10%, except in areas along the shipping routes and over the North Sea and the English Channel where titration effects are responsible for an increase in ozone levels.

12 For nitrogen deposition, the proposal by Finland, Germany and Norway results in a general reduction of nitrogen deposition levels by 5-10% with respect to the BAU scenario in 2020, and between 10-20% in coastal areas. The control of NO_x emissions from ships is effective to control eutrophication problems in European ecosystems (terrestrial), and also contributes positively to reduce problems associated with marine eutrophication.

13 It should be noted, however, that the effect of the control of ships PM emissions is mostly dominated by the reduction of sulphur emissions and to a much lesser degree it depends on stipulated reductions of NO_x emissions. NO_x control in ship emissions would be more efficient in areas with a surplus of ammonia in air. This explains why the reduction in PM concentrations in the Netherlands and neighbouring countries is enhanced in the Fi/Ge/N proposal when compared to the other options in MEPC 57/4. Here, the effect of reducing NO_x emissions adds to reductions of SO_x emissions, because there is still a surplus of ammonia. Without such surplus, NO_x reductions have a lesser effect on PM levels.

14 The Committee should note that the effect of the NO_x limits will change in post-2020 scenarios due changes in the composition of the fleet. The share of the fleet having Tier III technology will increase, and the share of the fleet having Tier I technology will decrease. This would imply that the NO_x limits will have larger environmental impact compared to the scenario presented here. When it comes to total NO_x emissions from ships after 2020, the Committee should also take into account that shipping activity is expected to increase.

Conclusion

15 It is recognized that the assumptions above on the effect of the proposed measures on the actual ship emissions introduce uncertainties in the 2020 scenario estimates and thus also in the evaluations of their environmental impact. However, it can be concluded that a global approach combined with regional requirements will have environmental benefits for wider regions than a regional approach only.

Action requested of the Committee

16 The Committee is invited to consider the findings in this document and decide as appropriate.