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WORKING GROUP ON REDUCTION OF
GHG EMISSIONS FROM SHIPS

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**CONSIDERATION OF HOW TO PROGRESS THE MATTER OF
REDUCTION OF GHG EMISSIONS FROM SHIPS**

Existing IMO activity related to reducing GHG emissions in the shipping sector

Note by the Secretariat

SUMMARY

Executive summary: As requested under the Roadmap approved at MEPC 70, this document by the Secretariat provides information on existing IMO activity related to reducing GHG emissions in the shipping sector

Strategic direction: 7.3

High-level action: 7.3.2

Output: 7.3.2.1

Action to be taken: Paragraph 5

Related documents: ISWG-GHG 1/1; MEPC 70/18 and MEPC 70/18/Add.1

Introduction

1 MEPC 70 (October 2016) approved a *Roadmap for developing a comprehensive IMO strategy on reduction of GHG emissions from ships* (the Roadmap), which foresees an initial GHG reduction strategy to be adopted in 2018 (MEPC 70/18, paragraph 7.19 and MEPC 70/18/Add.1, annex 11).

2 The Roadmap contains a list of activities, including further IMO GHG studies and significant intersessional work with relevant timelines and provides for alignment of those new activities with the ongoing work on the three-step approach (i.e. data collection, data analysis, followed by decision-making on what further measures, if any, are required) to ship energy efficiency improvements. This alignment provides a way forward to the adoption of a revised strategy in 2023 to include short-, mid- and long-term further measures, as required, with implementation schedules.

3 The Roadmap identifies the holding of an intersessional meeting in the week before MEPC 71 (3 to 7 July 2017) to start discussions, taking into account inputs including a "technical paper by the Secretariat compiling a list of existing IMO activity related to reducing GHG emissions in the shipping sector".

4 The annex to this document sets out the work to date by the Organization on technical, operational and market-based measures to address GHG emissions from international shipping. Furthermore, it identifies work by the Organization to control other emissions from ships including SO_x and PM, NO_x and Black Carbon; the development of technical standards to enable ships to use alternative fuels; and highlights related technical cooperation activities.

Action requested of the Working Group

5 The Working Group is invited to consider the information provided in the annex and to take action as appropriate.

ANNEX

EXISTING IMO ACTIVITY RELATED TO REDUCING GHG EMISSIONS IN THE SHIPPING SECTOR

INTRODUCTION

1 The International Maritime Organization (IMO) was established by Governments as a specialized agency under the United Nations to provide the machinery for intergovernmental cooperation in the field of regulation of ships engaged in international trade. IMO is responsible for the global regulation of all aspects of international shipping and has a key role in ensuring that lives at sea are not put at risk, including security of shipping, and that the environment is not polluted by ships' operations – as summed up in the IMO's mission statement: to promote safe, secure, environmentally sound, efficient and sustainable shipping through cooperation.

2 IMO is the global standard-setting authority for the safety, security and environmental performance of international shipping. Its regulatory framework covers all aspects of technical matters pertaining to the safety of ships and of life at sea, efficiency of navigation, and the prevention and control of marine and air pollution from ships. Following several high profile oil spills, the original focus of IMO's environmental work was on the prevention of marine pollution by oil, resulting in the adoption of the first-ever comprehensive anti-pollution convention, the International Convention for the Prevention of Pollution from Ships (MARPOL) in 1973. This has changed over the last few decades to include a much wider range of measures to prevent marine pollution, and the original MARPOL Convention has been amended to include requirements addressing pollution from chemicals, other harmful substances, garbage, sewage and, under an Annex VI adopted in 1997 by a Protocol to MARPOL, air pollution and control of emissions from ships.

CONTROL OF EMISSIONS FROM SHIPS – MARPOL ANNEX VI: REGULATIONS FOR THE PREVENTION OF AIR POLLUTION FROM SHIPS

3 In November 1991, the IMO Assembly adopted resolution A.719(17) on *Prevention of Air Pollution from Ships*, stating the desire to reduce air pollution from ships by cooperative efforts of Member Governments which may be best achieved by establishing a new annex to MARPOL which would provide rules for restriction and control of emission of harmful substances from ships into the atmosphere.

4 In September 1997, a Conference of Parties to MARPOL adopted the Protocol of 1997 to amend the Convention. The Protocol, which entered into force on 19 May 2005, incorporated in MARPOL a new Annex VI, entitled "Regulations for the prevention of air pollution from ships", with the aim of controlling airborne emissions from ships of sulphur oxides (SO_x), nitrogen oxides (NO_x), ozone-depleting substances (ODS), volatile organic compounds (VOCs) and their contribution to global air pollution and environmental impacts.

5 Eight years after its adoption, but only two months after its entry into force, the Marine Environment Protection Committee (MEPC), at its fifty-third session (MEPC 53 in July 2005), decided that Annex VI should undergo a general revision. The decision was based on new knowledge of the harmful impact that ships' exhaust gases may have on ecosystems and human health and recognized that technological developments would enable significant improvements of the current standards.

6 After three years of intensive work, MEPC 58 (October 2008) unanimously adopted a revised MARPOL Annex VI and the associated Technical Code on control of emissions of nitrogen oxides from marine diesel engines (NO_x Technical Code 2008) for surveying and certifying marine diesel engines, both of which entered into force on 1 July 2010. The revised Annex VI introduced even more stringent limits for the emission of air pollutants from ships, together with phased-in reductions, to be achieved through fuel oil quality and marine diesel engine design or equivalent technologies, in particular for SO_x and particulate matter (PM) and NO_x emissions.

IMO AND THE UNFCCC POLICY FRAMEWORK

7 Prior to the signing in December 1997 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), the aforementioned IMO International Air Pollution Conference in September 1997 adopted conference resolution 8 which recognized that CO₂ emissions, being greenhouse gases (GHGs), have an adverse impact on the environment, and noted that UNFCCC had recognized that GHGs also originate from international shipping and contribute to the global inventory of emissions. The resolution invited the MEPC to consider what CO₂ reduction strategies may be feasible in light of the relationship between CO₂ and atmospheric pollutants, especially NO_x, since NO_x emissions may exhibit an inverse relationship to CO₂ reductions.

8 In December 2003, the IMO Assembly adopted resolution A.963(23) on *IMO policies and practices related to the reduction of greenhouse gas emissions from ships* that urged the MEPC to identify and evaluate mechanisms to achieve the limitation or reduction of greenhouse gas emissions from international shipping and keep the matter under review and that, in doing so, it should cooperate with the Conference of the Parties (COP) to the UNFCCC.

9 Article 2.2 of the Kyoto Protocol states that the Parties included in Annex I shall pursue limitation or reduction of emissions of GHGs not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization (ICAO) and IMO, respectively.

10 No reference to IMO (nor ICAO) is made in either the articles of the 2015 Paris Agreement on Climate Change (the Paris Agreement) or the decisions to implement the agreement, including on the pre-2020 ambition (the period between the Kyoto Protocol commitment period ending on 31 December 2020 and the Paris Agreement entering into effect on 1 January 2020).

11 The forty-third session of the Subsidiary Body for Scientific and Technological Advice (SBSTA), held during COP 21 in Paris in December 2015, took note of the information received from and progress reported by the Secretariats of ICAO and IMO on their ongoing work on addressing emissions from fuel used for international aviation and maritime transport respectively, and invited the Secretariats to continue to report at future sessions of SBSTA on relevant work on this issue.

12 IMO reported to SBSTA 45 at COP 22 in Morocco in November 2016 on progress made subsequent to the Paris Agreement, including the adoption of the data collection system for fuel oil consumption of ships and the approval of the *Roadmap for developing a comprehensive IMO strategy on reduction of GHG emissions from ships*.

13 As requested by Assembly resolution A.963(23), and reaffirmed by MEPC 69 (April 2016), the Secretariat shall continue reporting to UNFCCC SBSTA under the agenda item on "Emissions from fuel used for international aviation and maritime transport" and participate in related United Nations system activities.

IMO GREENHOUSE GAS STUDIES

14 The 1997 Air Pollution Conference resolution 8 on *CO₂ emissions from ships* that initiated IMO's work to address GHG emissions from ships invited IMO to undertake a study of CO₂ emissions from ships for the purpose of establishing the amount and relative percentage of such emissions as part of the global inventory of CO₂ emissions. MEPC 63 (March 2012) noted that uncertainty existed in the estimates and projections of emissions from international shipping and agreed that further work should take place to provide the MEPC with reliable and up-to-date information to base its decisions on. MEPC 64 (October 2012) endorsed, in principle, an outline for an update of the GHG emissions estimate, and an expert workshop in Spring 2013 further considered the methodology and assumptions to be used to update the study. To date, three IMO Greenhouse Gas Studies have been published:

- .1 the First IMO GHG Study, published in 2000, estimated that international shipping in 1996 contributed about 1.8% of the global total anthropogenic CO₂ emissions;
- .2 the Second IMO GHG Study, published in 2009, estimated international shipping emissions in 2007 to be 880 million tonnes, or about 2.7% of the global total anthropogenic CO₂ emissions; and
- .3 the Third IMO GHG Study, published in 2014¹, estimated international shipping emissions in 2012 to be 796 million tonnes, or about 2.2% of the global total anthropogenic CO₂ emissions. The Study also updated the CO₂ estimates for 2007 to 885 million tonnes, or 2.8%.

15 The Third IMO GHG Study 2014 (MEPC 67/INF.3 and Corr.1) employed both top-down and bottom-up (individual ship activity) methods to provide two different and independent analysis tools for estimating emissions from ships. The top-down estimate mainly used data on marine fuel oil (bunker) sales (divided into international, domestic and fishing) from the International Energy Agency (IEA), and is the approach used by the Intergovernmental Panel on Climate Change (IPCC) to calculate CO₂ emissions from international bunkers. However, the top-down method is considered less accurate than the bottom-up method as IEA and the Organization for Economic Co-operation and Development (OECD) identified specific types of error in energy data that involve marine bunkers. The first is allocation or classification error involving imports, exports and marine bunker statistics. The second is country-to-country differences in data quality, specifically related to poor accuracy for international bunkers or stock changes.

16 The bottom-up estimate combined the global fleet technical data from the maritime information provider, IHS Fairplay, with fleet activity data derived from Automatic Identification System (AIS) observations to provide statistics on activity, energy use and emissions for all ships from 2007 to 2012. This approach removed uncertainties attributed to the use of average values and represented a substantial improvement in the resolution of shipping activity, energy demand and emissions data, showing that high-quality inventories of shipping emissions can be produced through the use of quality analysis, such as rigorous testing of bottom-up results against noon reports and Long-range Identification and Tracking (LRIT) and AIS data from a variety of providers, both shore-based and satellite-received data.

¹ The Study can be downloaded online:
<http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Greenhouse-Gas-Studies-2014.aspx>

17 Although international shipping is already the most energy-efficient mode of mass cargo transportation and carries over 80% of all goods by volume (over 55% in terms of freight activity by tonne-mile²), a global approach to further enhance its energy efficiency and effective emission control is needed as, depending on future economic and energy developments, the Third IMO GHG Study forecasted a growth in CO₂ emissions for international maritime transport of 50 to 250% in the period up to 2050.

18 Up-to-date emission estimates are considered necessary, in general, to provide a better foundation for future work by IMO to address GHG emissions from international shipping. Ocean transport is fuel-efficient and without these updated figures it would be difficult to provide a meaningful baseline to illustrate the steadily ongoing improvement in fuel efficiency due to improved hull design, more effective diesel engines and propulsion systems and more effective utilization of individual ships resulting from the introduction of mandatory technical and operational measures. Importantly, the 2012 estimate provides a baseline estimate for international shipping emissions prior to the entry into force of regulations on energy efficiency for ships in 2013.

ENERGY EFFICIENCY OF INTERNATIONAL SHIPPING

19 In July 2011, IMO adopted mandatory measures to improve the energy efficiency of international shipping through resolution MEPC.203(62), representing the first-ever mandatory global energy efficiency standard for an international industry sector, the first legally binding instrument to be adopted since the Kyoto Protocol that addresses GHG emissions and the first global mandatory GHG-reduction regime for an international industry sector.

20 The amendments adopted by resolution MEPC.203(62) added a new chapter 4 entitled "Regulations on energy efficiency for ships" to MARPOL Annex VI. This package of technical and operational requirements which apply to ships of 400 GT and above, are known as the Energy Efficiency Design Index (EEDI), applicable to new ships, which sets a minimum energy efficiency level for the work undertaken (e.g. CO₂ emissions per tonne-mile) for different ship types and sizes, and the Ship Energy Efficiency Management Plan (SEEMP), applicable to all ships. These mandatory requirements entered into force on 1 January 2013. The Energy Efficiency Operational Indicator (EEOI) for monitoring operational energy efficiency of ships also remains available for voluntary application.

21 The EEDI requirement aims to increase the energy efficiency of new ships over time. It is a non-prescriptive, performance-based mechanism that leaves the choice of technologies to use in a specific ship design to the industry. As long as the required energy efficiency level is attained, ship designers and builders are free to use the most cost-efficient solutions in complying with the regulations. It is therefore intended to stimulate innovation in, and continued development of, the technical elements influencing the energy efficiency of a ship. By February 2017 more than 2200 new ships have been certified to the energy efficiency design requirements.

22 The EEDI has been developed for the largest and most energy-intensive segments of the world merchant fleet and, following the inclusion of additional ship types, will embrace approximately 85% of emissions from international shipping. EEDI reduction factors are set until 2025 to the extent that ships constructed in 2025 will be required to be at least 30% more energy efficient than those constructed in 2014. The SEEMP establishes a mechanism for operators to improve the energy efficiency of existing ships against business-as-usual operations, in a cost-effective manner and also provides an approach for monitoring ship and fleet efficiency performance over time.

² International Council on Clean Transportation (ICCT), Long-term potential for increased shipping efficiency through the adoption of industry-leading practices, Wang & Lutsey, 2013.

23 All ships of 400 GT and above engaged in international trade are required to implement and maintain a SEEMP that establishes a mechanism for operators to improve the energy efficiency of ships. This should be achieved by monitoring the energy efficiency performance of a ship's transportation work, using, for example, the EEOI as a monitoring and/or benchmarking tool and at regular intervals considering new technologies and practices to improve energy efficiency.

24 A study³ undertaken following the adoption of the mandatory energy efficiency measures indicates that the uptake of SEEMP measures will have a significant effect in the short to medium term, while EEDI measures should have a greater impact in the longer term, as fleet renewal takes place and new technologies are adopted. Estimates suggest that a successful implementation of this energy efficiency framework by 2050 could reduce shipping CO₂ emissions by up to 1.3 gigatonnes per year against the business-as-usual scenario. To put this in context, the Third IMO GHG Study 2014 estimated global CO₂ emissions to be 35.64 gigatonnes in 2012.

25 Four important guidelines have been adopted⁴, intended to assist in the implementation of the mandatory regulations on energy efficiency for ships, as follows:

- .1 *2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships, as amended* (resolution MEPC.245(66));
- .2 *2016 Guidelines for the development of a Ship Energy Efficiency Management Plan (SEEMP)* (resolution MEPC.282(70));
- .3 *2014 Guidelines on survey and certification of the Energy Efficiency Design Index (EEDI), as amended* (resolution MEPC.254(67)); and
- .4 *2013 Guidelines for calculation of reference lines for use with the Energy Efficiency Design Index (EEDI)* (resolution MEPC.231(65)).

26 MEPC 65 (May 2013) agreed to include several additional ship types in the EEDI framework and further guidance was agreed, or existing guidance amended, to support the uniform implementation of the energy efficiency regulations. Furthermore, a work plan was endorsed to continue work on the development of the EEDI framework for ship types and sizes and propulsion systems not covered by the current EEDI requirements and to consider guidelines on propulsion power needed to maintain the manoeuvrability of a ship under adverse conditions.

27 MEPC 69 (April 2016) considered an interim report of its correspondence group conducting a review of the status of technological developments relevant to implementing Phase 2 of the EEDI regulations. This review is required by regulation 21.6 of MARPOL Annex VI, with a further review to take place before Phase 3. Following consideration, MEPC 69 instructed the group to continue considering the status of technological developments for ro-ro cargo and ro-ro passenger ships and to make recommendations to MEPC 70 on whether the time periods, the EEDI reference line parameters for relevant ship types and the reduction rates in regulation 21 of MARPOL Annex VI should be retained or, if proven necessary, amended.

³ Estimated CO₂ emissions reduction from introduction of mandatory technical and operational energy efficiency measures for ships, Lloyd's Register and DNV, October 2011 (MEPC 63/INF.2).

⁴ Originally adopted by MEPC 63 (March 2012) and subsequently revised and/or amended.

28 MEPC 70 (October 2016) agreed to retain the EEDI requirements for Phase 2 (except for ro-ro cargo ships and passenger ships which will be considered further at MEPC 71) and on the need for a thorough review of EEDI Phase 3 (1 January 2025 and onwards) requirements, including discussion on its earlier implementation and the possibility of establishing a Phase 4. Phase 3 requirements provide that new ships be built to be 30% more energy efficient compared to the baseline.

Development of further measures to enhance the energy efficiency of ships

29 At MEPC 65 (May 2013) several delegations recognized the importance of enhancing energy efficiency and reducing fuel consumption with subsequent reductions of CO₂ emissions and other pollutants emitted to air. The Committee noted considerable support for the development of further measures to enhance the energy efficiency of shipping and to use a three-step approach, i.e. data collection and data analysis, followed by decision-making on what further measures, if any, are required (the three-step approach).

30 MEPC 68 (May 2015) noted that one purpose of a data collection system was to analyse energy efficiency and that for this analysis to be effective, some transport work data needed to be included. In this regard, the Committee agreed that data collected by IMO, particularly that related to transport work, should be confidential and not publicly available, and that resulting administrative burdens, the impact on industry and variables that influence energy efficiency needed to be addressed.

31 IMO therefore focussed on the development of a data collection system for ships and MEPC 69 (April 2016) reaffirmed that it would follow the three-step approach and agreed that confidentiality of data is crucial and that no third-party access to the data should be permitted.

32 MEPC 70 (October 2016) adopted mandatory MARPOL Annex VI requirements for ships to record and report their fuel oil consumption. Under the amendments, ships of 5,000 GT and above (representing approximately 85% of the total CO₂ emissions from international shipping) will be required to collect consumption data for each type of fuel oil they use, as well as, additionally, other specified data, including proxies for "transport work". The aggregated data will be reported to the flag State after the end of each calendar year and the flag State, having determined that the data have been reported in accordance with the requirements, will issue a Statement of Compliance to the ship. Flag States will be required to subsequently transfer this data to an IMO Ship Fuel Oil Consumption Database. The Secretariat is required to produce an annual report to the MEPC, summarizing the data collected.

REDUCTION OF GREENHOUSE GAS EMISSIONS FROM SHIPS

33 The MEPC has a standing item on "Reduction of GHG emissions from ships" on its agenda. MEPC 69 (April 2016) considered several submissions addressing the issue and, following an extensive debate:

- .1 welcomed the Paris Agreement and acknowledged the major achievement of the international community in concluding the agreement;
- .2 recognized and commended the current efforts and those already implemented by IMO to enhance the energy efficiency of ships;
- .3 widely recognized and agreed that further appropriate improvements related to shipping emissions can and should be pursued;

- .4 recognized the role of IMO in mitigating the impact of GHG emissions from international shipping;
- .5 agreed to the common understanding that the approval at MEPC 69 and subsequent adoption of the data collection system was the priority;
- .6 reiterated its endorsement of the three-step approach; and
- .7 agreed to establish a working group at MEPC 70, with a view to an in-depth discussion on how to progress the matter.

Comprehensive IMO strategy on reduction of GHG emissions from ships

34 MEPC 70 approved a *Roadmap for developing a comprehensive IMO strategy on reduction of GHG emissions from ships*, which foresees an initial GHG reduction strategy to be adopted in 2018 (MEPC 70/18, paragraph 7.19 and annex 11). The Roadmap contains a list of activities, including further IMO GHG studies and significant intersessional work with relevant timelines and provides for alignment of those new activities with the ongoing work on the aforementioned three-step approach to ship energy efficiency improvements. This provides a way forward to the adoption of a revised strategy in 2023 to include short-, mid-, and long-term further measures, as required, with implementation schedules.

35 Discussions under the Roadmap should include, but not be limited to, the following elements:

- .1 levels of ambition and guiding principles for the strategy;
- .2 emissions scenarios;
- .3 assessment of the projected future demand for shipping;
- .4 parameters/indicators on energy efficiency of ships (current status and long-term potential);
- .5 emission reduction opportunities (near-, mid- and long-term actions), including alternative fuels;
- .6 costs and benefits;
- .7 capacity building and technical cooperation;
- .8 barriers to emissions reductions and how to overcome them;
- .9 priority areas for R&D, including in relation to technology;
- .10 impact of EEDI;
- .11 impacts on States, taking into account the HLAP (resolution A.1098(29)); and
- .12 impacts of other regulations on GHG emissions.

36 To progress the work intersessionally, MEPC 70 agreed to the establishment of an Intersessional Working Group on Reduction of GHG emissions from ships, subsequently endorsed by the Council (C 117/D, paragraph 7.3), with the following terms of reference:

"The Intersessional Working Group on Reduction of GHG emissions from ships is instructed, with a view to implementing the *Roadmap for developing a comprehensive IMO strategy on reduction of GHG emissions from ships* approved at MEPC 70 (MEPC 70/18/Add.1, annex 11) and taking into account documents submitted, to:

- .1 consider how to progress the matter of reduction of GHG emissions from ships and advise the Committee as appropriate; and
- .2 submit a report for consideration at MEPC 71."

Initial strategy

37 As indicated in paragraph 34, the Roadmap identifies key activities and possible actions that need to be considered before finalization of the initial strategy in 2018 and the final strategy in 2023.

38 The Roadmap foresees the adoption of an initial IMO Strategy, including, *inter alia*, a list of candidate short-, mid- and long-term further measures with possible timelines, to be revised as appropriate as additional information becomes available, by MEPC 72 (spring 2018).

Identification of a list of candidate further measures

39 As identified by resolution A.963(23), the list of further measures could include technical, operational and market-based measures. As the preceding paragraphs indicate, IMO has made significant progress to date on the development and delivery of technical and operational energy efficiency measures for ships, including the adoption of the data collection system for fuel oil consumption.

Technical and operational energy efficiency measures

40 For existing ships, MEPC 67 considered the development of mandatory fleet-wide operational energy efficiency standards but since no clear way forward on the need for such standards for ships could be concluded at that session, the Committee agreed that document MEPC 67/5/4, addressing energy efficiency metric options, should be held in abeyance until a future session, and invited Member Governments and international organizations to submit comments and proposals addressing the questions set out in paragraph 15 of document MEPC 67/5 and in document MEPC 67/5/6 to MEPC 68 (MEPC 67/20, paragraph 5.9). Following further consideration, MEPC 68 agreed that the development of a data collection system for ships should progress and follow the three-step approach (MEPC 68/21, paragraph 4.8). MEPC 70 identified further possible development of the EEDI framework for new ships (see paragraph 28).

Market-based measures to address GHG emissions from international shipping

41 Resolution A.963(23) urged MEPC to identify and develop the mechanism or mechanisms needed to achieve the limitation or reduction of GHG emissions from international shipping and, in doing so, to give priority to, inter alia, an evaluation of the use of technical, operational and market-based solutions. MEPC 55 adopted a work plan to identify and develop the mechanisms needed to achieve the limitation or reduction of CO₂ emissions from international shipping (MEPC 55/23, annex 9).

42 MEPC recognized that, in view of projected increases in the world's population and trade, market-based measures (MBMs) may be necessary to supplement the adopted technical and operational measures to ensure even further reductions in GHG emissions from international shipping (MEPC 59/24, paragraph 4.92). Several MBM proposals from governments and organizations were received and MEPC 60 established an expert group to undertake a feasibility study and impact assessment of the proposals (MEPC 60/22, paragraph 4.89). The outcome of the study and assessment was subsequently examined by an intersessional working group (GHG-WG 3) in March 2011, which was tasked with providing advice on, among other subjects, the compelling need and purpose of MBMs as possible mechanisms to reduce GHG emissions from international shipping; and with evaluating the outcome of work conducted by the expert group, which had also endeavoured to assess the impact of the proposed MBMs on, among others, international trade, the maritime sector of developing countries, least developed countries (LDCs) and Small Island Developing States (SIDS), as well as the corresponding environmental benefits.

43 Following completion of the expert group's study, some of the proposed MBMs were combined or further developed by their respective proponents and, in examining the proposals, the intersessional working group had an extensive exchange of views on issues related to, inter alia, the desirability of MBMs providing: certainty in emission reductions or carbon price; revenues for mitigation, adaptation and capacity-building activities in developing countries; incentives for technological and operational improvements in shipping; and offsetting opportunities. Based on such policy considerations, the group reported to the MEPC, in accordance with its terms of reference, related to: the grouping of the MBMs; the strengths and weaknesses of the MBM groups; their relation to relevant international conventions; and the aforementioned possible impacts. The report of GHG-WG 3 (MEPC 62/5/1) was held in abeyance by MEPC 62 and considered at MEPC 63 (MEPC 63/21, paragraph 5.7).

44 If an MBM for international shipping was considered further, then part of any consideration could be the possibility of raising funds from the implementation of such a measure. MEPC 63 noted (MEPC 63/23, paragraph 5.34.7) that there were several possible uses for revenues generated by an MBM for international shipping, as identified in the MBM proposals, including:

- .1 incentivizing shipping to achieve improved energy efficiency;
- .2 offsetting – purchase of approved emission reduction credits;
- .3 providing a rebate to developing countries;
- .4 financing adaptation and mitigation activities in developing countries;
- .5 financing improvement of maritime transport infrastructure in developing countries (e.g. Africa);
- .6 supporting R&D to improve energy efficiency of international shipping; and
- .7 supporting IMO's Integrated Technical Co-operation Programme (ITCP).

45 Should an MBM be introduced for international shipping, MEPC 63 recognized the need for a continued impact assessment and that its focus should be on possible impacts on consumers and industries in developing countries (MEPC 63/23, paragraph 5.14).

46 Following further consideration at MEPC 64 (October 2012), the Committee agreed to keep the documents presented in abeyance and postpone further debate on MBMs to MEPC 65 (MEPC 64/23, paragraph 5.15). MEPC 65 (May 2013) agreed to suspend discussions on market-based measures and related issues to a future session (MEPC 65/21, paragraph 5.1).

Reduction target for international shipping

47 MEPC 60 noted that there would be a need to consider whether the international maritime sector should be subject to an explicit emission ceiling (cap) or a reduction target comprising the entire world fleet of merchant vessels (MEPC 60/22, paragraph 4.89). The paramount questions would be how and by which international organization such a cap or reduction target should be established. Other questions related to whether a cap or a target line would include the methodology by which the cap/target is set and maintained as well as the possible connection with other transport modes and how they are regulated internationally.

48 MEPC 60 agreed that the debate on reduction targets was a vital part of IMO's GHG work (MEPC 60/22, paragraph 4.93) and the issue of a reduction target for international shipping was included in its agenda item on "Reduction of GHG emissions from ships". However, due to time constraints, the Committee held the matter in abeyance until consideration of MBMs was suspended at MEPC 65.

49 The Paris Agreement identifies a target of global temperature increase above pre-industrial level of "well below 2°C" with an aim of limiting the increase to 1.5°C. The "well below 2°C" could be considered as providing a policy goal under which emissions from international shipping need to be considered.

CONTROL OF OTHER EMISSIONS FROM SHIPS

50 The adoption of MARPOL Annex VI in 1997, its entry into force in 2005 and its subsequent revision in 2008 represent significant steps towards establishing a robust global regime responsive to the air quality issues experienced in coastal areas. By reducing harmful emissions to air from ships, the measures are expected to have a significant beneficial impact on the atmospheric environment and on human health, particularly for those people living in port cities and coastal communities. As of 10 February 2017, 88 States, the combined merchant fleets of which constitute approximately 96.13% of the gross tonnage of the world's merchant fleet, have ratified MARPOL Annex VI.

Sulphur Oxides (SO_X) and Particulate Matter (PM)

51 SO_X and PM emission controls apply to all fuel oils, as defined in regulation 2.9 of MARPOL Annex VI, combustion equipment and devices onboard and therefore include both main and all auxiliary engines together with items such as boilers and inert gas generators. These controls are divided into those applicable inside Emission Control Areas (ECAs) established to limit the emission of SO_X and PM and those applicable outside such areas, and are primarily achieved by limiting the maximum sulphur content of the fuel oils as loaded, bunkered and subsequently used onboard. These fuel oil sulphur limits (expressed in terms of % m/m, that is, by mass) have been subject to a series of step changes over the years (regulations 14.1 and 14.4 of MARPOL Annex VI). Currently, the sulphur limit outside an ECA established to limit SO_X and PM emissions is 3.50% m/m and will fall to 0.50% m/m on 1 January 2020, following a review of the availability of the required fuel oil completed at MEPC 70.

52 Most ships operating both outside and inside ECAs will therefore use different fuel oils in order to comply with the respective limits. In such cases, prior to entry into an ECA, the ship is required to have fully changed over to using ECA-compliant fuel oil and to have onboard written procedures showing how the changeover is to be undertaken (regulation 14.6 of MARPOL Annex VI). Similarly, a changeover from using ECA-compliant fuel oil is not to commence until after exiting the ECA. At each changeover it is required that the quantities of ECA-compliant fuel oils onboard are recorded, together with the date, time and position of the ship when either completing the changeover prior to entry or commencing changeover after exit from such areas. This is to be recorded in a logbook as prescribed by the ship's flag State, and in the absence of any specific requirement in this regard the record could be made, for example, in the ship's Annex I Oil Record Book.

53 The first level of control in this respect is therefore the actual sulphur content of the fuel oils as bunkered. This value is to be stated by the fuel oil supplier on the bunker delivery note and hence is, together with other related aspects, directly linked to the fuel oil quality requirements as covered under regulation 18 of MARPOL Annex VI. Thereafter it is for the ship's crew to ensure, in respect of ECA-compliant fuel oils, that through avoiding loading into otherwise part-filled storage, settling or service tanks, or in the course of transfer operations, such fuel oils do not become mixed with other, higher sulphur content fuel oils, so that the fuel oil as actually used within an ECA exceeds the applicable limit.

54 Consequently, regulation 14 of MARPOL Annex VI provides both the limit values and the means to comply. However, there are other means by which equivalent levels of SO_x and PM emission control, both outside and inside ECAs, could be achieved. These may be divided into methods termed primary (in which the formation of the pollutant is avoided) or secondary (in which the pollutant is formed but subsequently removed to some degree prior to discharge of the exhaust gas stream to the atmosphere). Regulation 4.1 of MARPOL Annex VI allows for the application of such methods, subject to approval by the administration. In approving such "equivalents" an Administration should take into account any relevant guidelines. There are no guidelines in respect of any primary methods (which could encompass, for example, onboard blending of liquid fuel oils). In terms of secondary control methods, guidelines have been adopted and subsequently amended for exhaust gas cleaning systems that operate by water washing the exhaust gas stream prior to discharge to the atmosphere (resolution MEPC.259(68)). In using such arrangements there would be no constraint on the sulphur content of the fuel oils as bunkered other than that given by the system's certification.

55 There are no provisions for PM in regulation 14, but it is recognized that the sulphur content of fuel oil relates to the PM of the exhaust. PM consists of particles of soot or smoke resulting from the burning of, primarily, heavier oils. It is considered to be a major health hazard as particulates may penetrate deep into the lungs and blood and cause cancer (see also Black Carbon discussion below).

Nitrogen Oxides (NO_x)

56 NO_x can act as indirect greenhouse gases by producing the tropospheric GHG ozone via photochemical reactions in the atmosphere. The control of diesel engine NO_x emissions is achieved through the survey and certification requirements leading to the issue of an Engine International Air Pollution Prevention (EIAPP) Certificate and the subsequent demonstration of in service compliance in accordance with the requirements of regulations 13.8 of MARPOL Annex VI and 5.3.2 of the NO_x Technical Code 2008.

57 The NO_x control requirements of MARPOL Annex VI apply to installed marine diesel engines of over 130 kW output power other than those used solely for emergency purposes, irrespective of the tonnage of the ship on which such engines are installed. Definitions of "installed" and "marine diesel engine" are given in regulations 2.12 and 2.14 of MARPOL Annex VI, respectively. Different levels (Tiers) of control apply based on the ship construction date, a term defined in regulations 2.19 and hence 2.2, and within any particular Tier the actual limit value is determined from the engine's rated speed. The most stringent limit, Tier III, applies only to specified ships while operating in ECAs established to limit NO_x emissions. Outside such areas Tier II controls apply. A marine diesel engine installed on a ship constructed on or after 1 January 2016 and operating in the North American ECA and the United States Caribbean Sea ECA shall comply with the Tier III NO_x standards.

58 The emission value for a marine diesel engine is to be determined in accordance with the NO_x Technical Code 2008 in the case of Tier II and Tier III limits. Most Tier I engines have been certified to the earlier 1997 version of the NO_x Technical Code which, in accordance with the *Guidelines for the application of the NO_x Technical Code relative to certification and amendments of Tier I engines* (MEPC.1/Circ.679), may continue to be used in certain cases until 1 January 2011. Certification issued in accordance with the 1997 NO_x Technical Code remains valid over the service life of such engines.

Emission control areas designated under MARPOL Annex VI

59 MARPOL Annex VI includes provisions to establish ECAs for the control of emissions of NO_x, SO_x and PM. The North American ECA (August 2011) and the United States Caribbean Sea ECA (January 2013) have been designated as ECAs for the control of emissions of SO_x, NO_x and PM. The North American ECA comprises the sea areas 200 nautical miles off the Pacific coasts of the United States and Canada; off the Gulf of Mexico and Atlantic coasts of the United States, Canada and the French territories; and off the coasts of the populated Hawaiian Islands. The United States Caribbean Sea ECA comprises waters adjacent to the coasts of Puerto Rico and the United States Virgin Islands.

60 The Baltic Sea (May 2005) and the North Sea including the English Channel (November 2006) have been designated for the control of SO_x emissions only. MEPC 70 (October 2016) approved amendments to MARPOL Annex VI to designate the North Sea and Baltic Sea as ECAs for the control of NO_x which, if adopted at MEPC 71, are expected to become effective on 1 January 2021.

61 Provisions were approved at MEPC 70 to allow ships fitted with non-Tier III compliant marine diesel engines to be built, converted, repaired and/or maintained at shipyards located in the designated NO_x Tier III ECAs.

Use of gas as fuel for international shipping

62 There is significant interest in the use of gas as fuel for international shipping as its combustion results in less harmful pollutants being emitted than by fuel oil. Depending on the gas used, the emissions can be virtually sulphur-free and there can be reduced emissions of NO_x (some engines solely fuelled by gas can meet Tier III limits), CO₂ and PM. This development lead to requests for the risks of using gas, and other low flashpoint fuels, to be appropriately regulated. Following several years of work, the International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code) was adopted in 2015, along with new SOLAS regulations making the Code mandatory which require ships constructed after 1 January 2017 to comply with the requirements of the IGF Code.

63 Furthermore, to allow the use of gas as a fuel under MARPOL Annex VI, the definitions of "fuel oil" and "marine diesel engine" have been amended and further amendments were made to permit the testing of gas-fuelled and dual fuelled engines to enable them to be appropriately certified under the NO_x Technical Code 2008. One of the current limitations for the use of gas as a fuel is the lack of a global gas bunkering network supporting an international trading fleet of gas-fuelled ships. Other alternative fuels for ships under consideration include methanol (see paragraph 68.5) and hydrogen in fuel cells.

Black Carbon

64 MEPC 62 (July 2011) agreed to the following work plan for the BLG Sub-Committee to consider the impact on the Arctic of emissions of Black Carbon from international shipping (MEPC 62/24, paragraph 4.20):

- .1 develop a definition for Black Carbon emissions from international shipping;
- .2 consider measurement methods for Black Carbon and identify the most appropriate method for measuring Black Carbon emissions from international shipping; and
- .3 investigate appropriate control measures to reduce the impact of Black Carbon emissions from international shipping.

65 The matter is now being considered by the Sub-Committee on Pollution Prevention and Response (PPR) under its agenda item on "Consideration of the impact on the Arctic of emissions of Black Carbon from international shipping". MEPC 68 (May 2015) approved a definition of Black Carbon for international shipping agreed by PPR 2 (January 2015).

66 PPR 3 (January 2016) developed a measurement reporting protocol for voluntary data collection of Black Carbon and invited interested Member Governments and international organizations to use the protocol and submit data to PPR 4. Voluntary measurement studies using the agreed definition of Black Carbon were reported to PPR 4 (January 2017) and are continuing, in order to identify the most appropriate measurement method(s).

67 MEPC 68 noted that at that stage it was not possible to consider possible control measures to reduce the impact on the Arctic of emissions of Black Carbon from international shipping. PPR 4 noted that some delegations encouraged information on potential control measures to be submitted to PPR 5.

IMO-published technical studies

68 In support of the work of the MEPC and to provide timely information to Member Governments, specifically to support developing countries with the implementation of the provisions of MARPOL Annex VI, and using funds donated by Canada and Norway, the Secretariat has undertaken and published⁵ a series of technical studies as follows:

- .1 investigation of appropriate control measures (abatement technologies) to reduce Black Carbon emissions from international shipping;
- .2 emission control and energy efficiency measures for ships in the port area;

⁵ <http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/IMO-Publications.aspx>

- .3 studies on the feasibility and use of liquid natural gas (LNG) as a fuel for shipping;
- .4 optimization of energy consumption as part of implementation of a Ship Energy Efficiency Management Plan (SEEMP); and
- .5 methanol as marine fuel: environmental benefits, technology readiness and economic feasibility.

PROMOTION OF TECHNICAL COOPERATION AND TRANSFER OF TECHNOLOGY RELATING TO THE IMPROVEMENT OF ENERGY EFFICIENCY OF SHIPS

69 In order to support countries that lack the requisite resources, experience or skills to implement IMO treaties, IMO has developed an Integrated Technical Co-operation Programme (ITCP) which is designed to assist Governments by helping them build the necessary capacity. Through technical cooperation and capacity-building activities, IMO helps to transfer know-how to those countries that need it, thereby promoting wider and more effective implementation of IMO measures.

70 Linked to the implementation of energy efficiency measures, and specifically to regulation 23 of MARPOL Annex VI, MEPC 65 (May 2013) adopted resolution MEPC.229(65) on *Promotion of technical co-operation and transfer of technology relating to the improvement of energy efficiency of ships*, requiring Administrations, in cooperation with IMO and other international bodies, to promote and provide, as appropriate, support directly or through the IMO to Member States, especially developing countries that request technical assistance. It also requires the Administration of a Party to MARPOL Annex VI to cooperate actively with other Parties, subject to its national laws, regulations and policies, to promote the development and transfer of technology and exchange of information to States that request technical assistance, particularly developing States.

71 Pursuant to resolution MEPC.229(65), MEPC 66 (April 2014) established an Ad Hoc Expert Working Group on Facilitation of Transfer of Technology for Ships. MEPC 69 considered the final report of the group and noted the outcome of its work, as follows:

- .1 A scoping document on the establishment of an inventory of energy efficiency technologies for ships was forwarded to the GEF-UNDP-IMO project "Transforming the global maritime transport industry towards a low carbon future through improved energy efficiency" (GloMEEP). Using this scoping document, GloMEEP has developed an information portal for energy efficiency technologies for ships⁶.
- .2 Development of a *Model agreement between Governments on technological cooperation for the implementation of the regulations in chapter 4 of MARPOL Annex VI* (MEPC.1/Circ.861).
- .3 Recommendations provided to guide and assist Member States, industry and other entities within States in implementing the regulations of chapter 4 of MARPOL Annex VI.
- .4 Assessments made to identify barriers to transfer of technology and potential implications and impacts on the implementation of the regulations in chapter 4 of MARPOL Annex VI, in particular on developing States, as a means to identify their technology transfer and financial needs.

⁶ <http://glomeep.imo.org/resources/energy-efficiency-technologies-information-portal/>

72 MEPC 69 also noted that a comprehensive update of the "Train the Trainer" package on "Energy Efficient Ship Operation" had been undertaken to include a new module on the regulatory framework related to the energy efficiency of ships, an EEDI calculator for training purposes, and other related updated information, such as the findings from the Third IMO GHG Study 2014. Member Governments and other interested delegations were encouraged to make use of it. MEPC 69 further noted that IMO's technical cooperation activities would seek to address the specific needs of LDCs and SIDS with regard to the implementation of ship energy efficiency requirements.

73 Building on the success of the cooperation agreement between the Korean International Co-operation Agency (KOICA) and IMO on "Building Capacities in East Asia countries to address Greenhouse Gas Emissions from Ships" undertaken between 2011 and 2013, IMO has engaged in two partnership projects to further technical cooperation and technology transfer: the aforementioned GloMEEP project and the establishment of a global network of regional Maritime Technology Cooperation Centres (MTCCs) (Global MTCC Network (GMN) project).

74 The two-year GloMEEP project, an initiative of the Global Environment Facility (GEF), the United Nations Development Programme (UNDP) and IMO, focusses in particular on building capacity to implement technical and operational measures in developing countries, where shipping is increasingly concentrated and controlled. Ten IMO Member States have signed up as lead pilot countries: Argentina, China, Georgia, India, Jamaica, Malaysia, Morocco, Panama, Philippines and South Africa. They are being supported through a series of national and regional workshops and the development of guides in taking a fast-track approach to pursuing relevant legal, policy and institutional reforms, and driving national and regional Government action and industry innovation to support the effective implementation of IMO's energy efficiency requirements.

75 The GMN project aims to form a global network of regional centres of excellence (MTCCs) to promote the uptake of low-carbon technologies and operations in maritime transport. The five target regions, Africa, Asia, the Caribbean, Latin America and the Pacific, have been selected for their significant number of LDCs and SIDS. Three of the five centres, i.e. MTCC-Africa (Kenya), MTCC-Asia (China) and MTCC-Caribbean (Trinidad&Tobago), have now been selected as part of the GMN project, with the remaining (Latin-America and Pacific) expected to be selected during 2017. The four-year project, administered by IMO with €10 million in funding from the European Union, is designed to enable beneficiary countries to limit and reduce GHG emissions from their shipping sectors through technical assistance and capacity building, while encouraging the uptake of innovative energy-efficient technologies among a large number of users through the widespread dissemination of technical information and know-how. This is expected to heighten the impact of technology transfer.
