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UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Subsidiary Body for Scientific and Technological Advice
Thirty-fifth session
Durban, 28 November to 3 December 2011

Item 9(a) of the provisional agenda
Methodological issues under the Convention
Emissions from fuel used for international aviation and maritime transport

Information relevant to emissions from fuel used for international aviation and maritime transport

Submissions from international organizations

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its thirty-fourth session, invited the secretariats of the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO) to report, at future sessions of the SBSTA, on relevant work on emissions from fuel used for international aviation and maritime transport.[1]

2. The secretariat has received submissions from ICAO and IMO containing information on emissions from fuel used for international aviation and maritime transport. In accordance with the procedure for miscellaneous documents, these submissions are attached and reproduced* in the language in which they were received and without formal editing.

[1] FCCC/SBSTA/2011/2, paragraph 73.

* These submissions have been electronically imported in order to make them available on electronic systems, including the World Wide Web. The secretariat has made every effort to ensure the correct reproduction of the texts as submitted.

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UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

The Thirty-fifth Session of the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA35)
(28 November to 3 December 2011 – Durban, South Africa)

Agenda Item 9 (a)
Emissions from fuel used for international aviation and maritime transport

TOWARDS SUSTAINABLE DEVELOPMENT OF INTERNATIONAL AVIATION

(Submission by the International Civil Aviation Organization (ICAO)

This submission describes the main outcome from the 37th Session of the ICAO Assembly on international aviation and climate change, and further progress being achieved on actions requested by the Assembly in four key areas: 1) States' action plans and assistance to States, 2) sustainable alternative fuels for aviation, 3) market-based measures, and 4) global aspirational goals. ICAO's positions and perspectives to the work related to long-term climate change finance are also presented.

1. ASSEMBLY RESOLUTION ON INTERNATIONAL AVIATION AND CLIMATE CHANGE (A37-19)

1.1 The climate change Resolution A37-19, adopted by the 37th Session of the ICAO Assembly in October 2011, provides a solid policy framework towards the achievement of the sustainable development for international aviation. The full text of the Resolution is included in Appendix.

1.2 The Resolution makes international aviation the first sector with global aspirational goals of improving annual fuel efficiency by 2 per cent and stabilizing its global CO_2 emissions at the 2020 levels. The Assembly also agreed on the guiding principles for market-based measures and decided to explore a global scheme for international aviation. A global CO_2 certification Standard for aircraft is expected to be developed by 2013. Sustainable alternative fuels for aviation offer one of the most promising opportunities to reduce aviation CO_2 emissions, and it was agreed that the Organization would continue to be at the forefront of international efforts to facilitate the development and deployment of such fuels on a global scale.

1.3 The agreement on the voluntary submission of member States' action plans to ICAO will lead to a dynamic shift in the Organization's policy outlook on the environment from a "Standards and policies setting" phase to a more action-oriented "implementation" mode. The action plans will allow States to identify their basket of measures and assistance needs, and enable ICAO to assess the progress in achieving the global aspirational goals and address the assistance needs of States.

2. RECENT PROGRESS AND NEXT STEPS

2.1 Since the 37th Session of the Assembly, ICAO has made important progress on actions requested by the Assembly, focusing on four key areas: 1) States' action plans and assistance to States, 2) sustainable alternative fuels for aviation, 3) market-based measures, and 4) global aspirational goals, as described below, in order to move international aviation closer to a sustainable future.

States' Action Plans

2.2 ICAO has already adopted guidance material to assist States in the preparation of their action plans on CO_2 emissions reduction activities for international aviation. An interactive web-interface that serves as an electronic template was also developed to facilitate the submission of States' action plans to ICAO by June 2012.

2.3 In addition, ICAO organized 5 regional hands-on training workshops from May to July 2011, and over 200 focal points from States that represent more than 90 per cent of global international aviation traffic were trained. A final workshop will be held from 21 to 23 November 2011 in Montréal, to provide States with another opportunity to obtain training. In addition, States that have made progress in the development and implementation of their plans will showcase their activities and share their experience with other States.

2.4 ICAO will continue to provide its member States with necessary assistance for the preparation, submission and implementation of their action plans. The member States' action plans will enable ICAO to assess the progress in achieving the global aspirational goals of the international aviation sector, as well as identify the implementation barriers and assistance needs of States, towards the provision of technical and financial assistance to States.

Sustainable Alternative Fuels for Aviation

2.5 ICAO held the Workshop on Aviation and Sustainable Alternative Fuels in October 2011(www.icao.int/sustaf), providing a forum for the exchange of information on the state of worldwide activities on sustainable alternative fuels for aviation. On the use of such fuels, aviation is a real and concrete example of how much can be done, within a relatively short timeframe to turn a dream into reality. Today, the use of drop-in biofuels in aviation has become a reality as airlines have started using them in commercial flights. Technological aspects are proven to be viable; however, the use of biofuels is not yet sustainable, as the cost, scalability and distribution of biofuels still need to be further examined.

2.6 In this regard, the workshop also enhanced dialogue among stakeholders to support actions that secure aviation's access to renewable sources of energy in the context of sustainable development. This workshop formed part of ICAO's preparation for the United Nations Conference on Sustainable Development (UNCSD) to be held in June 2012 in Rio de Janeiro (also known as Rio+20 Conference). Mr. Sha Zukang, UN Under-Secretary-General for Economic and Social Affairs and Secretary-General of Rio+20, delivered the keynote address of the workshop, inviting ICAO to inform Rio+20 intergovernmental process of the progress on this subject.

2.7 The workshop clearly acknowledged that the development and deployment of alternative fuels for aviation contributes to all the three pillars of sustainable development: 1) they can have a positive effect on the environment by reducing net CO_2 emissions and improving local air quality; 2) the creation of an alternative fuels industry provides a new source of employment and further facilitates greener air travel, thereby delivering a positive contribution to society; and 3) alternative fuels can help to stabilize fuel price

volatility, while providing a source of economic development in non-traditionally fuel producing regions of the world. ICAO will continue to be at the forefront of international efforts to facilitate the development and deployment of such fuels on a global scale.

Market-based Measures / Global Aspirational Goals

2.8 The 37th Session of the ICAO Assembly agreed on the development of a framework for market-based measures (MBMs), including the elaboration of the guiding principles adopted by the Assembly, and decided to explore a global MBM scheme for international aviation. It also requested the Council to review the *de minimis* provision to MBMs. The Secretariat is coordinating the first phase of technical studies, focusing on the economic impacts of introducing the *de minimis* provision to MBMs. The study is expected to be completed by the end of 2011, and will serve as information for further discussion by the Council.

2.9 In November 2011, the Council adopted the Declaration, with support of a majority of the Council member States, urging the EU and its member States to refrain from the inclusion of international aviation operations to/from non-EU member States in the EU emissions trading system. In addition, the Council re-affirmed by consensus the important role of ICAO in addressing aviation emissions and agreed on the acceleration of its work on MBMs to reach the best global solutions.

Global Aspirational Goals

2.10 The 37th Session of the ICAO Assembly agreed to review the medium-term global aspirational goal adopted by the Assembly, and to explore a long-term global aspirational goal for international aviation. ICAO will compile and analyze information related to the feasibility of the medium-term goal, including relevant information to be included in States' action plans. The ongoing work of the Committee on Aviation Environmental Protection (CAEP) on the environmental trends assessment and the analysis on the implications of limiting the increase in global average temperature to less than 2˚C above pre-industrial levels for aviation, will also serve as information for consideration of the long-term goal by the Council.

3. LONG-TERM CLIMATE CHANGE FINANCE

3.1 The Cancun Agreements recognized that developed countries are committed to a goal of mobilizing USD 100 billion per year by 2020 to address the needs of developing countries, and agreed that funds may come from a wide variety of sources, including alternative sources. The Cancun Conference took note of the report of the High-level Advisory Group on Climate Change Financing (AGF), and decided to establish the Green Climate Fund which has been designed by the Transitional Committee (TC). One of the options presented in the AGF report relates to potential generation of revenue through the application of market-based measures to international aviation.

3.2 ICAO provided its submission to the TC, describing the possible political, legal and practical implications of the AGF report on ICAO's existing policies and practices, including Resolution A37-19[2]. It should be noted that the global aspirational goals for the international aviation sector, adopted by the 37th Session of the ICAO Assembly, will require adequate financial resources within the sector itself, enabling it to effectively respond to the global climate change challenge. The ICAO Assembly agreed on the guiding

[2] http://unfccc.int/cooperation_and_support/financial_mechanism/green_climate_fund/items/5868.php

principles for the design and implementation of market-based measures, and decided to explore a global scheme for international aviation.

3.3 It is of utmost importance that the design and implementation of market-based measures for international aviation be treated as an element of ICAO's comprehensive mitigation strategy to achieve the global aspirational goals, as part of global solutions for the sustainable development of international aviation, and not in isolation.

3.4 In addition, discussions on climate change need to strike a good balance among the three pillars of social, economic and environmental sustainability which, once applied to the international aviation sector, will allow this sector to grow in an environmentally sustainable manner and at the same time, will continue to ensure freedom to travel, access to mobility, facilitate poverty eradication and the exchange of cultural and educational experiences.

4. CONCLUSIONS

4.1 ICAO has been working actively towards developing global solutions to address GHG emissions from international aviation. The ICAO Assembly Resolution A37-19 is a clear demonstration of the willingness of ICAO and its member States to take concrete steps towards the sustainable development of international aviation.

4.2 ICAO sincerely expects the Durban Conference to deliver an agreement that acknowledges ICAO's achievements as the specialized agency for international aviation in the area of climate change, and encourages its member States to work further through ICAO.

APPENDIX

ICAO Assembly Resolution A37-19

Consolidated statement of continuing ICAO policies and practices related to environmental protection – climate change

Whereas ICAO and its member States recognize the critical importance of providing continuous leadership to international civil aviation in limiting or reducing its emissions that contribute to global climate change;

Reemphasizing the vital role which international aviation plays in global economic and social development and the need to ensure that international aviation continues to develop in a sustainable manner;

Whereas the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to achieve stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system;

Whereas the Kyoto Protocol, which was adopted by the Conference of the Parties to the UNFCCC in December 1997 and entered into force on 16 February 2005, calls for developed countries (Annex I Parties) to pursue limitation or reduction of greenhouse gases from "aviation bunker fuels" (international aviation) working through ICAO (Article 2.2);

Acknowledging that international aviation emissions, currently accounting for less than 2 per cent of total global CO_2 emissions, are projected to grow as a result of the continued development of the sector;

Whereas a comprehensive assessment of aviation's impact on the atmosphere is contained in the special report on *Aviation and the Global Atmosphere*, published in 1999, which was prepared at ICAO's request by the Intergovernmental Panel on Climate Change (IPCC) in collaboration with the Scientific Assessment Panel to the Montreal Protocol on Substances that Deplete the Ozone Layer;

Whereas the IPCC special report recognized that the effects of some types of aircraft emissions are well understood, it revealed that the effects of others are not, and identified a number of key areas of scientific uncertainty that limit the ability to project aviation's full impacts on climate and ozone;

Whereas ICAO requested that the IPCC include an update of the main findings of the special report in its Fourth Assessment Report, published in 2007 and its Fifth Assessment Report to be published in 2014;

Noting the scientific view that the increase in global average temperature above pre-industrial levels ought not to exceed 2°C;

Acknowledging the principles and provisions on common but differentiated responsibilities and respective capabilities, and with developed countries taking the lead under the UNFCCC and the Kyoto Protocol;

Also acknowledging the principles of non-discrimination and equal and fair opportunities to develop international aviation set forth in the Chicago Convention;

Recognizing that this Resolution does not set a precedent for or prejudge the outcome of negotiations under the UNFCCC and its Kyoto Protocol nor represent the position of the Parties to the UNFCCC and its Kyoto Protocol;

Noting that, consistent with Assembly Resolution A36-22, the High-level Meeting on International Aviation and Climate Change in October 2009 (HLM-ENV/09) endorsed the Programme of Action on International Aviation and Climate Change which included global aspirational goals in the form of fuel efficiency, a basket of measures and the means to measure progress;

Recognizing that the aspirational goal of 2 per cent annual fuel efficiency improvement is unlikely to deliver the level of reduction necessary to stabilize and then reduce aviation's absolute emissions contribution to climate change, and that goals of more ambition will need to be considered to deliver a sustainable path for aviation;

Noting that, to promote sustainable growth of aviation, a comprehensive approach, consisting of work on technology and standards, and on operational and market-based measures to reduce emissions is necessary;

Noting that the HLM-ENV/09 declared that ICAO would establish a process to develop a framework for market based measures in international aviation, taking into account the conclusions of the HLM-ENV/9 and outcome of the UNFCCC COP 15 and bearing in mind relevant ICAO Assembly resolutions and the appendices with a view to complete this process expeditiously;

Noting that the Conference on Aviation and Alternative Fuels in November 2009 (CAAF/09) endorsed the use of sustainable alternative fuels for aviation, particularly the use of drop-in fuels in the short to mid-term, as an important means of reducing aviation emissions;

Also noting that the CAAF/09 established an ICAO Global Framework for Aviation Alternative Fuels (GFAAF);

Recognizing the different circumstances among States in their capacity to respond to the challenges associated with climate change and the need to provide necessary support, in particular to developing countries and States having particular needs;

Affirming that specific measures to assist developing States as well as to facilitate access to financial support, technology transfer and capacity building should be initiated;

Whereas the Kyoto Protocol provides for different flexible instruments (such as the Clean Development Mechanism — CDM) which would benefit projects involving developing States;

Affirming that addressing GHG emissions from international aviation requires the active engagement and cooperation of States and the industry, and *noting* the collective commitments announced by Airports Council International (ACI), Civil Air Navigation Services Organisation (CANSO), International Air Transport Association (IATA), and International Coordinating Council of Aerospace Industries Associations (ICCAIA) on behalf of the international air transport industry to continuously improve CO_2 efficiency by an average of 1.5 per cent per annum from 2009 until 2020, to achieve carbon neutral growth from 2020 and reducing its carbon emissions by 50 per cent by 2050 compared to 2005 levels;

Recognizing the need to monitor and report the potential impacts of climate change on international aviation operations and related infrastructure;

Recognizing the progress made by ICAO in its implementation of the Climate Neutral UN initiative and the significant support provided by ICAO to the initiative, in particular through the development of a common methodology for calculating GHG emissions from air travel;

The Assembly:

1. *Resolves* that this Resolution, together with Resolution A37-18: Consolidated statement of continuing ICAO policies and practices related to environmental protection - General provisions, noise and local air quality, supersede Resolution A36-22 and constitute the consolidated statement of continuing ICAO policies and practices related to environmental protection;

2. *Requests* the Council to:

   a) ensure that ICAO exercise continuous leadership on environmental issues relating to international civil aviation, including GHG emissions;

   b) continue to study policy options to limit or reduce the environmental impact of aircraft engine emissions and to develop concrete proposals and provide advice as soon as possible to the Conference of the Parties of the UNFCCC, encompassing technical solutions and market-based measures, and taking into account potential implications of such measures for developing as well as developed countries; and

   c) continue to cooperate with organizations involved in policy-making in this field, notably with the Conference of the Parties to the UNFCCC;

3. *Reiterates* that:

   a) ICAO should continue to take initiatives to promote information on scientific understanding of aviation's impact and action undertaken to address aviation emissions and continue to provide the forum to facilitate discussions on solutions to address aviation emissions; and

   b) emphasis should be on those policy options that will reduce aircraft engine emissions without negatively impacting the growth of air transport especially in developing economies;

4. *Resolves* that States and relevant organizations will work through ICAO to achieve a global annual average fuel efficiency improvement of 2 per cent until 2020 and an aspirational global fuel efficiency improvement rate of 2 per cent per annum from 2021 to 2050, calculated on the basis of volume of fuel used per revenue tonne kilometre performed;

5. *Agrees* that the goals mentioned in paragraph 4 above would not attribute specific obligations to individual States, and the different circumstances, respective capabilities and contribution of developing and developed States to the concentration of aviation GHG emissions in the atmosphere will determine how each State may voluntarily contribute to achieving the global aspirational goals;

6. *Also resolves* that, without any attribution of specific obligations to individual States, ICAO and its member States with relevant organizations will work together to strive to achieve a collective medium term global aspirational goal of keeping the global net carbon emissions from international aviation from 2020 at the same level, taking into account:

a) the special circumstances and respective capabilities of developing countries;

b) that the different circumstances, respective capabilities and contribution of States to the concentration of aviation GHG emissions in the atmosphere will determine how each State may contribute to achieving the global aspirational goals;

c) that some States may take more ambitious actions prior to 2020, which may offset an increase in emissions from the growth of air transport in developing States;

d) the maturity of aviation markets;

e) the sustainable growth of the international aviation industry; and

f) that emissions may increase due to the expected growth in international air traffic until lower emitting technologies and fuels and other mitigating measures are developed and deployed;

7. *Agrees* to review, at its 38th Session, the goal mentioned in paragraph 6 above in light of progress towards the goal, new studies regarding the feasibility of achieving the goal, and relevant information from States;

8. *Requests* the Council to explore the feasibility of a long term global aspirational goal for international aviation, through conducting detailed studies assessing the attainability and impacts of any goals proposed, including the impact on growth as well as costs in all countries, especially developing countries, for the progress of the work to be presented to the 38th Session of the ICAO Assembly. Assessment of long term goals should include information from member States on their experiences working towards the medium term goal.

9. *Encourages* States to submit their action plans outlining their respective policies and actions, and annual reporting on international aviation CO_2 emissions to ICAO;

10. *Invites* those States that choose to prepare their action plans to submit them to ICAO as soon as possible preferably by the end of June 2012 in order that ICAO can compile the information in relation to achieving the global aspirational goals, and the action plans should include information on the basket of measures considered by States, reflecting their respective national capacities and circumstances, and information on any specific assistance needs;

11. *Requests* the Council to facilitate the dissemination of economic and technical studies and best practices related to aspirational goals and to provide guidance and other technical assistance for the preparation of States' action plans prior to the end of June 2012, in order for States to conduct their necessary studies and to voluntarily submit their action plans to ICAO;

12. *Resolves* that a *de minimis* threshold of international aviation activity of 1 per cent of total revenue ton kilometres should apply to the submission of States' action plans as follows:

a) States below the threshold are not expected to submit action plans towards achieving the global goals; and

b) States below the threshold but that otherwise have agreed to voluntarily contribute to achieving the global goals are expected to submit action plans;

13. *Requests* the Council, with the support of member States, to undertake work to develop a framework for market-based measures (MBMs) in international aviation, including further elaboration of the guiding principles listed in the Annex, for consideration by the 38th Session of the ICAO Assembly;

14. *Urges* States to respect the guiding principles listed in the Annex, when designing new and implementing existing MBMs for international aviation, and to engage in constructive bilateral and/or multilateral consultations and negotiations with other States to reach an agreement;

15. *Resolves* on a *de minimis* threshold of international aviation activity, consistent with the guiding principles in the Annex, of 1 per cent of total revenue ton kilometres to MBMs as follows:

a) commercial aircraft operators of States below the threshold should qualify for exemption for application of MBMs that are established on national, regional and global levels; and

b) States and regions implementing MBMs may wish to also consider an exemption for other small aircraft operators;

16. *Requests* the Council to review the *de minimis* threshold to MBMs in paragraph 15, taking into account specific circumstances of States and potential impacts on the aviation industry and markets, and with regard to the guiding principles listed in the Annex, by the end of 2011;

17. *Urges* States to review existing and planned MBMs for international aviation to ensure their consistency with the guiding principles listed in the Annex and the provisions in paragraphs 15 and 16 above;

18. *Requests* the Council, with the support of member States and international organizations, to continue to explore the feasibility of a global MBM scheme by undertaking further studies on the technical aspects, environmental benefits, economic impacts and the modalities of such a scheme, taking into account the outcome of the negotiations under the UNFCCC and other international developments, as appropriate, and report the progress for consideration by the 38th Session of the ICAO Assembly;

19. *Recognizes* that in the short term voluntary carbon offsetting schemes constitute a practical way to offset CO_2 emissions, and *invites* States to encourage their operators wishing to take early actions to use carbon offsetting, particularly through the use of credits generated from internationally recognized schemes such as the CDM;

20. *Requests* the Council to collect information on the volume of carbon offsets purchased in relation to air transport, and to continue to develop and disseminate best practices and tools, such as the ICAO Carbon Emissions Calculator, that will help harmonize the implementation of carbon offset programmes;

21. *Requests* the Council to regularly report CO_2 emissions from international aviation to the UNFCCC, as part of its contribution to assessing progress made in the implementation actions in the sector based on information approved by its member States;

22. *Requests* the Council to:

a) study, identify and develop processes and mechanisms to facilitate the provision of technical and financial assistance, as well as facilitate access to existing and new financial resources, technology transfer and capacity building, to developing countries and report on its progress, including processes and mechanisms developed, results achieved as well as further recommendations, preliminarily by the end of 2012 and at the 38th Session of the Assembly; and

b) initiate specific measures to assist developing States as well as to facilitate access to financial resources, technology transfer and capacity building;

23. *Requests* States to:

a) promote scientific research aimed at continuing to address the uncertainties identified in the IPCC special report on Aviation and the Global Atmosphere and in the Fourth Assessment report;

b) ensure that future international assessments of climate change undertaken by IPCC and other relevant United Nations bodies include updated information, if any, on aircraft-induced effects on the atmosphere;

c) accelerate investments on research and development to bring to market even more efficient technology by 2020;

d) accelerate the development and implementation of fuel efficient routings and procedures to reduce aviation emissions;

e) accelerate efforts to achieve environmental benefits through the application of satellite-based technologies that improve the efficiency of air navigation and work with ICAO to bring these benefits to all regions and States;

f) reduce legal, security, economic and other institutional barriers to enable implementation of the new ATM operating concepts for the environmentally efficient use of airspace;

g) develop policy actions to accelerate the appropriate development, deployment and use of sustainable alternative fuels for aviation;

h) work together through ICAO and other relevant international bodies, to exchange information and best practices; and

i) consider measures to support sustainable aviation alternative fuels research and development, investments in new feedstock cultivations and production facilities, as well as incentives to stimulate commercialisation and use of sustainable alternative fuels for aviation to accelerate the reduction of aviation CO_2 emissions;

24. *Requests* the Council to:

a) continue to develop and keep up-to-date the guidance for member States on the application of policies and measures aimed at reducing or limiting the environmental impact of emissions from aviation, and conduct further studies with respect to mitigating the impact of aviation on climate change;

b) encourage States to cooperate in the development of predictive analytical models for the assessment of aviation impacts;

c) continue evaluating the costs and benefits of the various measures, including existing measures, with the goal of addressing aircraft engine emissions in the most cost-effective manner, taking into account the interests of all parties concerned, including potential impacts on developing world;

d) provide the necessary guidance and direction to ICAO's Regional Offices to assist member States with studies, evaluations and development of procedures, in collaboration with other States in the region, to limit or reduce GHG emissions on a global basis and work together collaboratively to optimize the environmental benefits that can be achieved through their various programmes;

e) develop a global CO_2 Standard for aircraft aiming for 2013;

f) further elaborate on relevant fuel efficiency metrics, including for international business aviation, and develop medium and long term technological and operational goals for aircraft fuel burn;

g) encourage member States and invite industry to actively participate in further work on sustainable alternative fuels for aviation;

h) work with financial institutions to facilitate access to financing infrastructure development projects dedicated to sustainable aviation alternative fuels and incentives to overcome initial market hurdles;

i) continue to develop the necessary tools to assess the benefits associated with ATM improvements, and intensify its efforts on the development of new guidance on operational measures to reduce international aviation emissions;

j) implement an emphasis on increasing fuel efficiency in all aspects of the ICAO's Global Air Navigation Plan, and encourage States and stakeholders to develop air traffic management that optimize environmental benefits and to promote and share best practices applied at airports in reducing the adverse effects of GHG emissions of civil aviation;

k) identify appropriate standard methodologies and a mechanism to measure/estimate, monitor and verify global GHG emissions from international aviation, and States support the work of ICAO on measuring progress through the reporting of annual data on traffic and fuel consumption;

l) request States to continue to support the efforts of ICAO on enhancing the reliability of measuring/estimating global GHG emissions from international aviation;

m) undertake a study on the possible application of CDM of the Kyoto Protocol to international aviation;

n) monitor and disseminate relevant information on the potential impacts of climate change on international aviation operations and related infrastructure, in cooperation with other relevant international organizations and the industry; and

o) continue to cooperate with the Climate Neutral UN initiative, remain at the forefront of developing methods and tools for quantifying aviation's GHG emissions with respect to the initiative, and further develop and implement the strategy for reducing GHG emissions and enhancing in-house sustainability management practices of the Organization.

Annex

The guiding principles for the design and implementation of market-based measures (MBMs) for international aviation:

a) MBMs should support sustainable development of the international aviation sector;

b) MBMs should support the mitigation of GHG emissions from international aviation;

c) MBMs should contribute towards achieving global aspirational goals;

d) MBMs should be transparent and administratively simple;

e) MBMs should be cost-effective;

f) MBMs should not be duplicative and international aviation CO_2 emissions should be accounted for only once;

g) MBMs should minimize carbon leakage and market distortions;

h) MBMs should ensure the fair treatment of the international aviation sector in relation to other sectors;

i) MBMs should recognize past and future achievements and investments in aviation fuel efficiency and in other measures to reduce aviation emissions;

j) MBMs should not impose inappropriate economic burden on international aviation;

k) MBMs should facilitate appropriate access to all carbon markets;

l) MBMs should be assessed in relation to various measures on the basis of performance measured in terms of CO_2 emissions reductions or avoidance, where appropriate;

m) MBMs should include *de minimis* provisions;

n) where revenues are generated from MBMs, it is strongly recommended that they should be applied in the first instance to mitigating the environmental impact of aircraft engine emissions, including mitigation and adaptation, as well as assistance to and support for developing States; and

o) where emissions reductions are achieved through MBMs, they should be identified in States' emissions reporting.

Paper no. 2A: International Maritime Organization

Note by the International Maritime Organization to the thirty-fifth session of the Subsidiary Body for Scientific and Technical Advice (SBSTA 35)

Agenda item 9(a) - Emissions from fuel used for international aviation and maritime transport

Breakthrough at IMO

The first ever legally binding and global CO_2 standard agreed for an industry sector

September 2011

SUMMARY

Mandatory measures to reduce GHG emissions from international shipping were adopted by Parties to MARPOL Annex VI represented in the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO), when it met for its 62nd session from 11 to 15 July 2011 in London, representing the first ever mandatory global greenhouse gas reduction regime for an international industry sector.

The amendments to MARPOL Annex VI - *Regulations for the prevention of air pollution from ships,* add a new chapter 4 to Annex VI *on Regulations on energy efficiency for ships* to make mandatory the Energy Efficiency Design Index (EEDI) for new ships, and the Ship Energy Efficiency Management Plan (SEEMP) for all ships. Other amendments to Annex VI add new definitions and the requirements for survey and certification, including the format for the International Energy Efficiency Certificate. The regulations apply to all ships of 400 gross tonnage and above and are expected to enter into force internationally through the tacit acceptance procedure on 1 January 2013.

Introduction

1 Work on the prevention of air pollution and control of greenhouse gas (GHG) emissions from ships started within the International Maritime Organization (IMO) in the late 1980s. The first regulatory steps were the phasing out of ozone depleting substances both as refrigerant gases and in fire-fighting systems. Later, prevention of air pollution in the form of oil cargo vapours and exhaust gases were targeted by, *inter alia*, adopting limits for nitrogen oxides and sulphur oxides in ships' exhaust gases. In recent years, the focus has been on control of GHG emissions from ships engaged in international trade.

2 Due to its close connection to global commerce, international shipping plays a vital role in the facilitation of world trade as the most cost-effective and energy-efficient mode of bulk transport, making a significant contribution to global prosperity in both developing and developed countries. Shipping is probably also the most international of all the world's industries and the global character of the industry requires global regulations that apply universally to all ships. IMO, as the United Nation's specialized agency responsible for the regulation of all facets pertaining to international shipping, has a key role in ensuring that lives at sea are not put at risk and that the environment is not polluted by ships' operations – as summed up in IMO's mission statement: **Safe, Secure and Efficient Shipping on Clean Oceans**.

3 As shipping is a global industry and ships are competing in a single global market, it must be regulated at the global level for any control regime to be environmentally effective (avoid carbon leakage) and to maintain a level playing field for all ships irrespective of flag (nationality) or ownership. IMO's vision is to eliminate all adverse environmental impact from ships by developing robust and effective regulations that apply universally to all ships.

Work on control of GHG emissions from international shipping

4 IMO's Assembly resolution A.963(23) on IMO Policies and Practices Related to the Reduction of Greenhouse Gas Emissions from Ships urges the Organization's Marine Environment Protection Committee (MEPC) to identify and develop the mechanisms needed to achieve limitation or reduction of GHG emissions from international shipping.

5 In this regard, although international maritime transport is the most energy efficient mode of bulk transport and only a modest contributor to global CO_2 emissions (2.7% in 2007) while carrying 90% of world trade, a global approach for further improvements in energy efficiency and emission reductions was seen as being necessary given that sea transport is predicted to continue growing significantly in line with world trade.

Outcome of MEPC 62 – adoption of mandatory CO_2 regulations

6 As reported to SBSTA 33 (FCCC/SBSTA/2010/MISC.14), MEPC 62 in July 2011 continued its consideration of making the already developed draft technical and operational measures mandatory by adding a new chapter on energy efficiency to MARPOL Annex VI – Regulations on the prevention of air pollution from ships. MEPC 62 was held at IMO's Headquarters in London with record attendance and a record number of submitted documents. Very good momentum had been generated in the lead up to the session, during which parties involved in informal talks had showed great willingness to work out a compromise regulatory text that could be accepted by all and be adopted by consensus.

7 A large number of delegations supported a compromise proposal by Singapore (MEPC 62/6/21) and expressed interest in further consideration of how it could be incorporated in the draft regulatory text. Noting that an informal group convened by the MEPC Chairman was holding consultations with a view to seeking consensus among Member States on the proposed energy efficiency regulations, the Committee agreed that the proposal by Singapore provided scope for a compromise agreement as it contained elements around which a consensus could be built.

8 Having held extensive informal negotiations, the Chairman was able to present to plenary, a compromise text on a new chapter on energy efficiency to be added to MARPOL Annex VI. The fruitful negotiations leading to a compromise text clearly indicated the Parties' willingness to find workable solutions and to respond to the urgent need for all industries, including international shipping, to contribute to the concerted worldwide effort to stem climate change.

9 Recognizing that capacity building and technical assistance to administrations without the required human and financial resources are essential elements for any new regulations to be effectively implemented and enforced in the world fleet of merchant vessels, the new chapter includes a regulation on *Promotion of technical co-operation and transfer of technology relating to the improvement of energy efficiency of ships.* This requires Administrations, in co-operation with IMO and other international bodies, to promote and provide, as appropriate, support directly or through IMO to States, especially developing States, that request technical assistance. It also requires the Administration of a Party to co-operate 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, which request technical assistance, particularly developing States, in respect of the implementation of measures to fulfil the new energy efficiency requirements.

10 All delegations that intervened in the ensuing plenary debate expressed their admiration for the Chairman's strenuous efforts to bring all Members together and produce a text on the basis of which consensus might be reached. In this respect, while some delegations considered that additional amendments and clarifications were required before adoption of the proposed text could be further considered, other delegations were of the view that the text presented by the Chairman was the most delicate of compromises and should be considered as the final text for adoption.

11 The Secretary-General congratulated the Chairman and delegations for their hard work and statesmanlike attitude in drafting the compromise text. Recalling his opening remarks to MEPC 62 appealing to all Members to compromise, and noting that every word, phrase, sentence and paragraph of the proposed text had been carefully crafted on the basis of concessions made by all engaged in the consultations, he commended the text to the Committee as it represented a well-balanced outcome that was workable in today's shipping reality and which also preserved the universality of IMO's regulations and the unity of its membership.

12 In turn, the Chairman thanked the Committee for its trust in his leadership on the issue and highlighted that the text on capacity-building had been based on corresponding regulatory text existing in other IMO conventions, which had, nevertheless, been improved and strengthened, while the text on application had been based on the proposal of Singapore but without the wording on denial of port entry. He, therefore, also commended the text and invited the Committee to adopt it.

13 The majority of delegations that responded to the Chairman's invitation supported adoption. However, one delegation requested that a vote be held on adoption of the aforementioned draft amendments while another delegation requested that the vote be undertaken by a roll-call. As 59 of the 64 Parties to MARPOL Annex VI were present and eligible to vote, the outcome of the roll call vote was as follows:

Yes: 49 Parties

No: 5 Parties

Abstain: 2 Parties

Not present in the room: 3 Parties

14 As a result of the roll call vote, mandatory measures to reduce GHG emissions from international shipping were adopted by Parties to MARPOL Annex VI, representing the first ever legally binding global greenhouse gas reduction regime for an international industry sector. It is understood that these amendments also constitute the first international climate change treaty provisions to be formally adopted since the Kyoto Protocol in 1997.

15 From the outcome of the vote it may be worth noting that the yes-voting countries represent some 79% of the world's merchant shipping tonnage, be that tonnage flagged in developing or developed countries. Moreover, in illustration of the universality of the regulatory measures now introduced into MARPOL Annex VI, the yes-voting countries represent all regions of the world – both exporters and importers, as well as the largest flag States, most of the large ship building nations and many of the countries that are most likely to suffer first from the effects of climate change. Perhaps most importantly, the yes-voting countries represent about 75% of CO_2 emissions from international shipping which, therefore, augurs well for the environmental effectiveness of the new IMO treaty obligations.

16 The amendments to MARPOL Annex VI (*Regulations for the prevention of air pollution from ships*), add a new chapter 4 *on Regulations on energy efficiency for ships* to make mandatory the Energy Efficiency Design Index (EEDI) for new ships, and the Ship Energy Efficiency Management Plan (SEEMP) for all ships. Other amendments add new definitions and requirements for survey and certification, including the format for the new International Energy Efficiency Certificate. The new regulations apply to all merchant ships of 400 gross tonnage and above, regardless of the national flag they fly or the nationality of the owner, and are expected to enter into force globally on 1 January 2013. However, an Administration that considers that its industry needs more time to comply may waive the requirement for new ships to comply with the EEDI for up to four years.

17 Commenting on the outcome of MEPC 62, IMO Secretary-General Efthimios E. Mitropoulos expressed satisfaction at the many and various significant achievements with which the session should be credited. "Although not by consensus – which of course would be the ideal outcome – the Committee has now adopted amendments to MARPOL Annex VI introducing mandatory technical and operational measures for the energy efficiency of ships. Let us hope that the work to follow on these issues will enable all Members to join in, so that the service to the environment the measures aimed at, will be complete" he said.

18 In this context, MEPC 62 also agreed a work plan to continue the work on energy efficiency measures for ships, to include the development of the EEDI framework for ship types and sizes,

and propulsion systems, not covered by the current EEDI requirements and the development of EEDI and SEEMP-related guidelines. To this end, an intersessional working group meeting on energy efficiency measures for ships is scheduled to take place in January 2012.

Market-based measures

19 Adoption of mandatory technical and operational measures is a very important step in ensuring that the global shipping industry has the necessary mechanisms to reduce its GHG emissions. However, the MEPC has, at several sessions, recognized that these measures would not be sufficient to satisfactorily reduce the amount of GHG emissions from international shipping in view of the growth projections of world trade. Therefore, market-based mechanisms (MBMs) are also being considered by the Committee in line with IMO Assembly resolution A963(23) and its GHG work plan.

20 A market-based mechanism would serve two main purposes:

.1 providing an economic incentive for the maritime industry to invest in more fuel-efficient ships and technologies, and to operate ships in a more energy-efficient manner (in sector reductions); and

.2 off-setting in other sectors of growing ship emissions (out of sector reduction).

21 The MBM proposals under review range from contribution schemes for all CO_2 emissions from international shipping (to be collected by fuel oil suppliers and transferred to a global fund), or only emissions from ships not meeting the EEDI requirement, via emission trading systems, to schemes based on a ship's actual efficiency both by design and operation. Among the measures, there are also proposals for rebate mechanisms and other ways to accommodate the difference in the socio-economic capabilities of developing and developed States, as well as other suggestions on how the special needs and circumstances of developing countries can be accommodated.

22 Some of the proposed schemes would reward efficient ships and ship operators by recycling parts of the financial contribution to the most efficient ones based on benchmarking. Other schemes would drive investments in more energy efficient technologies and improvements in operations by setting compulsory efficiency standards for all vessels (new and existing) and the trading of efficiency credits. Several of the proposed mechanisms - the contributions schemes (levy) inherently and the trading schemes through auctioning - would generate funds, the greater part of which the MEPC has considered should be used for climate change purposes in developing countries.

Conclusions

23 Being fully aware of the ultimate objective of the UNFCCC, which is to achieve stabilization of greenhouse gas concentrations at a level that prevents dangerous interference in the global climate system, IMO has sought a solution whereby a GHG control regime for international shipping, once enacted, will deliver real emission reductions and, at the same time, will contribute financially towards the wider efforts in combating climate change in developing countries.

24 The adoption by IMO of mandatory reduction measures for all new ships built from 2013 onwards will lead to significant emission reductions. By 2020, up to 50 million tonnes of CO_2 reductions are envisaged from the introduction of the EEDI for new ships, a figure that, by 2030,

will increase to 240 million tonnes of CO_2 annually. In addition, a 20% improvement in energy efficiency by 2020, on a tonne mile basis, is envisaged from introduction of the operational measures (the SEEMP).

25 Further work is needed on market-based measures but the foundations have already been developed and will facilitate the finalization of a robust, comprehensive and efficient GHG regime, complementing IMO's regime of 51 international treaties regulating all non-commercial aspects of shipping.

26 IMO will thus continue its endeavours to reduce any environmental impacts from international shipping, a transport industry that is vital to world trade, economic growth and sustainable development – an industry and its global regulator which have, with the adoption of the MARPOL Annex VI energy efficiency regulations, demonstrated their commitment to contribute substantively and substantially to worldwide efforts to stem climate change, and their determination to pursue further GHG-reduction measures.

27 It is for the strong reasons outlined above, that IMO participates in COP 17/CMP 7 and SBSTA 35 expecting that, as the Kyoto Conference did fourteen years ago, the global community will continue to place its confidence on the Organization for an effective contribution, from the shipping point of view, to the objectives this Conference pursues. IMO will spare no effort to do its duty in pursuing the mandate of its Assembly and Marine Environment Protection Committee and within any target or timeframe the present Conference may decide.

Paper no. 2B: International Maritime Organization

Note by the International Maritime Organization to the thirty-fifth session of the Subsidiary Body for Scientific and Technical Advice (SBSTA 35)

Agenda item 9(a) - Emissions from fuel used for international aviation and maritime transport

Technical and operational measures to improve the energy efficiency of international shipping and assessment of their effect on future emissions

November 2011

SUMMARY

July 2011 was marked by a breakthrough at IMO with the adoption of the first ever global and legally binding climate deal for an industry sector. IMO adopted a new chapter to Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL) that includes a package of mandatory technical and operational measures to reduce GHG emissions from international shipping, with the aim of improving the energy efficiency for ships through improved design and propulsion techniques, as well as through improved operational practices. These measures are expected to enter into force on 1 January 2013.

This document by the IMO Secretariat provides detailed information on the specific technical and operational energy efficiency measures adopted, the Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP). Background information by the IMO Secretariat on the development of regulatory measures and associated technical policy and legal considerations related to control of greenhouse gas emissions from international shipping can be found in a separate complementary document.

In October 2011 IMO completed a study to estimate the CO_2 emission reductions resulting from the adoption of mandatory technical and operational energy efficiency measures for international shipping. A summary of the results from the study is also provided.

INTRODUCTION

1 International shipping is the most environmentally-friendly and energy efficient mode of mass transport and only a modest contributor to the total volume of atmospheric emissions while moving a considerable part of world trade (90%). Nevertheless, a global approach for further improvements in energy efficiency and emission reduction is needed as sea transport is predicted to continue growing significantly in line with world trade.

2 The International Maritime Organization (IMO), as the UN's Specialized Agency responsible for the global regulation of all facets pertaining to international shipping, has a key role in ensuring that the environment is not polluted by ships – as summed up in IMO's mission statement: **Safe, Secure and Efficient Shipping on Clean Oceans**.

TECHNICAL AND OPERATIONAL ENERGY EFFICIENCY MEASURES FOR SHIPS

3 In recent years, discussions at IMO have resulted in the development of technical and operational measures for ships, the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP), respectively, that have the broad and emphatic support of Governments, industry associations and organizations representing civil society interests. All are united in the same purpose: to ensure that the EEDI and SEEMP deliver environmental effectiveness by generating, through enhanced energy efficiency measures, significant reductions in GHG emissions from international shipping.

4 Numerous stakeholders – policy-makers, shipowners, naval architects, class societies, etc. – are contributing to this endeavour, providing technical and other input to the debate, leading to the development of an instrument that is eminently suited for its intended purpose.

5 In October 2011 IMO completed a study to estimate the CO_2 emission reductions resulting from the adoption of mandatory technical and operational energy efficiency measures. The Executive Summary for the study is given at annex. The study indicates that by 2020, about 150 million tonnes of annual CO_2 reductions are estimated from the introduction of the EEDI for new ships and the SEEMP for all ships in operation, a figure that, by 2030, will increase to 330 million tonnes of CO_2 annually. In other words, the average reduction will, in 2020, be approximately 14% and, by 2030, approximately 23%, when compared with business as usual. The reduction measures will also result in a significant saving in fuel costs to the shipping industry, although these savings require deeper investments in more efficient ships and more sophisticated technologies than the business as usual scenario. The annual fuel cost saving estimate gives a staggering average figure of US$50 billion by 2020, and an even more astonishing US$200 billion by 2030.

MANDATORY REGULATIONS ON ENERGY EFFICIENCY FOR SHIPS

6 Amendments to MARPOL Annex VI were adopted during MEPC 62 in July 2011 (resolution MEPC. 203(62)), adding a new chapter 4 to Annex VI on *Regulations on energy efficiency for ships* to make mandatory the EEDI for new ships, and the SEEMP for all ships. The regulations apply to all ships of 400 gross tonnage and above and are expected to enter into force on 1 January 2013. However, under regulation 19, an Administration may waive the requirement for new ships of 400 gross tonnage and above from complying with the EEDI requirements. This waiver may not be

applied to ships above 400 gross tonnage for which the building contract is placed four years after the entry into force date of chapter 4. The amendments to MARPOL Annex VI represent the first ever mandatory global GHG regime for an international industry sector or transport mode.

IMO'S ENERGY EFFICIENCY DESIGN INDEX

7 Shipping is permanently engaged in efforts to optimize fuel consumption, e.g., through the development of more efficient engines and propulsion systems, optimized hull designs and larger ships, and thereby achieve a noteworthy reduction in fuel consumption and resulting CO_2 emissions on a capacity basis (tonne-mile). Although ships are the most fuel efficient mode of mass transport, the Second IMO GHG Study 2009 identified a significant potential for further improvements in energy efficiency mainly by the use of already existing technologies. Additional improvements in hull, engine and propeller designs, together with reduction in operational speed, may lead to considerable reductions as illustrated in Table 1.

Table 1: Potential reductions of CO_2 emissions by using existing technology and practices (Source: Second IMO GHG Study 2009)

<table>
<tr><th>DESIGN (New ships)</th><th>Saving of CO_2/tonne-mile</th><th>Combined</th><th>Combined</th></tr>
<tr><td>Concept, speed and capability</td><td>2% to 50%$^{+}$</td><td rowspan="6">10% to 50%$^{+}$</td><td rowspan="10">25% to 75%$^{+}$</td></tr>
<tr><td>Hull and superstructure</td><td>2% to 20%</td></tr>
<tr><td>Power and propulsion systems</td><td>5% to 15%</td></tr>
<tr><td>Low-carbon fuels</td><td>5% to 15%*</td></tr>
<tr><td>Renewable energy</td><td>1% to 10%</td></tr>
<tr><td>Exhaust gas CO_2 reduction</td><td>0%</td></tr>
<tr><td>OPERATION (All ships)</td><td colspan="2"></td></tr>
<tr><td>Fleet management, logistics and incentives</td><td>5% to 50%$^{+}$</td><td rowspan="3">10% to 50%$^{+}$</td></tr>
<tr><td>Voyage optimization</td><td>1% to 10%</td></tr>
<tr><td>Energy management</td><td>1% to 10%</td></tr>
</table>

$^{+}$ Reductions at this level would require reductions of operational speed.

* CO_2 equivalent, based on the use of Liquefied Natural Gas (LNG).

8 The EEDI addresses improvements in energy efficiency by requiring a minimum energy efficiency level for new ships; by stimulating continued technical development of all the components influencing the fuel efficiency of a ship; and by separating the technical and design-based measures from the operational and commercial ones. It is already being used to enable a comparison to be made of the energy efficiency of individual ships with similar ships of the same size that could have undertaken the same transport work (i.e. moved the same cargo).

Applicability

9 The EEDI formula – as presently drafted – is not supposed to be applicable to all ships. Indeed, it is explicitly recognized that it is not suitable for all ship types (particularly those not designed to transport cargo) or for all types of propulsion systems (e.g., ships with diesel-electric, turbine or hybrid propulsion systems will need additional correction factors).

10 Indeed, the first iteration of the EEDI has been purposefully developed for the largest and most energy intensive segments of the world merchant fleet, thus embracing 70% of emissions from new ships and covering the following ship types: oil and gas tankers, bulk carriers, general

cargo ships, refrigerated cargo carriers and container ships. For ship types not covered by the current formula, suitable formulae will be developed in due course to address the largest emitters first. IMO's MEPC (Marine Environment Protection Committee) is poised to consider the matter in detail at future sessions, with a view to adopting further iterations of the EEDI.

Purpose of the EEDI

11 The Energy Efficiency Design Index for new ships creates a strong incentive for further improvements in ships' fuel consumption. The purpose of IMO's EEDI is:

.1 to require a minimum energy efficiency level for new ships;

.2 to stimulate continued technical development of all the components influencing the fuel efficiency of a ship;

.3 to separate the technical and design based measures from the operational and commercial measures (they will/may be addressed in other instruments); and

.4 to enable a comparison of the energy efficiency of individual ships to similar ships of the same size which could have undertaken the same transport work (move the same cargo).

12 The EEDI establishes a minimum energy efficiency requirement for new ships depending on ship type and size and is a robust mechanism to increase the energy efficiency of ships step-wise for many decades to come. The EEDI 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 would be free to use the most cost-efficient solutions for the ship to comply with the regulations. The reduction level in the first phase is set to 10% and will be tightened every five years to keep pace with technological developments of new efficiency and reduction measures. IMO has set reduction rates up to 2025 from when a 30% reduction is mandated for most ship types calculated from a reference line representing the average efficiency for ships built between 1999 and 2009 (Table 2).

Table 2: Reduction factors (in percentage) for the EEDI relative to the EEDI Reference line

Ship Type	Size	Phase 0 1 Jan 2013 – 31 Dec 2014	Phase 1 1 Jan 2015 – 31 Dec 2019	Phase 2 1 Jan 2020 – 31 Dec 2024	Phase 3 1 Jan 2025 and onwards
Bulk Carrier	20,000 DWT and above	0	10	20	30
	10,000 – 20,000 DWT	n/a	0-10*	0-20*	0-30*
Gas carrier	10,000 DWT and above	0	10	20	30
	2,000 – 10,000 DWT	n/a	0-10*	0-20*	0-30*
Tanker	20,000 DWT and above	0	10	20	30
	4,000 – 20,000 DWT	n/a	0-10*	0-20*	0-30*
Container ship	15,000 DWT and above	0	10	20	30
	10,000 – 15,000 DWT	n/a	0-10*	0-20*	0-30*
General Cargo ships	15,000 DWT and above	0	10	15	30
	3,000 – 15,000 DWT	n/a	0-10*	0-15*	0-30*
Refrigerated cargo carrier	5,000 DWT and above	0	10	15	30
	3,000 – 5,000 DWT	n/a	0-10*	0-15*	0-30*
Combination carrier	20,000 DWT and above	0	10	20	30
	4,000 – 20,000 DWT	n/a	0-10*	0-20*	0-30*

* Reduction factor to be linearly interpolated between the two values dependent upon vessel size. The lower value of the reduction factor is to be applied to the smaller ship size.

n/a means that no required EEDI applies.

Implementation

13 The following circulars were issued (17 August 2009) following MEPC 59 and may be found on the IMO website: www.imo.org:

.1 the EEDI formula was circulated as MEPC.1/Circ.681, Interim Guidelines on the method of calculation of the Energy Efficiency Design Index for new ships (annex 17 to MEPC 59/24);

.2 the EEDI verification procedure was circulated as MEPC.1/Circ.682, Interim guidelines for voluntary verification of the EEDI (annex 18 to MEPC 59/24);

.3 the SEEMP was circulated as MEPC.1/Circ.683, Guidance for the development of a SEEMP (annex 19 to MEPC 59/24); and

.4 the Energy Efficiency Operational Indicator (EEOI) was circulated as MEPC.1/Circ.684, Guidelines for voluntary use of the ship EEOI (annex 20 to MEPC 59/24).

EEDI coverage

14 The EEDI is developed for the largest and most energy intensive segments of the world merchant fleet and will embrace 70% of emissions from the applicable new ships.

The EEDI formula

15 The EEDI provides a specific figure for an individual ship design, expressed in grams of CO_2 per ship's capacity-mile (a smaller EEDI value means a more energy efficient ship design) and calculated by the following formula based on the technical design parameters for a given ship:

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}\right) + \left(\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_w}$$

That can be illustrated by the following simplified formula:

$$EEDI = \frac{CO_2 \ emission}{transport \ work}$$

16 The CO_2 emission represents total CO_2 emission from combustion of fuel, including propulsion and auxiliary engines and boilers, taking into account the carbon content of the fuels in question. If shaft generators or innovative mechanical or electrical energy efficient technologies are incorporated on board a ship, these effects are deducted from the total CO_2 emission. The energy saved by the use of wind or solar energy will also is deducted from the total CO_2 emissions, based on actual efficiency of the systems. For technologies for EEDI reduction please refer to Table 3.

Table 3: Technologies for EEDI reduction

No.	EEDI reduction measure	Remark
1	Optimised hull dimensions and form	Ship design for efficiency via choice of main dimensions (port and canal restrictions) and hull forms.
2	Lightweight construction	New lightweight ship construction material.
3	Hull coating	Use of advanced hull coatings/paints.
4	Hull air lubrication system	Air cavity via injection of air under/around the hull to reduce wet surface and thereby ship resistance.
5	Optimisation of propeller-hull interface and flow devices	Propeller-hull-rudder design optimisation plus relevant changes to ship's aft body.
6	Contra-rotating propeller	Two propellers in series; rotating at different direction.

7	Engine efficiency improvement	De-rating, long-stroke, electronic injection, variable geometry turbocharging, etc.
8	Waste heat recovery	Main and auxiliary engines' exhaust gas waste heat recovery and conversion to electric power.
9	Gas fuelled (LNG)	Natural gas fuel and dual fuel engines.
10	Hybrid electric power and propulsion concepts	For some ships, the use of electric or hybrid would be more efficient.
11	Reducing on-board power demand (auxiliary system and hotel loads).	Maximum heat recovery and minimising required electrical loads flexible power solutions and power management.
12	Variable speed drive for pumps, fans, etc.	Use of variable speed electric motors for control of rotating flow machinery leads to significant reduction in their energy use.
13	Wind power (sail, wind engine, etc.)	Sails, fletnner rotor, kites, etc. These are considered as emerging technologies.
14	Solar power	Solar photovoltaic cells.
15	Design speed reduction (new builds)	Reducing design speed via choice of lower power or de-rated engines.

17 The transport work is calculated by multiplying the ship's capacity as designed with the ship's design speed measured at the maximum design load condition and at 75% of the rated installed shaft power. Speed is the most essential factor in the formula and may be reduced to achieve the required index.

Safe Speed

18 The need for a minimum speed to be incorporated into the EEDI formula has been duly acknowledged by the MEPC and, to that end, regulation 21.5 states that "For each ship to which this regulation applies, the installed propulsion power shall not be less than the propulsion power needed to maintain the manoeuvrability of the ship under adverse conditions, as defined in the guidelines to be developed by the Organization."

19 It should, therefore, be clear that IMO fully supports the view that a minimum installed power to maintain safe navigation in adverse weather conditions is of critical importance to ensure both the safety and efficiency of international shipping. While the EEDI instrument therefore contains the standard to be achieved on this matter, implementation of that standard will be enabled through guidelines that are also to be adopted. With technical input from all concerned parties, these guidelines will be further developed. A draft set of such guidelines will be considered for adoption by the MEPC in March 2012.

Installed Power

20 Although the easiest way to improve a ship's fuel efficiency is, indeed, to reduce speed – hence the move to slow steaming by a significant number of ships – there is a practical minimum at which fuel efficiency will decrease as a ship is slowed down further. There are other ways to improve fuel efficiency, such as waste heat generators, which do not impact on speed (they impact on auxiliary engines). Indeed, improvements in road transport efficiency have been made through advances in technology that have, however, not led to a sacrifice in speed; rather, quite the opposite.

21 It has been (wrongly) argued that the EEDI limits installed power and so induces owners to use small-bore high-rpm engines, thereby increasing fuel consumption. However, a reduction of installed power does not require a reduction in engine bore and increasing rpm. The easiest way to reduce power would be to "de-rate" the exact same engine by limiting the "maximum" rpm (remember, horsepower = torque multiplied by rpm). This would have the impact of increasing propeller efficiency (if the exact same propeller is installed), as propeller efficiency will generally improve as rpm decreases. Another practical way to reduce installed horsepower is to install an engine with one cylinder fewer. This would have no impact on specific fuel consumption or rpm. Such engines can be identified by reference to the catalogues of major engine manufacturers.

22 Of course, there are "economies of scale" in ships' fuel efficiency. The larger the ship is (at a given speed), the lower the fuel consumption per unit of cargo. However, such economies of scale are limited by trade considerations, physical port limitations (generally, draft) or cargo logistics issues. Therefore, ships tend to be designed to be as large as practical for a given trade.

Status of the EEDI

23 As stated in paragraph 13 (Implementation), the EEDI was circulated in August 2009 for trial purposes to ensure its feasibility and for further improvement of the calculation method. The regulatory text introducing the EEDI as a mandatory measure for all new ships under MARPOL Annex VI was adopted by Parties to MARPOL Annex VI in July 2011. The amendments to MARPOL Annex VI are expected to enter into force on 1 January 2013.

Future developments

24 The EEDI formula is not applicable to all ship types e.g., Ro-Ro ships, or all types of propulsion systems, e.g., ships with diesel-electric, turbine or hybrid propulsion systems will need additional correction factors, and MEPC will consider the matter in detail at future sessions.

Conclusions EEDI

25 The EEDI establishes a minimum energy efficiency requirement for new ships depending on ship type and size and is a robust mechanism that may be used to increase the energy efficiency of ships stepwise to keep pace with technical developments for many decades to come. The EEDI is a non-prescriptive mechanism that leaves the choice of what technologies to use in a ship design to the stakeholders as long as the required energy efficiency level is attained enabling the most cost-efficient solutions to be used.

26 Introduction of the EEDI as a mandatory measure for all ships will mean, provided it enters into force as expected on 1 January 2013; that between 31 and 42 million tonnes of CO_2 will be removed from the atmosphere annually by 2020 compared with business as usual depending on the growth in world trade. For 2030, the reduction will be between 155 and 224 million tonnes annually from the introduction of the EEDI. By 2050, the estimated annual reductions are 603 and 995 million tonnes of CO2 respectively.

Verification of the EEDI

27 Regulation 20 of the regulatory text requires the attained EEDI for a new ship to be verified. Guidelines on verification of the EEDI are to be considered for adoption at MEPC in March 2012 to assist verifiers (ship surveyors) of the EEDI in conducting the verification in a uniform manner. The

guidelines will also assist shipowners, shipbuilders as well as engine and equipment manufacturers, and other interested parties, in understanding the procedures of EEDI verification.

Verification in two stages

28 The attained EEDI should be calculated in accordance with the EEDI calculation Guidelines. EEDI verification should be conducted on two stages: preliminary verification at the design stage, and final verification at the sea trial, before issuance of the final report on the verification of the attained EEDI. The basic flow of the verification process is presented in Figure 1.

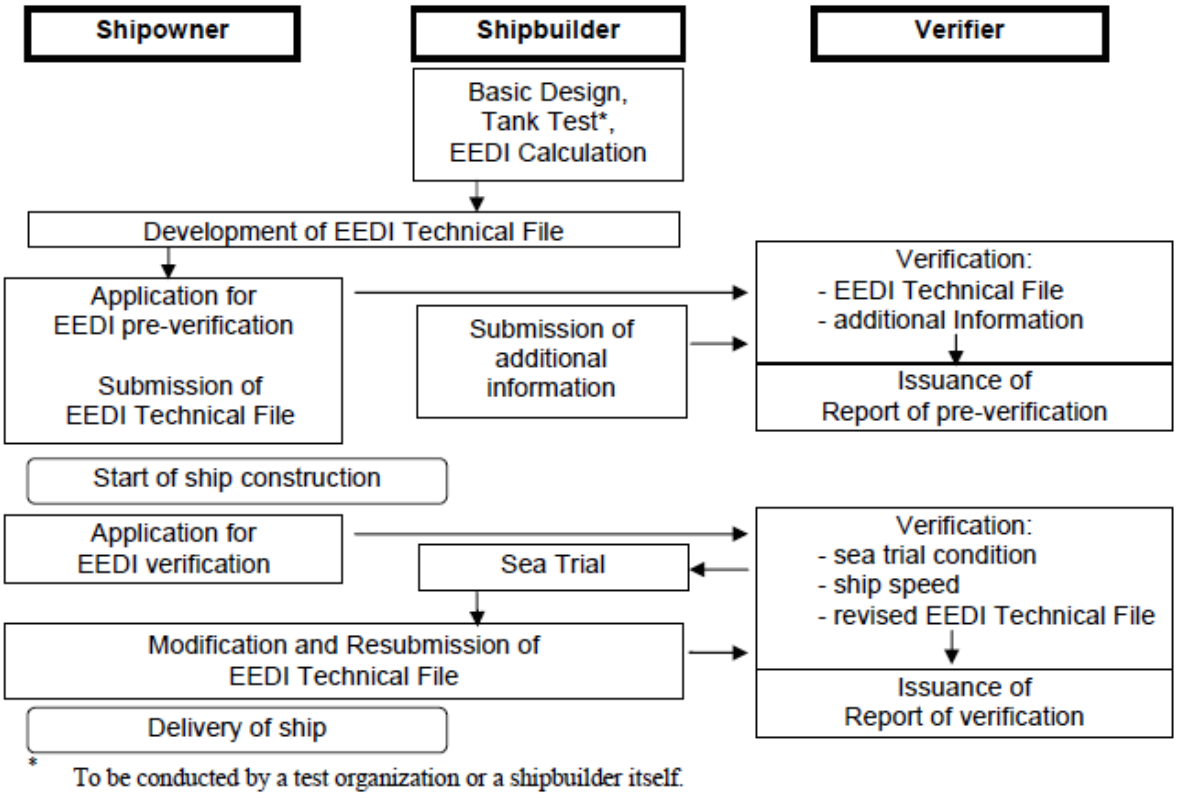

Figure 1: Basic flow of verification process

Preliminary verification at the design stage

29 For the preliminary verification at the design stage, a shipowner should submit to a verifier (e.g., a Maritime Administration or a Classification Society) an application for the verification and an EEDI Technical File containing the necessary information for the verification and other relevant background documents as required by the guidelines.

Final verification of the Attained EEDI at sea trial

30 Prior to the sea trial, a shipowner should submit the application for the verification of the EEDI together with the final displacement table and the measured lightweight, as well as other technical information as necessary. The verifier should attend the sea trial and confirm compliance in accordance with the guidelines and the EEDI guidelines.

Issuance of the EEDI verification report

31 The verifier should issue the Report on the Preliminary Verification of EEDI after it has verified the Attained EEDI at design stage in accordance with the guidelines. Following the sea trial, the verifier should issue the final report on the verification of the attained EEDI after it has verified the Attained EEDI at the sea trial in accordance with the guidelines.

Status of the verification guidelines

32 The guidelines are to be applied to new ships for which an application for EEDI verification has been submitted to a verifier, and form part of the regulatory framework governing the scheme.

IMO'S SHIP ENERGY EFFICIENCY MANAGEMENT PLAN

33 The amendments to MARPOL Annex VI require that all international ships over 400 gross tonnage retain on-board a Ship Energy Efficiency Management Plan (SEEMP). Guidance for the development of a SEEMP is contained in IMO circular MEPC.1/Circ.683.

34 The purpose of the SEEMP is to establish a mechanism for a company and/or a ship to improve the energy efficiency of ship operations. Preferably, the ship-specific SEEMP is linked to a broader corporate energy management policy for the company that owns, operates or controls the ship. It should be recognized that the international fleet of merchant vessels comprises a wide range of ship types and sizes that differ significantly in their design and purpose, and that ships operate under a broad variety of different conditions.

35 Sea transport has a justifiable image of conducting its operations in an energy efficient way, and in a manner that creates little impact on the global environment. It is nevertheless the case that enhancement in efficiencies can reduce fuel consumption, save money, and decrease the environmental impacts from ships. While the yield of individual measures may be small, the collective effect across the entire fleet will be significant. In global terms it should be recognized that operational efficiencies delivered by a large number of ships will make a valuable contribution to reducing global carbon emissions.

Practical approach

36 Mandatory management plans are used to regulate a range of ship operations where traditional command and control regulations would not work, and is also the chosen option for reduction of GHG emissions from the operation of ships engaged in international trade. To regulate ship operations by traditional prescriptive regulations (as is the customary practice for technical regulations) is not feasible, e.g., to determine the most energy efficient speed, optimum ship handling practices or the preferred ballast conditions for all ships in a set of regulations could hardly be done and keeping it updated would not be possible. A management plan is a familiar tool for the shipping industry and provides a flexible mechanism where shipowners and operations can choose the most cost-effective solutions for their ships and their operations.

37 The SEEMP provides an approach for monitoring ship and fleet efficiency performance over time and forces the responsible persons and entities to consider new technologies and practices when seeking to optimize the performance of the ship (see Table 4 for SEEMP related measures). The Second IMO GHG Study 2009 indicates that a 20% reduction on a tonne-mile basis by mainly operational measures is possible and would be cost-

effective even with the current fuel prices, and the SEEMP will assist the shipping industry in achieving this potential.

Table 4: SEEMP related measures

No.	Energy Efficiency Measure	Remark
1	Engine tuning and monitoring	Engine operational performance and condition optimisation.
2	Hull condition	Hull operational fouling and damage avoidance.
3	Propeller condition	Propeller operational fouling and damage avoidance.
4	Reduced auxiliary power	Reducing the electrical load via machinery operation and power management.
5	Speed reduction (operation)	Operational slow steaming.
6	Trim/draft	Trim and draft monitoring and optimisation.
7	Voyage execution	Reducing port times, waiting times, etc. and increasing the passage time, just in time arrival.
8	Weather routing	Use of weather routing services to avoid rough seas and head currents, to optimize voyage efficiency.
9	Advanced hull coating	Re-paint using advanced paints.
10	Propeller upgrade and aft body flow devices	Propeller and after-body retrofit for optimisation. Also, addition of flow improving devices (e.g. duct and fins).

38 The IMO circular MEPC.1/Circ.683 provides guidance for the development of a SEEMP that should be adjusted to the characteristics and needs of individual companies and ships. The SEEMP is a management tool to assist a company in managing the ongoing environmental performance of its vessels and, as such, it is recommended that the plan be implemented in a manner which limits any onboard administrative burden to the minimum necessary**.**

Ship-specific plan

39 The SEEMP should be developed as a ship-specific plan by the shipowner, operator or any other party concerned, e.g., the charterer. The SEEMP seeks to improve a ship's energy efficiency through four steps: planning, implementation, monitoring, and self-evaluation and improvement. These components play a critical role in the continuous cycle to improve ship energy management.

Status of the SEEMP

40 The regulatory text introducing the SEEMP as a mandatory measure for all ships under MARPOL Annex VI was adopted by Parties to MARPOL Annex VI in July 2011. The amendments to MARPOL Annex VI are expected to enter into force on 1 January 2013.

Guidance on best practices for fuel-efficient operation of ships

41 The above mentioned IMO circular also contains guidance on best practices related to voyage performance, optimized ship handling, hull and propulsion system maintenance, the use of waste heat recovery systems, improved fleet management, improved cargo handling and energy management. It also covers areas such as fuel types, compatibility of measures, age and operational service life of a ship as well as trade and sailing area.

42 Industry has also begun to develop model plans based on experience. The Oil Companies International Marine Forum (OCIMF) have produced a model SEEMP and submitted it to IMO for information in document MEPC 62/INF.10.

THE ENERGY EFFICIENCY OPERATIONAL INDICATOR

43 Improvements in energy efficiency are possible by operational measures, such as fleet management, voyage optimization and energy management, with 10 to 50% reductions of CO_2 emissions (on a capacity mile basis) estimated through the combined use of these measures. Saving energy at the operational stage is presently addressed by the SEEMP and the EEOI can be used as a monitoring tool and to establish benchmarks for different ship segments of the world fleet categorized by ship type and size.

Purpose of the EEOI

44 Guidelines for voluntary use of the ship EEOI have been developed to establish a consistent approach for measuring ships' energy efficiency at each voyage or over a certain period of time, which will assist shipowners and ship operators in the evaluation of the operational performance of their fleet. As the amount of CO_2 emitted from ships is directly related to the consumption of bunker fuel oil, the EEOI can also provide useful information on a ship's performance with regard to fuel efficiency.

45 The EEOI enables continued monitoring of individual ships in operation and thereby the results of any changes made to the ship or its operation. The effect of retrofitting a new and more efficient propeller would be reflected in the EEOI value and the emissions reduction could be quantified. The effect on emissions by changes in operations, such as introduction of just in time planning or a sophisticated weather routing system, will also be shown in the EEOI value.

EEOI coverage

46 The EEOI can be applied to almost all ships (new and existing) including passenger ships, however it cannot be applied to ships that are not engaged in transport work, such as service and research vessels, tug boats or FPSOs, as it is the transport work that is the input value together with emissions (fuel consumed x CO_2 factors for different fuel types).

The EEOI formula

47 The EEOI provides a specific figure for each voyage. The unit of EEOI depends on the measurement of cargo carried or the transport work done, e.g., tonnes CO_2/(tonnes·nautical miles), tonnes CO_2/(TEU·nautical miles) or tonnes CO_2/(person·nautical miles), etc. The EEOI is calculated by the following formula, in which a smaller EEOI value means a more energy efficient ship:

$$EEOI = \frac{actual\ CO_2\ emission}{performed\ transport\ work}$$

48 The actual CO_2 emission represents total CO_2 emission from combustion of fuel on board a ship during each voyage, which is calculated by multiplying total fuel consumption for each type of

fuel (distillate fuel, refined fuel or LNG, etc.) with the carbon to CO_2 conversion factor for the fuel(s) in question (fixed value for each type of fuel).

49 The performed transport work is calculated by multiplying mass of cargo (tonnes, number of TEU/cars, or number of passengers) with the distance in nautical miles corresponding to the transport work done.

Status of the EEOI

50 The EEOI is circulated to encourage shipowners and ship operators to use it on a voluntary basis and to collect information on the outcome and experiences in applying it. The EEOI will be used as a monitoring tool in the SEEMP and to establish benchmarks.

51 A sample form of a SEEMP is presented below for illustrative purposes.

Name of Vessel:		GT:	
Vessel Type:		Capacity:	
Date of Development:		Developed by:	
Implementation Period:	From: Until:	Implemented by:	
Planned Date of Next Evaluation:			

1 Measures

Energy Efficiency Measures	**Implementation** (including the starting date)	**Responsible Personnel**
Weather Routeing	<Example> Contracted with [Service providers] to use their weather routeing system and start using on trial basis as of 1 July 2012.	<Example> The master is responsible for selecting the optimum route based on the information provided by [Service providers].
Speed Optimization	While the design speed (85% MCR) is 19.0 kt, the maximum speed is set at 17.0 kt as of 1 July 2012.	The master is responsible for keeping the ship speed. The log-book entry should be checked every day.

2 Monitoring

- Description of monitoring tools (e.g. the EEOI, or another suitable indicator or MRV tool)

3 Goal

- Measurable goals

4 Evaluation

- Procedures of evaluation

MODEL COURSE FOR ENERGY EFFICIENT OPERATION SHIPS

52 At MEPC 60 the Committee noted that, to assist in achieving the visions and goals set out in resolution A.947(23) on the "Human Element Vision, Principles and Goals for the Organization", and the principles and aims of resolution A.998(25) on the "Need for capacity-building for development and implementation of new and amendments to existing, instruments", the IMO Secretariat had engaged the World Maritime University (WMU) to develop a draft model course on energy efficient operation of ships.

53 A draft Model Course was submitted to MEPC 62 as document MEPC 62/INF.39. It was developed on the elements comprising the SEEMP as agreed at MEPC 59 (MEPC 59/24, annex 19) as well as on the Guidance for the development of a SEEMP as agreed and contained in MEPC.1/Circ.683. This draft model course provides general background on the climate change issue and IMO's related work and aims at building the different operational and technical tools into a manageable course programme, which will promulgate best practice throughout all sectors of the industry. The Course will help create benchmarks against which operators can assess their own performance.

54 The Committee agreed that the draft model course was an excellent start to providing a structured training course but that it required additional work to identify the relevant parts and information, such as key practical operational efficiency measures, which are pertinent to the ship's deck and engineering officers. The Committee also considered important that consideration be given to integration of the SEEMP into the on board safety management system. In light of the improvements necessary to the Model Course, the Committee invited interested delegations to provide practical information and examples on the efficient operation of ships to the Secretariat by 31 August 2011 for inclusion in the IMO Model Course. The draft Model Course will be published in November 2011.

55 The purpose of the IMO model courses is to assist training providers and their teaching staff in organizing and introducing new training courses, or in enhancing, updating or supplementing existing training material, so that the quality and effectiveness of the training courses may thereby be improved.

ASSESSMENT OF CO_2 EMISSION REDUCTIONS RESULTING FROM THE INTRODUCTION OF TECHNICAL AND OPERATIONAL ENERGY EFFICIENCY MEASURES FOR SHIPS

56 Following the adoption of mandatory energy efficiency measures for ships, IMO commissioned a study (completed in October 2011) by Lloyd's Register and DNV on estimated CO_2 emission reductions associated with the mandatory technical and operational measures The full study can be found in IMO document MEPC 63/INF.2.

57 The study indicates that the adoption by IMO of mandatory reduction measures for all ships from 2013 and onwards will lead to significant emission reductions and also a striking cost saving for the shipping industry. By 2020, about 150 million tonnes of annual CO_2 reductions are estimated from the introduction of the EEDI for new ships and the SEEMP for all ships in operation,

a figure that, by 2030, will increase to 330 million tonnes of CO_2 annually. In other words, the average reduction will in 2020 be approximately 14%, and by 2030 approximately 23%, when compared with business as usual. The reduction measures will also result in a significant saving in fuel costs to the shipping industry, although these savings require deeper investments in more efficient ships and more sophisticated technologies than the business as usual scenario. The annual fuel cost saving estimate gives a staggering average figure of US$50 billion by 2020, and even more astonishing US$200 billion by 2030.

FUTURE ACTIVITY

58 The new chapter 4 to MARPOL Annex VI also includes a regulation on Promotion of technical co-operation and transfer of technology relating to the improvement of energy efficiency of ships, which requires Administrations, in co-operation with IMO and other international bodies, to promote and provide, as appropriate, support directly or through IMO to States, especially developing States, that request technical assistance. It also requires the Administration of a Party to co-operate 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, which request technical assistance, particularly developing States, in respect of the implementation of measures to fulfil the requirements of Chapter 4.

59 In advance of entry into force of the foregoing regulatory provisions, IMO is already providing technical assistance to developing countries for the transition to energy effient shipping. A programme funded by the Republic of Korea is providing such support in Asia while further interventions, funded by IMO itself and other donours, will follow in other regions.

60 MEPC 62 also agreed on a work plan and schedule for further development of the remaining EEDI and SEEMP related guidelines, EEDI framework for ship types and sizes and propulsion systems not covered by the current EEDI requirements. For this purpose, MEPC 62 agreed to terms of reference for an intersessional working group meeting on energy efficiency measures for ships that will take place in January 2012. The intersessional working group meeting should report to MEPC 63 in February/March 2012 and is tasked with:

.1 further improving, with a view to finalization at MEPC 63,

.1 draft Guidelines on the method of calculation of the EEDI for new ships;

.2 draft Guidelines for the development of a SEEMP;

.3 draft Guidelines on Survey and Certification of the EEDI; and

.4 draft interim Guidelines for determining minimum propulsion power and speed to enable safe manoeuvring in adverse weather conditions.

.2 considering the development of EEDI frameworks for other ship types and propulsion systems not covered by the draft Guidelines on the method of calculation of the EEDI for new ships;

.3 identifying the necessity of other guidelines or supporting documents for technical and operational measures;

.4 considering the EEDI reduction rates for larger tankers and bulk carriers; and

.5 considering the improvement of the guidelines on the Ship Energy Efficiency Operational Indicator (EEOI) (MEPC.1/Circ.684).

***

ANNEX 1

ASSESSMENT OF IMO MANDATED ENERGY EFFICIENCY MEASURES FOR INTERNATIONAL SHIPPING

ESTIMATED CO_2 EMISSIONS REDUCTION FROM INTRODUCTION OF MANDATORY TECHNICAL AND OPERATIONAL ENERGY EFFICIENCY MEASURES FOR SHIPS

EXECUTIVE SUMMARY OF THE PROJECT FINAL REPORT

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Date of report:
31 October 2011

Executive Summary

1 This study was commissioned by the International Maritime Organization (IMO) to analyse the potential reduction resulting from the mandated energy efficiency regulations on EEDI and SEEMP as finalised at MEPC 62 in July 2011 and also to estimate the projected reduction in CO_2 emissions from international shipping for every year up to year 2050 resulting from these agreed measures, using a number of scenarios.

2 This Study was undertaken by Lloyd's Register (LR) in partnership with Det Norske Veritas (DNV). Dr. Zabi Bazari (LR) and Mr. Tore Longva (DNV) were the main contributors to the report. They additionally received assistance from colleagues within their organizations.

3 Mandatory measures to reduce greenhouse gas (GHG) emissions from international shipping were adopted by Parties to MARPOL Annex VI represented in the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO), when it met for its 62nd session from 11 to 15 July 2011 in London, representing the first ever mandatory global GHG reduction regime for an international industry sector.

4 The amendments to MARPOL Annex VI - *Regulations for the prevention of air pollution from ships,* add a new chapter 4 to Annex VI *on Regulations on energy efficiency for ships* to make mandatory the Energy Efficiency Design Index (EEDI) for new ships, and the Ship Energy Efficiency Management Plan (SEEMP) for all ships. Other amendments to Annex VI add new definitions and the requirements for survey and certification, including the format for the International Energy Efficiency Certificate. The regulations apply to all ships of 400 gross tonnage and above, and are expected to enter into force internationally through the tacit acceptance procedure on 1 January 2013.

Reduction factors (in percentage) for the EEDI relative to the reference line for each ship type.

	Size	Phase 0 1 Jan 2013 – 31 Dec 2014	Phase 1 1 Jan 2015 – 31 Dec 2019	Phase 2 1 Jan 2020 – 31 Dec 2024	Phase 3 1 Jan 2025 onwards
Bulk Carriers	>20,000 Dwt	0%	10%	20%	30%
	10-20,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
Gas tankers	>10,000 Dwt	0%	10%	20%	30%
	2-10,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
Tanker and combination carriers	>20,000 Dwt	0%	10%	20%	30%
	4-20,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
Container ships	>15,000 Dwt	0%	10%	20%	30%
	10-15,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
General Cargo ships	>15,000 Dwt	0%	10%	15%	30%
	3-15,000 Dwt	n/a	0-10%*	0-15%*	0-30%*
Refrigerated cargo carriers	>5,000 Dwt	0%	10%	15%	30%
	3-5,000 Dwt	n/a	0-10%*	0-15%*	0-30%*

* The reduction factor is to be linearly interpolated between the two values depending on the vessel size. The lower value of the reduction factor is to be applied to the smaller ship size.

Table i – EEDI reduction factors, cut off limits and implementation phases

5 The EEDI requires a minimum energy efficiency level (CO_2 emissions) per capacity mile (e.g. tonne mile) for different ship type and size segments (Table i). With the level being tightened over time, the EEDI will stimulate continued technical development of all the components influencing the energy efficiency of a ship. Reduction factors are set until 2025 when a 30% reduction is mandated

over the average efficiency for ships built between 1999 and 2009. The EEDI has been developed for the largest and most energy intensive segments of the world merchant fleet and will embrace about 70% of emissions from new oil and gas tankers, bulk carriers, general cargo, refrigerated cargo and container ships as well as combination carriers (wet/dry bulk). For ship types not covered by the current EEDI formula, suitable formulas are likely to be developed in the future according to work plan agreed at MEPC 62.

6 The SEEMP establishes a mechanism for a shipping company and/or a ship to improve the energy efficiency of ship operations. The SEEMP provides an approach for monitoring ship and fleet efficiency performance over time using, for example, the Energy Efficiency Operational Indicator (EEOI) as a monitoring and/or benchmark tool. The SEEMP urges the ship owner and operator at each stage of the operation of the ship to review and consider operational practices and technology upgrades to optimize the energy efficiency performance of a ship.

7 In this study, scenario modelling was used to forecast possible world's fleet CO_2 emission growth trajectories to 2050. The scenarios included options for fleet growth, EEDI and SEEMP uptake, fuel price and EEDI waiver. Table ii shows the combined scenarios modelled in this Study.

8 A model, designed specifically to account for the uptake of emission reduction technologies and measures and the implementation of regulations to control emissions, has been used to predict likely CO_2 emission levels to 2050. The model keeps track of the year of build for all ships, and scraps the oldest and least energy efficient ships first. By including the scrapping rate, the renewal rate of the fleet is taken into account. A methodology was used to determine the impact of future EEDI regulatory limits on various ships based on the level of spread (expressed by the standard deviation) of EEDI values for the current fleet reference lines.

Scenario	IPCC growth scenario	EEDI Uptake scenario	SEEMP uptake	Fuel price scenarios	Waiver scenario
A1B-1	A1B	Regulation	Low*	Reference	5%
A1B-2	A1B	Regulation	Low	High	5%
A1B-3	A1B	Regulation	High**	Reference	5%
A1B-4	A1B	Regulation	High	High	5%
B2-1	B2	Regulation	Low	Reference	5%
B2-2	B2	Regulation	Low	High	5%
B2-3	B2	Regulation	High	Reference	5%
B2-4	B2	Regulation	High	High	5%
A1B-3W	A1B	Regulation	High	Reference	30%

* 30% ** 60%

Table ii – Combined scenarios

9 Based on scenarios modelled in this Study, results shows that the adoption by IMO of mandatory reduction measures from 2013 and onwards will lead to significant emission reductions by the shipping industry (see Figure i).

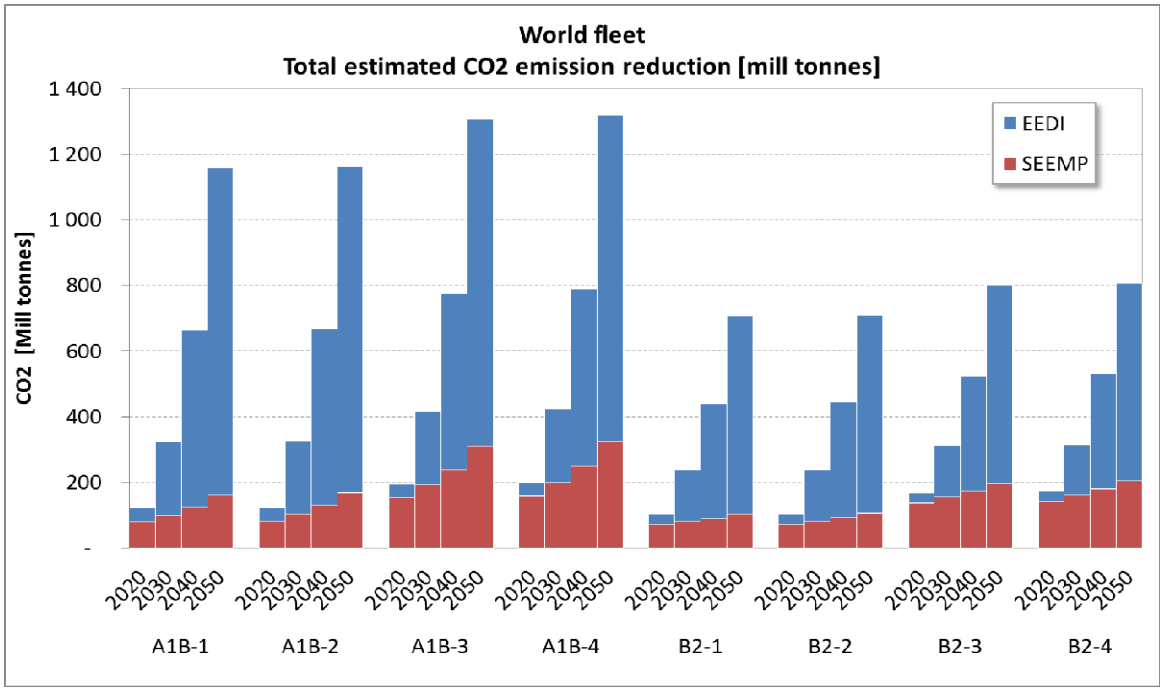

Figure i – Overall annual CO_2 reduction potential for SEEMP and EEDI (waiver 5%)

Findings

10 According to Figure i:

.1 By 2020, an average of 151.5 million tonnes of annual CO_2 reductions are estimated from the introduction of the EEDI for new ships and the SEEMP for all ships in operation, a figure that by 2030, will increase to an average of 330 million tonnes annually (Table iii, showing the average for scenarios A1B-4 and B-2);

Year	**BAU** Mill tonnes	**Reduction** Mill tonnes	**New level** Mill tonnes
2020	1103	152	951
2030	1435	330	1105
2040	1913	615	1299
2050	2615	1013	1602

Table iii - Estimated average CO_2 emission reductions (million tonnes) for world fleet compared with estimated BAU CO_2 emissions (million tonnes)

.2 Compared with Business as Usual (BAU), the average annual reductions in CO_2 emissions and fuel consumed are estimated between 13% and 23% by 2020 and 2030 respectively (Tables iii);

.3 CO_2 reduction measures will also result in a significant reduction in fuel consumption (Table iv) leading to a significant saving in fuel costs to the shipping

industry, although these savings require deeper investments in more efficient ships and more sophisticated technologies, as well as new practices, than the BAU scenario.

Year	2020		2030	
Scenarios	**Low (B2-1)** Mill tonnes	**High (A1B-4)** Mill tonnes	**Low (B2-1)** Mill tonnes	**High (A1B-4)** Mill tonnes
BAU fuel consumption	340	390	420	530
Reduction in fuel consumption	30	70	80	140
New fuel consumption level	310	320	340	390

Table iv - Annual fuel consumption reduction (in million metric tonnes) for world fleet

.4 The average annual fuel cost saving is estimated between US$20 and US$80 billion (average US$50 billion) by 2020, and between US$90 and US$310 billion (average US$200 billion) by 2030 (Table v).

	High (A1B-4)		Low (B2-1)	
Year	**2020 $billion**	**2030 $billion**	**2020 $billion**	**2030 $billion**
BAU fuel cost	490	1170	240	510
Reduction in fuel cost	80	310	20	90
New fuel cost level	410	860	220	420

Table v - Annual fuel cost reduction (in billion US$) for world fleet

11 The results of the study indicate that SEEMP measures (mainly operational) have an effect mostly in the medium term (e.g. 2020) whilst EEDI measures (technical) should have significant impact on the long term (e.g., 2030) as fleet renewal takes place and new technologies are adopted; however, none of the scenarios modelled will achieve a reduction in total CO_2 level relative to year 2010 (Figure ii).

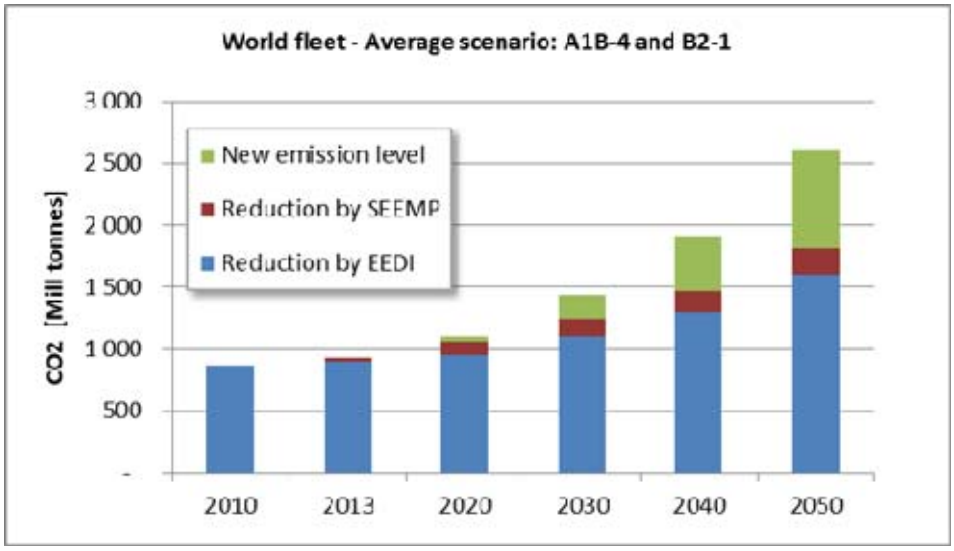

Figure ii - Annual emission reduction by 2050 and new emissions levels (average of A1B-4 and B2-1 scenarios)

Concluding remarks

12 Based on the results of this Study, the following conclusions may be made:

.1 Significant potential for reduction of CO_2 emissions from ships due to EEDI and SEEMP regulations is foreseen to 2050 with emission reduction due to SEEMP (primarily operational measures) likely to be realised more rapidly than that for EEDI (primarily technical measures), as the effect of EEDI will occur only as and when older, less efficient, tonnage is replaced by new, more efficient tonnage.

.2 The existing mandatory application of EEDI will drive more energy efficient ship design and realise the CO_2 emission reduction potential associated with technical innovation and the use of lower or no carbon fuels. Calculations made within this Study suggest that the existing limits to the EEDI can be achieved via technological developments and some design speed reduction as highlighted in this report.

.3 Forecasts with different scenarios indicate total annual CO_2 emissions in 2050 of 3215 million tonnes for BAU and new emissions level of 1895 million tonnes (1320 million tonnes reduced) for scenario A1B-4 (high growth combined with high SEEMP uptake and high fuel price) and a total annual CO_2 emissions in 2050 of around 2014 million tonnes for BAU and new emissions level of 1344 million tonnes (706 million tonnes reduced) for scenario B2-1 (low growth combined with low SEEMP uptake and reference fuel price).

.4 For EEDI, an annual reduction of about 1000 million tonnes of CO_2 for A1B scenario and 600 million tonnes of CO_2 for B2 scenario is foreseen in 2050. For SEEMP, an annual reduction of about 325 million tonnes of CO_2 for A1B-4 scenario and 103 million tonnes of CO_2 for B2-1 scenario is foreseen by 2050.

.5 The transport efficiency will improve with the same rate as the emission reduction taking into account the growth rate of the fleet. Table vi provides the transport efficiency development for different ship types under the modelled scenarios. As indicated, various vessels' transport energy efficiency nearly doubles and the emissions per cargo unit nearly halves from 2005 to 2050.

Year	Bulk carrier	Gas tanker	Tanker	Container ship	General cargo ship	Refrigerated cargo carrier
2005	9	13	13	30	40	40
2010	9	12	12	28	37	37
2020	8	10	10	23	30	30
2030	7	9	9	20	27	27
2050	5	7	7	16	21	20

Table vi - Transport efficiency (g CO_2/tonne-mile) improvement associated with the different ship types using scenario B2-4/A1B-4

.6 The impact of the waiver clause in Regulation 19.5 is estimated to be low on total emissions reduction potential due to EEDI. A change of waiver level from 5% to 30% will result in a decrease in CO_2 reduction levels by 7 million tonnes per year in 2030 (overall reduction is 416 million tonnes for this scenario).

.7 Based on the analysis provided in this appendix, it is concluded that the likelihood of Flag States or shipowners to opt for an EEDI waiver is low due to low compliance costs and commercial disadvantage of non-compliance. Accordingly, the level waiver uptake level taken in this Study as 5% (low) and 30% (high) is regarded as reasonable. It is most likely that waiver will be at the level of 5% as current indications imply.

.8 Implementation of SEEMP-related energy efficiency measures are generally cost effective; however, it is likely that adoption of these measures will need to be stimulated. Follow-on monitoring and audits, and high carbon and fuel prices are expected to play a role in driving uptake of SEEMP efficiency measures. Although it is not anticipated to have a target-based regulatory framework for SEEMP in the foreseeable future; putting in place an effective audit/monitoring system, building awareness and resolving split incentive issues on operational energy efficiency measures will facilitate enhanced uptake of SEEMP measures in the world fleet.

	EEDI reduction measure	Energy Efficiency Measure
1	Optimised hull dimensions and form	Engine tuning and monitoring
2	Lightweight construction	Hull condition
3	Hull coating	Propeller condition
4	Hull air lubrication system	Reduced auxiliary power
5	Optimisation of propeller-hull interface and flow devices	Speed reduction (operation)
6	Contra-rotating propeller	Trim/draft
7	Engine efficiency improvement	Voyage execution
8	Waste heat recovery	Weather routing
9	Gas fuelled (LNG)	Advanced hull coating
10	Hybrid electric power and propulsion concepts	Propeller upgrade and aft body flow devices
11	Reducing on-board power demand (auxiliary system and hotel loads).	
12	Variable speed drive for pumps, fans, etc.	
13	Wind power (sail, wind engine, etc.)	
14	Solar power	
15	Design speed reduction (new builds)	

Table vii Technologies for EEDI reductions and SEEMP related measures

.9 The mandatory use of SEEMP based on current IMO Regulations will provide a procedural framework for shipping companies to recognise the importance of the operational energy saving activities. It will significantly boost the level of awareness and, if implemented properly, will lead to a positive cultural change. However, and in view of lack of regulatory requirements for target setting and monitoring, SEEMP effectiveness will need to be stimulated / incentivised via other initiatives.

.10 To make the application of SEEMP more effective and to prepare the shipping industry for likely future carbon pricing via MBMs, it seems that use of the EEOI (Energy Efficiency Operational Indicator) or a similar performance indicator should be encouraged or mandated. This will involve more accurate and verifiable measurement of fuel consumption that could pave the way for CO_2 foot printing and data verification in the future.

.11 The estimated reductions in CO_2 emissions, for combined EEDI and SEEMP, from the world fleet translate into a significant average annual fuel cost saving of about US$50 billion in 2020 and about US$200 billion by 2030; using fuel price increase scenarios that take into account the switch to low sulphur fuel in 2020.

.12 Investigations show that ship hydrodynamic and main engine optimisation will bring about energy saving opportunities of up to about 10% with no significant additional cost of shipbuilding. In addition, the main and auxiliary engines are already available with reduced specific fuel consumption of about 10% below the values used in the reference line calculations. The above two combined effects is indicative that cost of compliance, for an “average ship”, to phases 0 and 1 will not be significant. As a consequence of current developments in ship design and

new technologies coming onto market, the cost of EEDI compliance in phase 1 seems to be marginal as the 10% reduction requirement may be achieved by low-cost hull form design and main engine optimisations. Cost of compliance for phase 2 and phase 3 may be higher and will involve some design-speed reduction for an average ship. However, the overall life-cycle fuel economy of the new ships will be positive as indicated by the high savings in fuel costs.

.13 Despite the significant CO_2 emission reduction potential resulting from EEDI and SEEMP regulations, an absolute reduction in total CO_2 emissions for shipping from the 2010 level appears not to be feasible using these two measures alone. For all scenarios, the projected growth in world trade outweighs the achieved emission reduction using EEDI and SEEMP, giving an upward trend, albeit at a very much reduced rate compared to BAU.

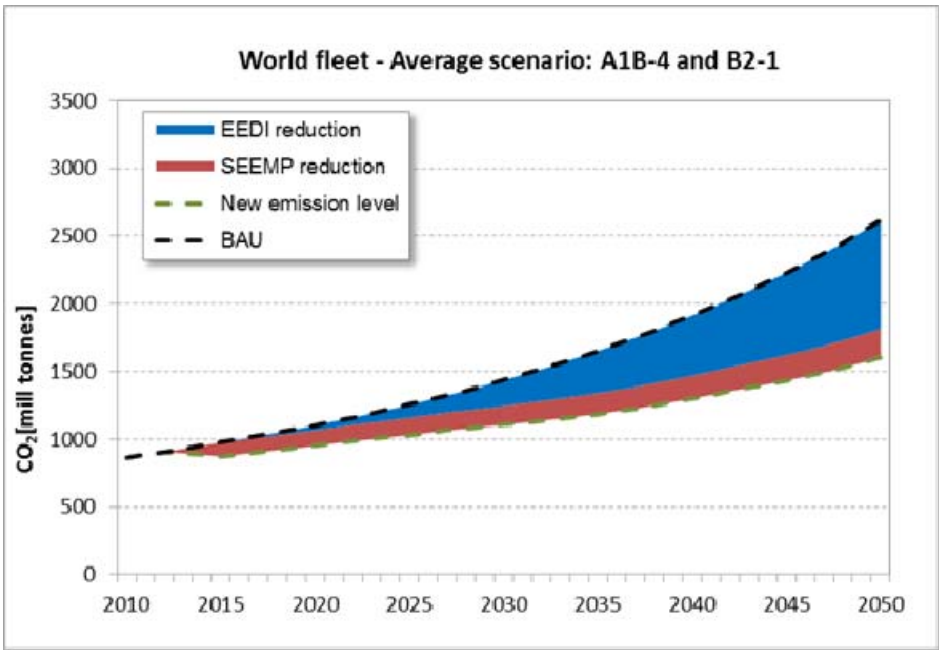

Figure iii – World fleet CO_2 level projections (average of A1B-4 and B2-1 scenarios)