MARITIME AND PORT AUTHORITY OF SINGAPORE
SHIPPING CIRCULAR TO SHIPOWNERS
NO. 12 OF 2013

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Applicable to: Ship owners, managers, operators, masters, crew members, surveyors, shipyards and the Shipping Community.

GUIDANCE ON SHIPBOARD OPERATIONAL MATTERS: CIRCULARS APPROVED BY THE 65TH SESSION OF THE MARINE ENVIRONMENT PROTECTION COMMITTEE (MEPC 65) OF IMO

Refer to Shipping Circular No. 11 of 2013 for *Resolutions adopted by the 65th Session of the Marine Environment Protection Committee (MEPC 65) of IMO.*

1. The Marine Environment Protection Committee of IMO, at its 65th session (13 – 17 May 2013), approved a number of circulars that provided guidance for the prevention and control of pollution from ships. This shipping circular informs the Shipping Community of the MEPC circulars, as listed below. In general, MPA accepts the guidance given in the MEPC circulars and shipowners and managers should approach the Class of their vessels for further details.

2. **Ballast Water Management Convention**

a. BWM.2/Circ.42 – Guidance on ballast water sampling and analysis for trial use in accordance with the BWM Convention and Guidelines (G2)

The guidance provides general recommendations on methodologies and approaches to sampling and analysis for testing compliance with the D-1 and D-2 standards under the BWM Convention. MEPC 65 also agreed on the recommendations related to the trial period for reviewing, improving and standardising the guidance and on the principle that port states refrain from applying criminal sanctions on the basis of sampling only during the trial period.

b. BWM.2/Circ.43 – Amendments to the Guidance for Administrations on the type approval process for ballast water management systems in accordance with Guidelines (G8)

The circular supersedes BWM.2/Circ.28 and provides guidance to Administrations on the procedure for evaluating applications for type approval of BWMS. Manufacturers submitting systems for approval are required to refer to the guidance.

c. BWM.2/Circ.44 – Options for ballast water management for Offshore Support Vessels in accordance with the BWM Convention

The circular provides options available for offshore support vessels to comply with the requirements of the BWM Convention arising from concerns that the activities of these vessels differ from those of deep sea trading vessels.

d. BWM.2/Circ.45 – Clarification of “major conversion” as defined in regulation A-1.5 of the BWM Convention

The circular provides clarifications that new installation of BWMS should not be treated as a “major conversion” of a ship, and also on the conversions that constitute as a change of ship type.

e. BWM.2/Circ.46 – Application of the BWM Convention to Mobile Offshore Units

The circular proposes unified interpretations for the application of the BWM Convention to mobile offshore units.

3. **Air Pollution and Energy Efficiency**

a. MEPC.1/Circ.815 – 2013 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI

The guidance provides the methodology of calculation, survey and certification of innovative energy efficiency technologies for the attained EEDI under MARPOL Annex VI to interested parties related to EEDI of ships.

b. MEPC.1/Circ.816 – 2013 Guidelines on survey and certification of the Energy Efficiency Design Index (EEDI)

The circular is a consolidated text of the guidelines on survey and certification of the EEDI and incorporates the amendments adopted under resolution MEPC.234(65).

4. **Garbage Management**

a. MEPC.1/Circ.809 – Revised Guidance on the management of spoilt cargoes

The circular provides guidance on managing spoilt cargoes during voyage and takes into account the London Protocol and revised MARPOL Annex V.

b. MEPC.1/Circ.810 – Implementation of MARPOL Annex V (Adequate port reception facilities for cargoes declared as harmful to the marine environment under MARPOL Annex V)

The circular permits the discharge of cargo hold washwater from holds previously containing solid bulk cargo classified as HME under certain conditions when no adequate port reception facilities are available at the discharge port. The relaxation is only valid until 31 December 2015.

5. **Biofouling**

a. MEPC.1/Circ.811 – Guidance for evaluating the 2011 guidelines for control and management of ships' biofouling to minimize the transfer of invasive aquatic species

The guidance is intended to assist interested parties in evaluating the guidelines for control and management of ships' biofouling to minimize the transfer of invasive aquatic species.

6. Shipowners are urged to take note and where necessary, implement the recommendations in the circulars. They may approach the nine approved classification societies to seek further guidance.

7. Any queries relating to this circular should be directed to Mr Zafrul Alam (Tel: 6375 6204) or Mr Princet Ang (Tel: 6375 6259).

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BWM.2/Circ.42
24 May 2013

INTERNATIONAL CONVENTION FOR THE CONTROL AND MANAGEMENT OF SHIPS' BALLAST WATER AND SEDIMENTS, 2004

Guidance on ballast water sampling and analysis for trial use in accordance with the BWM Convention and Guidelines (G2)

1 The Marine Environment Protection Committee, at its fifty-eighth session (October 2008), following the adoption of the *Guidelines for ballast water sampling (G2)* (MEPC.173(58)), instructed the Sub-Committee on Bulk Liquids and Gases (BLG) to develop, as a matter of high priority, a circular to provide sampling and analysis guidance.

2 MEPC 65 (13 to 17 May 2013) approved the *Guidance on ballast water sampling and analysis for trial use* in accordance with the BWM Convention and Guidelines (G2), as agreed by BLG 17 (4 to 8 February 2013), set out in the annex.

3 Member Governments are invited to bring this circular to the attention of all parties concerned.

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ANNEX 1

GUIDANCE ON BALLAST WATER SAMPLING AND ANALYSIS FOR TRIAL USE IN ACCORDANCE WITH THE BWM CONVENTION AND GUIDELINES (G2)

1 INTRODUCTION

The purpose of this guidance is to provide general recommendations on methodologies and approaches to sampling and analysis to test for compliance with the standards described in regulations D-1 and D-2 of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention). This document is an updated version of the guidance contained in document BLG 16/WP.4, taking into account advances in research since the document was first drafted. This document should be read in conjunction with the BWM Convention, the port State control guidelines, the *Guidelines for ballast water sampling (G2)*, and the *Guidance for the assessment of compliance with the discharge standards of the BWM Convention*. Furthermore, and as instructed by MEPC 64, the sampling and analysis procedures to be used for enforcement of the BWM Convention should result in no more stringent requirements than what is required for Type Approval of ballast water management systems (BWMS).

1.2 This document is made up of two parts:

.1 a discussion of the principles of sampling, accompanied by a list of recommended methods and approaches for analysis and sampling protocols available for compliance testing to the D-1 and D-2 standards in section 5; and

.2 background information on sampling and analysis methodologies and approaches. This can be found in the annex.

1.3 Sampling and analysis for compliance testing is a complex issue. According to the *Guidelines for ballast water sampling (G2)*, testing for compliance can be performed in two steps. As a first step, prior to a detailed analysis for compliance, an indicative analysis of ballast water discharge may be undertaken to establish whether a ship is potentially in compliance with the Convention.

1.4 When testing for compliance, the sampling protocol used should result in a representative sample of the whole discharge of the ballast water from any single tank or any combination of tanks being discharged.

2 DEFINITIONS

2.1 For the purpose of this guidance, the definitions in the BWM Convention apply and:

.1 A **sample** means a relatively small quantity intended to show what the larger volume of interest is like.

.2 **Representative sampling** reflects the relative concentrations and composition of the populations (organisms and/or chemicals) in the volume of interest. Samples should be taken in accordance with the annex, part 1 and/or part 2 of the *Guidelines on ballast water sampling (G2)*.

.3 **Analysis** means the process of measuring and determining the concentrations and composition of the populations of interest (organisms and/or chemicals) within the sample.

.4 An **indicative analysis** means a compliance test that is a relatively quick indirect or direct measurement of a representative sample of the ballast water volume of interest:

.1 an indirect, indicative analysis may include measurements whose parameters do not provide a value directly comparable to the D-2 standard, including biological, chemical, or physical parameters (e.g. dissolved oxygen levels, residual chlorine levels, Adenosine triphosphate (ATP), nucleic acid, *chlorophyll a*, and that by variable fluorescence, etc. The practicalities, applicability and limitations of these methods should be understood before they are used in compliance testing;

.2 a direct measurement, which is directly comparable to the D-2 standard (i.e. the determination of the number of viable organisms per volume) may also be indicative if it has:

- a large confidence interval, or

- high-detection limits; and

.3 an indicative analysis is an analysis performed in accordance with sections 4.1 and 4.2.

.5 A **detailed analysis** means a compliance test that is likely to be more complex than indicative analysis and is a direct measurement of a representative sample used to determine the viable organism concentration of a ballast water volume of interest. The result of such measurement:

.1 should provide a direct measurement of viable organism concentration in the ballast water discharge which is directly comparable to the D-2 standard (number of viable organisms per volume);

.2 should be of sufficient quality and quantity to provide a precise measurement of organism concentration (+/- [X] organisms per volume) for the size category(ies) in the D-2 standard being tested for; and

.3 should use a measurement method with an adequate detection limit for the purpose for which it is being applied.

A detailed analysis is an analysis performed in accordance with the methods and approaches in sections 4.3 and 4.4. Detailed analysis should usually be undertaken on a sample taken in accordance with the procedures in section 4.4.

.6 **Testing for compliance** using indicative analysis and detailed analysis can employ a range of general approaches or standard methods. These approaches or methods are divided into those that sample a small proportion of the volume of interest to indicate or confirm compliance or a larger proportion of the volume of interest that can be utilized to indicate and confirm compliance. Those that provide a wide confidence interval should not be used to confirm compliance unless the result and confidence limit are demonstrably over the D-2 standard as measured directly or indirectly. Approaches/Standards are highlighted in sections 4.1, 4.2 and 4.4 for indicative analysis and sections 4.3 and 4.4 for detailed analysis.

.7 **Method** means a detailed step-by-step analysis procedure (for indicative or detailed analysis) or sampling methodology, which the laboratory or organization undertaking the work can follow, be audited against and be accredited to.

.8 **Approach** means a detailed step-by-step analysis procedure (for indicative or detailed analysis) or sampling methodology, which the laboratory or organization undertaking the work can follow. These procedures will not have been validated by an international or national standards organization.

.9 **General approach** means a conceptual description or broad methodology of sample collection or analysis.

.10 **The precision** of a measurement system is the degree to which repeated measurements under unchanged conditions show the same results.

.11 **The detection limit** is the lowest concentration level that can be determined to be statistically different from a blank sample within a stated confidence interval. Limits of detection are method and analysis specific.

.12 **Plankton** means **phytoplankton** (e.g. diatoms or dinoflagellates) **and zooplankton** (e.g. bivalve larvae or copepods) that live in the water column and are incapable of swimming against a current.

.13 **Confidence interval** means a statistical measure of the number of times out of 100 that test results can be expected to be within a specified range. For example, a confidence level of 95 per cent means that the result of an action will probably meet expectations 95 per cent of the time.

.14 **Operational indicator** means a parameter used to monitor and control the operation of the BWMS as defined during testing for Type Approval, e.g. limit values of physical or chemical parameters such as flow rates, dose, etc.

.15 **Performance Indicator** means a biological parameter (e.g. ATP, *chlorophyll a*, direct counts) used to estimate or measure the performance of the BWMS in achieving the D-2 standard.

3 PRINCIPLES FOR SAMPLING AND ANALYSIS FOR BALLAST WATER DISCHARGES

3.1 All samples and analysis carried out to determine whether a ship is in compliance with the BWM Convention should be performed under reliable and verified QA/QC procedures (note that any method, approach or sampling procedure should be rigorously validated and practicability should be assessed).

3.2 The first premise of any sampling and/or any analysis protocol is to identify the purpose of the protocol, i.e. to prove whether the discharge of a ship is meeting the D-1 standard or meeting the D-2 standard. There are many ways in which this can be done; however, they are limited by:

.1 the requirements of the methodologies available for sampling the ballast water discharge;

.2 the methods of analysis of samples being collected;

.3 the methods involved in statistically processing the results of these analyses;

.4 the specific operation of the ballast water management system (including when the treatment is applied during the ballast cycle and the type of treatment used); and

.5 the practicalities of sampling a very large volume of water and analysing it for very low concentrations of organisms.

3.3 Successful sampling and analysis is also based on identifying the viable biological population being sampled and its variability. If this population is homogenous, it is much easier to sample than one that is known to be heterogeneous. In the case of ballast water, the sample is drawn from a discharge with a population that can vary significantly. Consequently, the samples collected for indicative or detailed analysis should be representative samples.

3.4 Sampling a ballast water discharge is restricted even further when parts of the ballast water may have already been discharged. Very few inferences can be made on the quality of that ballast water already discharged based on sampling the remaining discharge as it happens. So the challenge is to determine the volume of interest and how to sample it.

3.5 The qualitative difference between indicative analysis and detailed analysis often relies on the level of statistical confidence, which, in detailed analysis may be superior.

3.6 Indicative analysis (using operational or performance indicators) can be undertaken at any time throughout the discharge. In cases where indicative analysis identifies that a system is grossly exceeding the D-2 standard, it may be sufficient to establish non-compliance, however, the practicalities, application and limitations of the methodology being used for indicative analysis need to be understood fully.

3.7 Based on the discussion in section 3.3, two different potential detailed sampling approaches can therefore be considered:

.1 sampling the entire discharge from a vessel during a port visit. During this approach:

.1 it will be impossible, by definition, for vessels to discharge prior to sampling;

.2 large numbers of samples are likely to be required over a long period of time;

.3 large sample volumes may be required over a long period of time; and

.4 sampling personnel would be required on the vessel over a significant period of time;

.2 collecting a representative sample of the ballast water being discharged during some chosen period of time, e.g. one sample or a sequence of samples. During this approach:

.1 the sampling can be developed to fit the situation on board the vessel; and

.2 a representative sample of the discharge can be taken, and that volume can be selected in many ways, providing the opportunity for identifying and sampling specific volumes of the discharge if appropriate, e.g. choosing a percentage of the discharge or sampling duration.

3.8 The D-2 standard expresses a low concentration of organisms to identify in the analysis. The confidence in the result of any sampling and analysis depends on the error inherent in the sampling method and on the error inherent in the method used for analysing the sample. The cumulative error of both must be taken into account when evaluating the result.

3.9 The tables in sections 4.1, 4.2 and 4.3 set out the range of methodologies and approaches, currently identified for use to analyse ballast water discharges and how they relate to the specific sampling protocols in section 4.4. These methodologies and approaches are stand-alone techniques that need to be combined with specific sampling protocols. These protocols should recognize the limitations of each methodology, its inherent sampling requirements, and how it can fit into a comprehensive sampling protocol for compliance testing.

3.10 Although some methodologies and approaches used in type approval testing may also be applicable in compliance testing, the latter, especially indicative sampling, may also require other approaches.

Table 1

DEFINITION AND DIFFERENCES BETWEEN INDICATIVE AND DETAILED ANALYSIS FOR THE D-2 STANDARD

	Indicative analysis	**Detailed analysis**
Purpose	To provide a quick, rough estimate of the number of viable organisms	To provide a robust, direct measurement of the number of viable organisms
Sampling		
Volume	Small or large depending on specific analysis	Small or large depending on specific analysis
Representative sampling	Yes, representative of volume of interest	Yes, representative of volume of interest
Analysis method		
Analysis parameters	Operational (chemical, physical) and/or performance indicators (biological)	Direct counts (biological)
Time-consuming	Lower	Higher
Required skill	Lower	Higher
Accuracy of numeric organism counts	Poorer	Better
Confidence with respect to D-2	Lower	Higher

4 METHODOLOGIES FOR COMPLIANCE TESTING UNDER THE BWM CONVENTION

4.1 Table 2: Analysis methods that may provide an indication of compliance with the D-1 standard[1]

Indicator	General approach	Standard method	Notes	Level of confidence or detection limit and citation for validation studies
Salinity	Conductivity meter to monitor salinity.	No international standard for ballast water analysis at this time although standard methods for measuring salinity do exist.	External elements can affect the salinity.	To be determined.
Salinity	Refractometer to monitor salinity.	No international standard for ballast water analysis at this time although standard methods for measuring salinity do exist.	Temperature can affect the readings.	To be determined.
Types of organisms in discharge – oceanic, coastal, estuarine or fresh water	Visual identification.	No international standard for ballast water analysis at this time.	Expensive, time-consuming, needs extensively trained personnel; may produce false results if encysted organisms from previous ballasting operations hatch.	To be determined.
Turbidity	Portable turbidity sensors.	No international standard for ballast water analysis at this time.	Requires understanding of turbidity characteristics in relation to the distance from shore.	To be determined.
Dissolved Inorganic and Organic constituents (Nutrients, metals coloured dissolved organic matter (CDOM))	Portable nutrient sensors.	No international standard for ballast water analysis at this time.	Requires understanding of inorganic or organic constituent characteristics in relation to the distance from shore.	To be determined.

1 Additional information can be found in document BLG 16/4.

4.2 Table 3: Indicative analysis methods for use when testing for potential compliance with the D-2 standard[2]

Indicator	General approach	Standard method	Notes	Level of confidence or detection limit and citation for validation studies
Viable organisms ≥ 50 µm	Visual counts or stereo-microscopy.	No international standard for ballast water analysis at this time.	Can be expensive and time-consuming, needs moderately trained personnel. (Note that OECD Test Guideline for Testing of Chemicals 202, "*Daphnia* sp. acute immobilization test and reproduction test" could be used as basis for standard methodology.)	To be determined.
Viable organisms ≥ 50 µm	Visual inspection.	No international standard for ballast water analysis at this time.	Visual inspection is likely to only register organisms bigger than 1,000 micro-metres in minimum dimension.	To be determined.
Viable organisms ≥ 10 µm and < 50 µm	Variable fluorometry.	No international standard for ballast water analysis at this time.	Only monitors photosynthetic phytoplankton and thus may significantly underestimate other planktonic organisms in this size fraction.	To be determined.
Viable organisms ≥ 50 µm and ≥ 10 µm and < 50 µm	Photometry, nucleic acid, ATP, bulk fluorescein diacetate (FDA), *chlorophyll a.*	No international standard for ballast water analysis at this time.	Semi-quantitative results can be obtained. However, some of these organic compounds can survive for various lengths of time in aqueous solution outside the cell, potentially leading to false positives. Welschmeyer and Maurer (2012).	To be determined.

2 Additional reference can be found in document BLG 15/5/4.

Indicator	General approach	Standard method	Notes	Level of confidence or detection limit and citation for validation studies
Viable organisms ≥ 50 µm and ≥ 10 µm and < 50 µm	Flow cytometry.	No international standard for ballast water analysis at this time.	Very expensive.	To be determined.
Enterococci	Fluorometric diagnostic kit.	No international standard for ballast water analysis at this time.	Minimum incubation time 6 h. Semi-quantitative results from portable methods (see paragraph 2.2.2 of annex 1).	To be determined.
Escherichia coli	Fluorometric diagnostic kit.	No international standard for ballast water analysis at this time.	Minimum incubation time 6 h. Semi-quantitative results from portable methods (see paragraph 2.2.2 of annex 1).	To be determined.
Vibrio cholerae (O1 and O139)	Test kits.	No international standard for ballast water analysis at this time.	Relatively rapid indicative test methods are available.	To be determined.

4.3 Table 4: Detailed Analysis Methods for use when testing for compliance with the D-2 standard

Indicator	General approach	Standard method	IMO citation	Notes	Level of confidence or detection limit and citation for validation studies
Viable organisms ≥ 50 µm and ≥ 10 µm and < 50 µm	Visual counts or stereo-microscopy examination. May be used with vital stains in conjunction with fluorescence + movement.	No international standard for ballast water analysis at this time, but see US EPA ETV Protocol, v. 5.1	BLG 15/5/5 and BLG 15/5/6 BLG 15/INF.6	Can be expensive and time-consuming, needs trained personnel. (Note that OECD Test Guideline for Testing of Chemicals 202, "*Daphnia* sp. acute immobilization test and reproduction test" could be used as basis for standard methodology.)	To be determined.
Viable organisms ≥ 10 µm and < 50 µm	Visual counts with use of vital stains.	No international standard for ballast water analysis at this time, but see US EPA ETV Protocol, v. 5.1	BLG 15/5/10 (method) BLG 15/5/5 and BLG 15/5/6 (approach) MEPC 58 /INF.10	Requires specific knowledge to operate them. It should be noted that there may be limitations using vital stains with certain technologies.	To be determined. Steinberg et al., 2011
Viable organisms ≥ 10 µm and < 50 µm	Flow cytometers (based on *chlorophyll a* and vital stains).	No international standard for ballast water analysis at this time.	BLG 15/5/5 and BLG 15/5/6	Expensive and require specific knowledge to operate them. It should be noted that there may be limitation using vital stains with certain technologies.	To be determined.

Indicator	General approach	Standard method	IMO citation	Notes	Level of confidence or detection limit and citation for validation studies
Viable organisms ≥ 50 µm and Viable organisms ≥ 10 µm and < 50 µm	Flow cameras (based on *chlorophyll a* and vital stains).	No international standard for ballast water analysis at this time.	BLG 15/5/5 and BLG 15/5/6	Expensive and require specific knowledge to operate them. It should be noted that there may be limitations using vital stains with certain ballast water management systems.	To be determined.
Viable organisms ≥ 50 µm and Viable organisms ≥ 10 µm and < 50 µm	Culture methods for recovery, regrowth and maturation.	No international standard for ballast water analysis at this time.	BLG 15/5/5 and BLG 15/5/6	Require specific knowledge to conduct them. Densities are expressed as Most Probable Numbers (the MPN method). Most species do not manage to grow using this method therefore cannot be used alone. 2-3 weeks incubation time needed.	To be determined.
Enterococci	Culture methods.	ISO 7899-1 or ISO 7899-2	BLG 15/5/5 and BLG 15/5/6	Requires specific knowledge to conduct them. At least 44-h incubation time. EPA Standard Method 9230	To be determined.
Escherichia coli	Culture methods.	ISO 9308-3 or ISO 9308-1	BLG 15/5/5 and BLG 15/5/6	Requires specific knowledge to conduct them. At least 24-h incubation time. EPA Standard Method 9213D	To be determined.

Indicator	General approach	Standard method	IMO citation	Notes	Level of confidence or detection limit and citation for validation studies
Vibrio cholerae (O1 and O139)	Culture and molecular biological or fluorescence methods.	ISO/TS 21872-1/13/	BLG 15/5/5 and BLG 15/5/6	Requires specific knowledge to conduct them. 24-48 h incubation time. US EPA ETV Fykse et al., 2012 (semi-quantitative pass/fail-test) Samples should only be cultured in a specialized laboratory.	To be determined.
Enterococci, *Escherichia coli, Vibrio cholerae (O1 and O139)*	Culture with fluorescense-in-situ hybridization (FISH)	No international standard for ballast water analysis at this time.		Requires specific knowledge to conduct them. Quantitative and qualitative results after 8 h. Samples should only be cultured in a specialized laboratory.	To be determined.
Viable organisms ≥ 50 µm and viable organisms ≥ 10 µm and < 50 µm	Visual counts using stereo-microscopy examination and flow cytometry.	No international Standard for ballast water analysis at this time.	BLG 17/INF.15	A Sampling Protocol that identifies whether a system is broken or not working and producing a discharge that is significantly above the D-2 standard. Designed to detect gross non-compliance with 99.9% confidence. Needs to be Validated.	To be determined.

4.4 Table 5: General approaches for sampling use when testing for compliance with the BWM Convention

General approaches for sampling	Discharge line or BW tank	Citation for validation study or use	Sample error and detection limit	Relative sample error amongst approaches
Filter skid + isokinetic sampling	Discharge line	Drake et al., 201First et al., 2012 (land-based testing); shipboard validation underway, Prototype 01, SGS	To be determined	Lower
Cylinder containing plankton net + isokinetic sampling	Discharge line	MEPC 57/INF.17	To be determined	Lower
Sampling tub containing plankton net + isokinetic sampling	Discharge line	Gollasch, 2006 and Gollasch et al., 2007 Cangelosi et al., 2011	To be determined	Lower
Continuous drip sampler + isokinetic sampling	Discharge line	Gollasch and David, 2010, 2013	To be determined	Lower
Grab sample	BW tank	David and Perkovic, 2004; David et al. 2007, BLG14/INF.6	To be determined	Higher

4.5 Table 6: Sampling and analysis methods/approaches for use when testing compliance with the BWM Convention. A checkmark indicates an appropriate combination of sampling and analysis.

Analysis type **size class or indicator microbe** **analysis method/approach**	**Filter skid** **+** **isokinetic sampling**[3]	**Plankton net** **+** **isokinetic sampling**	**Continuous drip sampler** **+** **isokinetic sampling**	**Grab sample**
<u>Indicative Analysis</u> ≥ 50 μm Visual inspection Stereomicroscopy counts Flow cytometry Nucleic acid ATP *Chlorophyll a,* Bulk *FDA*	✓	✓		
<u>Indicative Analysis</u> < 50 μm and ≥ 10 μm variable fluorometry Flow cytometry Nucleic acid ATP *Chlorophyll a,* bulkBulk *FDA*			✓	✓

3 Methods other than using an isokinetic approach as defined in Guidelines (G2) for acquiring a representative sample may be used in certain circumstances. Such methods should be validated prior to use.

Analysis type **size class or indicator microbe** **analysis method/approach**	**Filter skid** **+** **isokinetic sampling**[3]	**Plankton net** **+** **isokinetic sampling**	**Continuous drip sampler** **+** **isokinetic sampling**	**Grab sample**
Indicative Analysis Enterococci, *E. coli* Fluorometric diagnostics			✓	✓
Indicative Analysis *Vibrio cholerae* Test kits Culture methods + microscopy			✓	✓
Detailed Analysis ≥ 50 µm Stereomicroscopy counts Flow cytometry/Flow camera	✓	✓		
Detailed Analysis < 50 µm and ≥ 10 µm Visual counts + vital stain(s) Flow cytometry/Flow camera Culture methods			✓	
Detailed Analysis Enterococci, *E. coli* Culture methods FISH with pre-cultivation			✓	
Detailed Analysis *Vibrio cholerae* Culture methods FISH with pre-cultivation			✓	

4.6 References

David M & Perkovic M (2004). Ballast Water Sampling as a Critical Component of Biological Invasions Risk Management, Marine Pollution Bulletin, Vol. 49, 313-318.

David M, Gollasch S, Cabrini M, Perkovič M, Bošnjak D & Virgilio D (2007). Results from the First Ballast Water Sampling Study in the Mediterranean Sea – the Port of Koper Study. Marine Pollution Bulletin 54(1), 53-65.

First MR, Lemieux EJ, Hyland WB, Grant JF, Moser CS, Riley SC, Robbins-Wamsley SH, Steinberg MK, Wier TP, Drake LA (2012). Validation of a closed-housing filter skid for in-line sampling of aquatic organisms. Journal of Plankton Research 34:321-331.

Fykse EM, Nilsen T, Nielsen AG, Tryland I, Delacroix S, Blatny JM (2012). Real-time PCR and NASBA for rapid and sensitive detection of *Vibrio cholerae* in ballast water. Marine Pollution Bulletin 64:200-206.

Gollasch S (2006). A new ballast water sampling device for sampling organisms above 50 micron. Aquatic Invasions, Volume 1, Issue 1: 46-50.

Gollasch S, David M, Voigt M, Dragsund E, Hewitt C & Fukuyo Y (2007). Critical review of the IMO International Convention on the Management of Ships' Ballast Water and Sediments. In Hallegraeff, G.M. (ed.): Harmful Algae 6, 585-600.

Gollasch S & David M (2013). Recommendations for Representative Ballast Water Sampling. Final report of research study of the Bundesamt für Seeschifffahrt und Hydrographie (BSH), Hamburg, Germany. Order Number 4500025702. 28 pp.

Gollasch S & David M (2010). Testing Sample Representativeness of a Ballast Water Discharge and developing methods for Indicative Analysis. Final report of research study undertaken for the European Maritime Safety Agency (EMSA), Lisbon, Portugal, 124 pp.

Steinberg MK, Lemieux EJ, Drake LA (2011). Determining the viability of marine protists using a combination of vital, fluorescent stains. Marine Biology 158:1431-1437.

U.S. Environmental Protection Agency (2010). Environmental Technology Verification Program (ETV) Generic protocol for the verification of ballast water treatment technology, Version 5.1. Report number EPA/600/R-10/146, United States Environmental Protection Agency, Washington, D.C.

Welschmeyer N & Maurer B (2012). A portable, sensitive plankton viability assay for IMO shipboard ballast water compliance testing. In: Proceeding of the Global R and D forum on Compliance Monitoring and Enforcement, Eds. A. Olgun, F.T. Karokoc and F. Haa.

Throndsen, J (1978). Chapter 7.6: The dilution-culture method. In Phytoplankton manual, Ed: Sourina, A., UNESCO, France, p. 218-224.

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ANNEX 2

TECHNICAL DISCUSSION FOR THE GUIDANCE TO BALLAST WATER SAMPLING AND ANALYSIS IN ACCORDANCE WITH THE BWM CONVENTION AND GUIDELINES (G2)

1 INTRODUCTION

1.1 The purpose of this annex is to provide background information on:

- the development and use of methodologies for both indicative and detailed analysis and appropriate sampling; and

- analysis of the sample at an accredited laboratory.

1.2 This annex highlights the advantages, disadvantages and limitations of many different measures. Although recommendations are given in this document on what methodologies may be used, there are distinct benefits in using certain technologies at certain times. This should not stop the use of any of the methodologies, as long as the limitations are taken into account.

1.3 Any methods for analysis used for assessing compliance with the BWM Convention should be carefully validated under a range of operating conditions.

2 INDICATIVE ANALYSIS: METHODOLOGY AND APPROACHES

2.1 The D-1 standard

2.1.1 The D-1 standard requires the vessel to exchange its ballast water 200 nm from the coastline in waters 200 m deep, or if this cannot be achieved for safety reasons, 50 nm from the coastline in waters of the same depth. Therefore, the water in exchanged ballast water should have a similar salinity to that of mid-ocean water.

2.1.2 Indicative analysis for the D-1 standard of the BWM Convention could rely on the chemical parameters (e.g. salinity) of the water in the ballast water discharge, or on an estimate of species present. However the latter might need trained personnel, If the ballast water discharge being tested has a salinity significantly less than that of 30 PSU, then it is likely that the ballast water has not been exchanged en route under the conditions required in the D-1 standard, or that the exchange has not been completed successfully.

2.1.3 Two exceptions to this are:

- when ballast water is taken up in port areas that are located in high-salinity environments, above 30 PSU. In such a case ballast water with a PSU of 30 may not originate from mid-ocean waters and therefore the ship may not be compliant with the D-1 standard; or

- when ballast water has been exchanged in designated ballast water exchange areas within 50 nm from the coastline in waters that may be of less salinity than the mid-ocean water. In this case the ballast water exchange would be compliant.

Therefore, the origin of the last ballast water exchange should be known before interpreting the results of salinity analysis.

2.1.4 Checking salinity could be backed up by further analysis of the organisms in the ballast water discharge to determine the origin of the ballast water; however, this would take time and need experienced staff. This can be done in line with the visual analysis methodologies outlined in paragraph 2.4.3 below. However, it should be noted that there are many external factors that could affect the salinity and the organisms in the ballast water, such as wet sediments in the ballast tanks, the state of the tide in the port concerned during its uptake and the fact that exchange may not remove all coastal organisms.

2.1.5 There are many ways to quickly and easily monitor the salinity of water on the market, and generic salinity measures should be used for indicative analysis.

2.2 Bacteria levels in the D-2 standard

2.2.1 Bacterial levels could be tested by a wealth of available portable methods. However, as the D-2 standard for bacteria is measured in colony forming units (CFU), the systems utilized may have to include a specific incubation time of the samples, which for commercially available systems is never shorter than four hours. Therefore, the time it takes for incubation limits the use of such systems for indicative analysis.

2.2.2 Advances in fluorometric diagnostics have resulted in a methodology that identifies the presence or absence of bacteria in a sample of the ballast water discharge. This methodology is based upon the detection of enzymes produced by the target bacteria in unconcentrated fresh water or marine samples and presently easily portable test kits for E. coli and Enterococci are available. This method can identify low levels of bacteria in water samples in less than 10 minutes, but the results are only semi-quantitative, i.e. a low level reading equates to a low level of bacteria. However, although the presence of bacteria can be shown, whether or not these organisms are living (i.e. form colonies) cannot be proven with this method at the present time. These diagnostic methods could be used in indicative analysis if very large numbers of organisms are identified.

2.3 Organisms of less than 50 micrometres and greater than or equal to 10 micrometres in minimum dimension[1] in the D-2 standard

2.3.1 Methods to measure the organisms in this category of the D-2 standard can be divided into two categories as follows:

- .1 the use of biological indicators for organisms:
  - .1 nucleic acid;
  - .2 adenosine triphosphate (ATP), a coenzyme used as the main energy storage and transfer molecule in the cells of all known organisms; and
  - .3 indicators for the presence of organisms, such as *chlorophyll a*;
- .2 the use of direct counts of living organisms (coupling a means to determine viability and manual or automatic counting of individual organisms).

[1] The "Minimum Dimension" means the minimum dimension of an organism based upon the dimensions of that organism's body, ignoring e.g. the size of spines, flagellae, or antenna. The minimum dimension should therefore be the smallest part of the "body", i.e. the smallest dimension between main body surfaces of an individual when looked at from all perspectives. For spherical shaped organisms, the minimum dimension should be the spherical diameter. For colony forming species, the individual should be measured as it is the smallest unit able to reproduce that needs to be tested in viability tests. This should be considered whenever size is discussed in this document.

2.3.2 The presence of nucleic acid or ATP in a sample may be taken as an indication of life, but it should be noted that this nucleic acid or ATP could come from any living organism of any size within the sample. There are no definitive methods available to correlate the amount of nucleic acid or ATP with the amount, or viability of organisms in the sample and, therefore, the presence of these chemicals are limited as an indicative analysis methodology. However, zero measurements of these chemicals may indicate that no organisms are in the sample, i.e. the treatment process was successful and in the D-2 standard is being met. Additionally, if nested filters are used to isolate specific size groups, then ATP, which degrades relatively quickly, can provide an indication of the potential presence of a large concentration of organisms in one size class. If linked to thresholds of ATP concentrations, this can be used to indicate samples which are highly likely to be above the standard.

2.3.3 The same problems occur when using other bio-chemical indicators to monitor the number of organisms in this category. As many of the organisms in this size range are likely to be phytoplankton, an obvious step would be to measure the level of *chlorophyll a*, a photosynthetic pigment which is essential for photosynthesis in the sample. Zero concentrations may indicate that there is no phytoplankton in the sample and chlorophyll *a* may also be a good indicator as to whether a BWMS using an oxidizing process was working to design dosages, as it might be expected to bleach such pigments. However, caution has to be exercised as:

.1 *chlorophyll a* can persist in seawater outside of a cell, therefore sampling should only be limited to the particulate phase. However, nucleic acid and ATP can exist in dead organisms, detrital material, senescent or dead cells, decomposing macroalgae, plant detritus from terrestrial ecosystems and other non-living particles, etc.;

.2 there may be zooplankton in the sample being analysed;

.3 no cell count can be directly measured from a *chlorophyll a* measurement, as many small cells may provide a similar signal strength to that of fewer bigger cells; and

.4 no size distinction can be made and the *chlorophyll a* could derive from phytoplankton in the larger size category of the D-2 standard.

As a consequence, direct concentration measurements of this chemical would be difficult to use in indicative analysis. A wealth of portable tools exists to document the *chlorophyll* a content in seawater.

2.3.4 One potential exception is the Pulse-Amplitude Modulated Fluorometer (PAM) which measures the *chlorophyll a* fluorescence in living cells by exciting *chlorophyll a* molecules and registering the subsequent fluorescent signal. Such a response is only available in living cells and it should be noted that this method only provides an indirect measurement of those phytoplankton that use *chlorophyll a* in the sample, in both size categories of the D-2 standard. Testing this methodology on ballast water discharges suggests that there is a correlation between the ratio of variable and maximum fluorescence and the number of phytoplankton in this size category. However, the relationship between fluorescence signals and mixed assemblages of phytoplankton from different locations needs to be validated.

2.3.5 For analysis of organisms above 10 microns in minimum dimension, a flow cytometer may also be used. A common element of these systems is that they automatically count objects, including organisms, per size class in a fluid. The more simplified systems cannot separate organisms from sediment and detritus, or living from dead organisms. More sophisticated systems can also assess organism viability for phytoplankton by using organism stains together with flow cytometry. The separation of living phytoplankton from detrital material and zooplankton is based on the presence of auto chlorophyll fluorescence of phytoplankton cells. It should be noted, however, that using *chlorophyll a* fluorescence as an indicator of living organisms may result in over counting, as the molecule can remain intact for a significant amount of time as has been proved in preparing fixed (dead) samples. The practicability to use such devices on board a ship should be carefully assessed before use. To make a stable stream to produce adequate size of water particles, the device should be set in perfectly horizontal. Also any vibration should be isolated for accurate measurement.

2.3.6 Systems using flow cytometry deliver automated results promptly and may be used to assess the number of living phytoplankton in a sample after treatment with a viability stain. However, readings provided by the flow cytometer should also be examined manually to verify the automated readings. Concerns have been raised by users that the viability of smaller algae may not always be categorized correctly in these systems, as the viability signal may be too low for detection. Other concerns include the efficiency of portable versions and the limited ability of some of them to monitor organisms greater than or equal to 50 micrometres in minimum dimension. Although these systems may become a major tool in the future, there are elements, such as the reliability of portable versions of the systems that limit their use at the present time, which is especially the case for organisms greater than or equal to 50 micrometres in minimum dimension. Also, it is not clear if the time to analyse a sample is greater than can be allotted in compliance testing. These can be overcome by taking the sample off the ship and using a fixed or mobile system near to the ship or the port.

2.3.7 Visual inspection could be another method of indicative analysis that is a quick and simple way to justify the need for detailed analysis. Taking an appropriate sample, concentrating it if necessary, and visually inspecting it against the light may show living organisms in the sample, but it should be noted that without magnification a visual inspection is likely to result in only organisms greater than or equal to 1,000 micrometres in minimum dimension being detected, unless chains or clumps are formed by colony forming organisms or the density of organisms is sufficiently large to colour the water. An assessment of the viability in such an inspection is limited to complete body movements of the organisms as organ activity and antennae or flagella movements may not be seen. As samples from BWMS that are not compliant are likely to contain organism levels that are orders of magnitude above the D-2 performance standard, visual inspections could be used in indicative analysis. However, it is assumed that only organisms bigger than 1,000 micrometres in minimum dimension may be determined in such way, therefore its use for this size category is limited.

2.3.8 Visual inspection can also be undertaken using a field stereomicroscope with a low magnification (e.g. x 10). However, this methodology may require concentration of the sample and may need analysis by a trained operator to detect viable organisms. It should be also be noted that this methodology would be more efficient and practicable for organisms greater than or equal to 50 micrometres in minimum dimension.

2.4 Organisms greater than or equal to 50 micrometres in minimum dimension in the D-2 standard

2.4.1 Many of the methodologies for monitoring organisms less than 50 micrometres and greater than or equal to 10 micrometres in minimum dimension may also be valid for monitoring organism levels in this category. However, nucleic acid and ATP methodologies encounter the same problems as outlined in paragraphs 2.3.2 and 2.3.3; and monitoring *chlorophyll a* levels, through fluorometers or the PAM methodology described above, has limited value for this size category of the D-2 standard, as the majority of organisms in this category are likely to be zooplankton.

2.4.2 Visual inspections may significantly underestimate the number of organisms in this size category due to the issues described in paragraph 2.3.8. However, the method may be robust enough to determine whether the BWMS is working at orders of magnitude above the D-2 standard based on a simple extrapolation from the sample to the D-2 standard. Detailed analysis may be needed to confirm this, especially when levels near the D-2 standard are encountered.

2.4.3 Additionally, stereomicroscopy can also be used to identify viable organisms greater than or equal to 50 micrometres in minimum dimension. The sample should be concentrated appropriately. Viability assessment should be based on movements of intact organisms. This movement may be stimulated. In addition organ activity should be observed and fully intact non-moving organisms which show organ activity should be counted as living. Stains might also be used to help in viability determination – though methods are still under development. The viable organism numbers should be recorded and the numbers extrapolated up to the total volume of water filtered.

2.4.4 If the results in paragraphs 2.4.2 and 2.4.3 show elevated levels of organisms, then this result will indicate that the D-2 standard is not being met.

2.4.5 Further research must be encouraged; innovative methods for assessing for D-2 compliance, preferably based on in situ, automatic sampling and analytical procedures, should facilitate the most uniform implementation of the BWM Convention.

2.5 Operational indicators

2.5.1 Other indirect parameters and indicators could be used to indicate whether a BWMS is meeting the D-2 standard. These include, but are not limited to, indicators from the electronic self-monitoring of the BWMS and residual chemicals (or lack of) from the BWMS, such as dissolved oxygen levels, residual chlorine, etc.

3 DETAILED ANALYSIS METHODOLOGIES AND APPROACHES

3.1 Once detailed analysis has been instigated by the port State, they should be prepared to undertake full analysis of the sample at an appropriate laboratory.

3.2 Bacteria

3.2.1 There are already international standards in place to analyse for the bacteriological indicators contained within the D-2 standard.

3.2.2 For Enterococci, ISO 7899-1 or 7899-2; or Standard Method 9230 (in the United States) should be used, and ISO 9308-3, ISO 9308-1 or Standard Method 9213D (in the United States) are appropriate for Escherichia coli. The methods used should be quantitative and based on a 95-percentile statistical evaluation. The number of laboratory samples should be sufficient to define the mean and standard deviation of Log 10 bacterial enumerations.

3.2.3 For *Vibrio cholerae* ISO/TS 21872-1/13 is appropriate. 100 ml of ballast water should be filtered and incubated according to ISO/TS 21872-1. Analysis needs to be undertaken in a specialist laboratory.

3.3 Organisms of less than 50 micrometres and greater than or equal to 10 micrometres in minimum dimension

3.3.1 Many of the analysis methods used to ascertain the numbers of organisms within this category have already been discussed in section 2. However, section 2 focuses on indicative analysis, rather than the more detailed analysis. Therefore, the following sections examine these methodologies in more detail. Some of these methodologies discussed here also relate to organisms greater than or equal to 50 micrometres in minimum dimension.

3.3.2 Simple upright and inverted microscopes are very useful for the enumeration of morphologically healthy organisms and motile organisms, as well as for measuring the size of organisms. Using this technology needs some skill and experience to evaluate the health of the individual organisms in the sample. However, this technology and experience should be available globally.

3.3.3 Fluorescence generated from photosynthetic pigments can be used for more detailed analysis of the morphological health of organisms and for the evaluation of stained organisms and a microscope with fluorescence capabilities is needed. However, this methodology only identifies phytoplankton (both living and dead) in the sample and makes no size differentiation. Zooplankton should be analysed through the methods highlighted in section 3.4.

3.3.4 Fluorescein di-acetate (FDA), chloromethylfluorescein diacetate (CMFDA) and Calcein-AM vital stains have both been used to determine viability. When non-specific esterases (enzymes found in live cells) are present, they cleave the acetate groups from the stains, and the resultant fluorescein molecules fluoresce green when illuminated with a blue light from an epi-fluorescence microscope. This method works best with live samples. Microscopes with a fluorescence capability and operators with skills and experience of analysis should be available at universities and research laboratories worldwide. However, it should be noted that these stains do not always work on all species or at all salinities and further research to validate this approach may be needed to support the use of these stains for this type of analysis.

3.3.5 Flow cytometers are advanced technologies which can be used in a laboratory to determine size, and viability of organisms in ballast water when a reliable vital stain(s) is (are) used to indicate organism viability. Cytometer detected particles, including organisms, can be processed visually or by a computer to quantify viable organisms in that sample. These systems reduce manual labour, but require specific knowledge to operate them. High particle loads in ballast water may reduce the detection limits of these methodologies and the volume of samples analysed. At the present, portable versions of these technologies have not fully been proven for use on ballast water discharges, however, samples could be taken off the ship and analysed using a fixed or mobile system near to the ship or the port.

3.3.6 Regrowth experiments, in which the visual appearance of photosynthetic organisms in a sample is followed by a specific period in order to quantify the Most Probable Number (MPN), are methods to evaluate the number of organisms in a sample. However, these are slow and are work intensive. In addition, a major drawback of this methodology may be that specific growth factors during the incubation may not be fulfilled, giving a risk of bias. Regrowth and reproduction may be seasonably variable, giving different results at different times. Further, a viable organism may be in good health and reproducing rapidly, or in poor health, not reproducing until health has improved. Finally, this is likely to be time-consuming.

3.3.7 Bulk parameter measurements, such as photosynthetic activity, are also not suitable for detailed analysis (please see paragraphs 2.3.2 and 2.3.3), but can be used as supporting data for other methods used to determine the number of viable organisms in the ballast water samples.

3.3.8 Planktonic organisms may be fragile and samples may need to be concentrated further to aid the accurate quantification of organisms. There are many methods to achieve this, however, care has to be taken to reduce physical stress as this may result in reduced viability levels. A simple, rapid, flexible and cautious method for concentrating plankton cells is the use of transparent membrane filters. If the sample analysis is performed on board the sample can be filtered directly on to this membrane, which can subsequently be placed directly under a microscope for examination. The sample volume to be analysed would need to be adjusted depending on the cell density, however, live, vital stained and fixed organisms within this size category can be evaluated on these filters. If the representative analysis is performed at a laboratory, this process for concentration should be performed at the laboratory just before starting the staining process to avoid under-estimate of viable organisms. Importantly, the loss (if any) of organisms (i.e. those cells passing through the filter and recovered in the filtrate) would need to be determined. Alternatively a filter mesh may be used to concentrate the sample and the concentrated organisms may, after filtration, be transferred into an observation chamber. Again, the loss of organisms through damage must be quantified.

3.4 Organisms greater than or equal to 50 micrometres in minimum dimension in the D-2 standard

3.4.1 Paragraphs 3.3.2 to 3.3.8 are also applicable to the analysis of organisms in this size category.

3.4.2 In addition, the following issues need to be considered when developing a methodology for analysing organism numbers in this size category:

.1 testing the sample for movement and response to different stimuli are simple techniques for the examination of viable/dead zooplankton under a stereomicroscope. The observation for organ activity, such as heartbeats, may also contribute to the viability assessment. The use of a filtering mesh (e.g. 50 microns in diagonal dimension) under the Petri dish of the stereomicroscope, or the addition of 50 micron micro beads to the sample, may help with size calculations and vital stains may also add value to these methodologies. Separate guidelines on this issue are being developed through the land-based facilities and the ETV protocol in the United States;

.2 methods using a combination of flow cytometry and microscopy have the disadvantage of high complexity, high price and small sample sizes, which means the ballast water samples would have to be concentrated further; and

.3 the storage condition and time before analysis is likely to be critical to reduce mortality in the sample.

3.4.3 It is therefore recommended that simple microscopic examination of organisms in this size category is used for compliance monitoring. The microscopic examination of organisms is a robust, simple and cheap methodology which can be completed in laboratories worldwide.

4 Sources of error

4.1 The ideal method for compliance monitoring is a procedure that:

- detects organisms in the ballast water discharge;
- has an appropriate limit of detection;
- is precise;
- is accurate;
- is economical;
- is quick;
- can be carried out with minimal technical expertise; and
- can be obtained in all parts of the world.

However, any result obtained would have to include confidence limits based on both the sampling error and analytical error.

4.2 Sources of error include, but are not limited to, errors arising within:

.1 sampling, including:

- sample loss (e.g. during filtration);
- incorrect use of equipment;
- day-to-day variations in the conditions in which the sampling is taking place; and
- the experience of the technicians;

.2 processing the sample, including:

- incorrect use of equipment;
- day-to-day variations in the conditions in which the sampling is taking place; and
- the experience [and fatigue] of the technicians;

.3 analysis of the sample:

- incorrect use of equipment;
- the experience [and fatigue] of the technicians;
- day-to-day variations in the conditions in which the sampling is taking place;
- the number of organisms counted. The distribution of organisms in a range of samples usually follows the Poisson distribution and higher numbers of samples give a lower relative variation and sample error;
- the inherent variation and errors arising from the methods used for analysis. This is especially so when the evaluation of organism numbers in a sample is based on manual counting methods due to human error. For example, although the definition of the minimum dimension of an organism in Guidelines (G2) is quite detailed, analytical results may be influenced by practical issues. These include situations when the size of an organism is determined on a two dimensional microscope, which cannot view the organism "from all perspectives"; and
- poor harmonization between laboratories and quality control within the laboratory. In the field of chemical analysis, inter-laboratory calibration occurs and is tested. Inter-laboratory calibration of biological samples is also common practice, but the difficulty in the compliance monitoring context is that the viability of the organisms needs to be documented and the viability may be impaired by the mode and duration of sample shipments to different laboratories. Therefore, laboratories should be well managed, and uncertainty limits (the analysis variation) should be calculated for each laboratory. This should be achieved in conjunction with ISO 17025, which provides a standard for the general requirements needed by laboratories to prove they are competent to carry out tests and/or calibrations, including sampling.

4.3 The variation arising from sampling should be added to that from analysis to determine the confidence limits within which the true value of the organism number lies. This has an important bearing on how the result can be used for enforcement of the BWM Convention.

4.4 The sampling uncertainty can be obtained by setting up a null–hypothesis, that is a general or default position that is expected in the results, e.g. the average concentration of organisms is equal to the D-2 standard at a selected level of significance and then the data would be analysed using one of the following tests:

Table 1: Statistical handling of the results

Distribution of the results	Test	Notes
Normal distribution	t-test	It is unlikely this test will be used, as it is not used with "rare" populations, i.e. the expected population of organisms in treated ballast water
A distribution that is not normal	Non-parametric Wilcoxon rank test	Not normal due to the small number of samples
Poisson distribution	Chi-square test	Used when the analytical results are treated as one sample (i.e. the numbers of organisms over the entire volume are very rare [low] and combined).

Ideally, an analysis of the distribution should be performed before the data are statistically evaluated.

4.5 There has been much discussion within the IMO on whether the results of the analysis should be averaged to assess compliance or that every result should have to meet the D-2 standard. This is a unique debate at IMO due to the biological nature of the subject matter being analysed, and different States have significantly different views on this issue. Therefore, it will be very difficult to arrive at a conclusion as in the case of non-compliance the results of the analysis are likely to be used in the legal jurisdictions of each IMO Member State, and each of those States may require different evidence to support any enforcement action.

4.6 If the results of detailed analysis are to be averaged, then both the sample variation and the analysis variation need to be calculated and applied to the result. However, some analysis of the sample variation may be needed, as it may be unacceptably high. For example, for five treated ballast water samples, viable organism number results of 9,9,9,9 and 9 will provide the same average as 0,0,0,0 and 45. Both systems would pass the D-2 standard, if averaged; however, the variation is considerably bigger for the second set of results and may prove to be unacceptable because of the one large value.

4.7 If each of the results is treated as an individual value that has to meet the D-2 standard, then again the confidence limits would have to be calculated from the sampling and analytical errors. Here if all results are less than the D-2 standard, then the sampling has proved that the BWMS is meeting the standard.

4.8 The basic difference between instantaneous and average approaches is that the results of the average approach describe the variations of the concentration of organisms during the de-ballasting event, whereas the results of the instantaneous approach describes the variation based on the assumptions of the Poisson distribution. However, the average approach, based on the results of a few samples, has the disadvantage that the variation may be too high, is unacceptable and needs to be improved, which could invalidate the evaluation and lead to inconclusive results.

4.9 The instantaneous approach has the disadvantage that variations in the organism levels at different times of the discharge are not taken into account, which should not be a problem if all the samples meet the D-2 standard. If the discharge is not always under the D-2 standard, the problem can be mitigated by using a flow-integrated sample over set periods of time, which, if taken properly, represents an average of the organisms in the treated ballast water over that time when presented with variance estimates and confidence intervals. This constitutes a better representation of the ballast water quality than separate samples. In addition, a lower variation should be obtained because a larger sample is being analysed. The average approach is likely to have the same disadvantages unless the samples are very large and collected over most of the discharge.

4.10 The differences between applying an instantaneous sampling regime or an average sampling regime to the result are less extreme when taking numerous flow-integrated samples. This is because for each discharge there will be a number of results arising from samples that have been averaged over a specific time.

5 DETAILED ANALYSIS: THE SAMPLE PROTOCOL

5.1 Sample protocols for discharges of treated ballast water through a distinct discharge point fall into two categories, the first based on specified and replicated volumes and the second based on flow integration over a specified time. The first entails taking a specific number of set volumes of the ballast water discharge, whilst the second takes a continuous sample over a set time period. The flow integration sampling protocol can be achieved by either continuously sub-sampling a small amount throughout the entire duration of the discharge, therefore collecting one sample over time, or taking multiple sub-samples over a specific time scale (i.e. 5 minutes, 10 minutes or 15 minutes) repeatedly throughout the discharge, providing a result for each sub-sample.

5.2 However, for sampling protocols based on specified and replicated volumes, defining both the number of samples and their volume to ensure representativeness, takes time. As a representative sampling procedure is needed to ensure compliance with the BWM Convention, then the flow integration protocols based on set times should be implemented.

5.3 Using a sampling protocol that continuously sub-samples small amounts throughout the entire duration of the discharge, may significantly underestimate the amount of larger organisms (i.e. organisms greater than or equal to 50 micrometres in minimum dimension) in the sample due to damage to the organisms held in the cod-end of the filter. If such a system is used then a protocol for replacing the cod end needs to be developed.

5.4 The arrangements for detailed analysis should take into account the requirements of the methods and/or approaches they intend to use for detailed and/or indicative analysis. Special consideration should be given and contingencies arranged for sampling in remote ports, where it is likely to take time to mobilize samplers and sampling resources.

6 DETAILED METHODOLOGY

6.1 As described in paragraph 5.1, there are two distinct ballast water sampling protocols, one based on flow integration and one based on the use of specified and replicated volumes. As they both use filtration and concentration of the sample the following section can apply to both methods.

6.2 For in-line sampling, a sampling system should be set up which:

- collects organisms greater or equal to 50 μm;
- allows samples of the ballast water to be taken and filtered;
- enables the amount of ballast water sampled to be measured to allow for extrapolation of the results; and
- allows the filtered ballast water to be discharged safely without affecting the stability and safety of the ship, its crew and the samplers, or other discharges from the vessel such as bilge water.

ANNEX 6

RECOMMENDATIONS RELATED TO THE TRIAL PERIOD FOR REVIEWING, IMPROVING AND STANDARDIZING THE CIRCULAR ON GUIDANCE ON BALLAST WATER SAMPLING AND ANALYSIS FOR TRIAL USE IN ACCORDANCE WITH THE BWM CONVENTION AND GUIDELINES (G2)

Introduction

1 Circular BWM.2/Circ.[...] provides the current state of knowledge of methods and approaches for ballast water sampling and analysis.

2 It is recognized that the many of the sampling and test methods in the circular have not yet been adequately validated. As a consequence, these methods have not yet been fully integrated in port State control procedures in order to validate their practical utility for determining compliance with the Convention. Given that these methods are rapidly improving, Member States and observers are encouraged to further develop sampling and analysis protocols, including but not limited to, the range of options outlined in the Circular. Information on detailed protocols should be provided to the Sub-Committee for inclusion in revisions of the Circular as appropriate.

3 Once the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 enters into force, a trial period will be initiated where port State control can further trial the approaches in the circular to ensure they are practical and fit for purpose. The trial period would be for 2 to 3 years following entry into force of the Convention.

4 It is to be noted that MEPC 64 agreed that sampling for port State control should be no more stringent than the sampling used for type approval of a ballast water management system.

5 The results of the trial will be reviewed by the Committee and when appropriate the trial should be halted or extended. The goal at the end of the trial period would be to have a suite of accepted procedures that can be used for sampling and analysing ballast water in a globally consistent way.

Nature of Trial Period

6 The trial period, and the data gathered during the trial, is essential in providing a sound basis for future enforcement. Prior to a satisfactory completion of the trial period, leading to agreement on the appropriate sampling and analysis protocols, port States would refrain from applying criminal sanctions or detaining the ship, based on sampling. This does not prevent the port State from taking preventive measures to protect its environment, human health, property or resources

7 During the trial period, aside from the provision above relating to sampling, all port State control activities (for example certificate review and operating procedural review) and enforcement options will be available to port State control. Therefore, the ship should have evidence that the ballast water management system is Type Approved and has been maintained and operated in accordance with the ships' Ballast Water Management Plan. The system should incorporate a self-monitoring system in accordance with the Guidelines (G8) and associated guidance. Having a treatment system particulars document on board is also recommended (see document MEPC 61/INF.19).

Trial Procedure

8 The trial will evaluate, review and assess the potential sampling and analysis protocols with a view to recommending for approval by the Committee detailed analysis protocols that may be used to assess compliance with regulation D-2 of the Convention.

8.1 At least one standard precise protocol for indicative and detailed analysis of organisms at each size class is desired; the trial may, however, identify that multiple protocols are available for detailed or indicative analysis at a given size class. Key factors to be reviewed for each protocol will be:

8.1.1 Practicability:

.1 Cost effectiveness and timeliness; and

.2 General applicability with regard to vessel type and geographic region.

8.1.2 Effectiveness in assessing compliance:

.1 Consistency with Guidelines (G8) Type Approval sampling procedures

9 In advance of the trial, before the required entry into force conditions for the BWM Convention have been met, the following actions are anticipated:

.1 development of new methods and scientific validation of new and existing methods, approaches and general approaches communicated to the Organization are incorporated into BWM.2/Circ.[…] on an on-going basis;

.2 further development of PSC guidance by FSI; and

.3 development and approval of the process by which the trial will be evaluated.

10 In advance of the trial, at the first meeting of the Sub-Committee after the required entry into force conditions for the BWM Convention have been met, the following actions are anticipated:

.1 The methods and approaches in BWM.2/Circ.[…] that are considered mature enough for use in the context of port state control are identified for inclusion in the trial;

.2 taking into account the methods and approaches identified in paragraph 10.1, the trial procedure is reviewed and confirmed; and

.3 the methods and approaches and trial procedure identified are communicated to all interested parties by the Organization.

11 During the trial, the following actions are anticipated;

.1 port States sample and analyse the ballast water on vessels according to the port State control guidelines, using the methods and approaches selected in paragraph 10.1; and

.2 port States share the results of the sampling and analysis process as usual, making clear the trial nature of the procedure.

12 Following the first year of the trial, which begins upon the entry into force of the convention, the following actions are anticipated:

.1 port States that sample and analyse the ballast water of ships may submit information reports to the BLG Sub-Committee on the key factors for review listed in paragraph 8, and generally on any insights gained that are relevant to the purpose of the trial period;

.2 similarly, Member States and observers may submit information reports containing similar insights drawn from their experiences or brought to their attention during the trial; and

.3 following consideration of these reports, the Organization reviews the details of the methods and approaches being trialled and/or removes/adds methods and approaches as appropriate. Appropriate revisions are made to BWM.2/Circ.[…] and communicated to all interested parties by the Organization.

13 Following the second year of the trial, the following actions are anticipated:

.1 the actions described in paragraph 12 are repeated;

.2 the reports from both years of the trial are reviewed to determine if changes are needed to standardize the options available; and

.3 consideration is given to any need to extend the trial to a third year.

14 Following the conclusion of the trial, the following actions are anticipated:

.1 recommendations are provided to the Committee on standardized sampling and analysis protocols considered appropriate for use in the assessment of compliance with regulation D-2, and amendments are incorporated in BWM.2/Circ.[…];

.2 the agreed arrangements in paragraphs 6 and 7 in place for the trial are discontinued; and

.3 advances in scientific knowledge on methods, approaches and general approaches that are communicated to the Organization are considered by the Committee and may be incorporated into BWM.2/Circ.[…] if approved, for use by port State control officers.

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BWM.2/Circ.43
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INTERNATIONAL CONVENTION FOR THE CONTROL AND MANAGEMENT OF SHIPS' BALLAST WATER AND SEDIMENTS, 2004

Amendments to the Guidance for Administrations on the type approval process for ballast water management systems in accordance with Guidelines (G8) (BWM.2/Circ.28)

1 The Marine Environment Protection Committee, at its sixty-first session (27 September to 1 October 2010), approved the Guidance for Administrations on the type approval process for ballast water management systems in accordance with Guidelines (G8) developed by the BLG Sub-Committee at its fourteenth session (8 to 12 February 2010) as disseminated in BWM.2/Circ.28.

2 MEPC 65 (13 to 17 May 2013) approved amendments to BWM.2/Circ.28, agreed by BLG 17 (4 to 8 February 2013), as set out in annex 1.

3 For ease of reference, the entire text of the Guidance for Administrations on the type approval process for ballast water management systems in accordance with Guidelines (G8), as amended by MEPC 65, is set out in annex 2.

4 The text of the Guidance, as set out in annex 2, supersedes the text contained in BWM.2/Circ.28.

5 Member Governments are invited to bring this circular to the attention of all parties concerned.

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ANNEX 1

AMENDMENTS TO THE GUIDANCE FOR ADMINISTRATIONS ON THE TYPE APPROVAL PROCESS FOR BALLAST WATER MANAGEMENT SYSTEMS IN ACCORDANCE WITH GUIDELINES (G8) (BWM.2/CIRC.28)

1 Paragraphs 3.1.14 and 3.1.15 are replaced by the following:

"3.1.14 Provided the following, when submitting the Type Approval application:

.1 sufficient information to verify operation in different salinity ranges (fresh, brackish and marine water) in which the BWMS will operate;

.2 sufficient information to verify operation in the different temperature ranges (cold, temperate and tropical) in which the BWMS will operate;

.3 sufficient information to verify operation with the different sediment loads under which the BWMS will operate;

.4 sufficient information to verify operation of the minimum effective treatment flow rate as well as the maximum Treatment Rated Capacity (TRC) including the duration of these tests; and

.5 suggestions for improvements of the installation related to safety or additional testing R&D,

3.1.15 Made all laboratory-scale and, if appropriate, full-scale land-based test results and documentation available, including all unsuccessful, failed and invalid tests, to the Administration; and"

2 A new paragraph 3.1.16 is added as follows:

"3.1.16 Made all shipboard test results and documents available, including all unsuccessful, failed and invalid tests as well as detailed information of the test set up and flow rate at each test cycle, to the Administration."

3 A new paragraph 3.2 is added as follows:

"3.2 In accordance with paragraphs 4.10 to 4.14 of Guidelines (G8), Administrations should ensure that type approved BWMS have a suitable self-monitoring system that will monitor and record sufficient data to verify correct operation of the system. Administrations should make every effort to ensure that newly installed BWMS that have already been granted Type Approval meet this recommendation within one year following approval of this circular. Administrations should issue treatment system particulars, including details of the self-monitoring system (as described in document MEPC 61/INF.19), for all type-approved systems."

4 Paragraph 5.2.13 is replaced with the following:

"5.2.13 A safety and hazard assessment of the installation, operation and maintenance of the BWMS on the shipboard test is undertaken and approved in line with the technical guidance developed by the Organization (BWM.2/Circ.20), and includes as a minimum:

.1 any potential impact on the crew health and safety; and

.2 references to the classification society safety and hazard rules and recommendations."

5 Paragraph 5.3.4 is replaced with the following:

"5.3.4 In accordance with Guidelines (G8), the appendix of the Type Approval Certificate should include details on all imposed limiting conditions on the operation of the BWMS. Such limiting conditions to include any applicable environmental conditions (e.g. salinity, UV transmittance, temperature, etc.) and/or system operational parameters (e.g. min/max pressure, pressure differentials, min/max Total Residual Oxidants (TRO), etc.)."

6 Paragraph 5.3.5 is replaced with the following:

"5.3.5 An annex to the Type Approval Certificate should contain the test results of each land-based and shipboard test run. Such test results shall include at least the numerical salinity, temperature, flow rates, and where appropriate UV transmittance. In addition, these test results shall include all other relevant variables."

7 Paragraph 6.1 is replaced with the following:

"6.1 The Administration should forward a report of the Type Approval process to the Organization including the relevant documentation as specified in resolution MEPC.228(65)."

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ANNEX 2

GUIDANCE FOR ADMINISTRATIONS ON THE TYPE APPROVAL PROCESS FOR BALLAST WATER MANAGEMENT SYSTEMS IN ACCORDANCE WITH GUIDELINES (G8)

1 PURPOSE

1.1 This document provides guidance for Administrations on the procedure for evaluating an application for Type Approval of a ballast water management system (BWMS), in accordance with the *Guidelines for approval of ballast water management systems (G8)*. This document can act as an aide-memoire for Administrations and is not intended, in any way, to interfere with the authority of an Administration.

1.2 This document provides guidance on interpretation of Guidelines (G8) and does not replace or supersede the requirements of those Guidelines.

1.3 This document is intended to provide guidance to Administrations on the details of the Type Approval to be reported to the Committee.

2 KEY DOCUMENTS

2.1 In evaluating an application for Type Approval of a BWMS, the latest version of the following documents should be consulted:

- The International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention);

- *Guidelines for approval of ballast water management systems (G8)*;

- *Procedure for approval of ballast water management systems that make use of Active Substances (G9)*;

- *Guidelines for ballast water sampling (G2)*;

- *Guidance to ensure safe handling and storage of chemicals and preparations used to treat ballast water and the development of safety procedures for risks to the ship's crew resulting from the treatment process*;

- Resolution MEPC.175(58) – *Information reporting on type-approved ballast water management systems*;

- Methodology for information gathering and conduct of work of the GESAMP-BWWG; and

- Other pertinent ballast water management resolutions, guidance and circulars.

3 RECOMMENDATIONS FOR REQUIREMENTS OF MANUFACTURERS OR THEIR AGENTS

3.1 To facilitate Type Approval of a BWMS, the Administration should ensure that the manufacturers, or their agents have, at minimum:

.1 been informed if the Administration delegates to or utilizes the services of a third party quality assurance organization (e.g. Recognized Organization, nominated body, classification society, surveyors, etc.) in some, or all of the Type Approval processes;

.2 understood the steps and requirements of the processes outlined in the documents listed in section 2 of this document;

.3 a fully working system built that can be used in the Type Approval process. It should be noted that the construction procedures and materials for the unit tested need to be the same as for the follow-on production units;

.4 undertaken preliminary testing to ensure that their BWMS is viable, will meet the D-2 standard of the BWM Convention, will work on board a ship and that the system has been determined not to pose any unacceptable risk to the environment;

.5 understood the extent of testing that needs to be completed by a recognized testing facility, including toxicity analysis;

.6 provided a description of the preliminary test to the Administration that should at least include the following:

.1 the test set-up, including sampling points;

.2 responsible persons/organizations for all or portions of the preliminary testing;

.3 possible Quality Management Plan (QMP) of the testing facility;

.4 testing laboratories that will be used;

.5 Quality Assurance Project Plan (QAPP) for the preliminary test; and

.6 provision for survey of the test facility, if required;

.7 provided a detailed report of the preliminary test results including, at least:

.1 toxicity data;

.2 Active Substances if relevant; and

.3 any other chemicals generated during the process;

.8 an understanding of whether the system under consideration, uses an Active Substance, as defined in the BWM Convention. If it utilizes an Active Substance, the system will require additional approval under Procedure (G9), whilst the systems not using an Active Substance only need approval under Guidelines (G8);

.9 a contractual agreement to undertake the shipboard testing needed under Guidelines (G8) with the owner of a suitable ship;

.10 arranged for a trained person to be present at the land-based testing facility to operate the equipment being type approved and ensure that for the shipboard test the ship's crew is familiar with the equipment and sufficiently trained to operate the equipment;

.11 consulted with the classification society that the ship undertaking the shipboard testing is being registered, where necessary, and obtained approval for installation of the BWMS;

.12 demonstrated by using mathematical modelling and/or calculations or by full-scale shipboard testing, that any up or down scaling will not affect the ultimate functioning and effectiveness on board a ship of the type and size for which the equipment will be certified. In doing so, the manufacturers should take into account all relevant guidance developed by the Organization;

.13 prepared a Type Approval application in compliance with Guidelines (G8), annex, part 1, that includes at least the following:

.1 detailed description of the design, construction, operation and functioning of the BWMS;

.2 preliminary assessment of the corrosion effects of the system proposed;

.3 preliminary test results;

.4 technical Manual;

.5 BWMS piping and instrumentation diagram (P&ID);

.6 link to the provisions required in a ballast water management plan;

.7 environmental and public health effects; and

.8 specific salinities to be tested;

.14 provided the following, when submitting the Type Approval application:

.1 sufficient information to verify operation in different salinity ranges (fresh, brackish and marine water) in which the BWMS will operate;

.2 sufficient information to verify operation in the different temperature ranges (cold, temperate and tropical) in which the BWMS will operate;

.3 sufficient information to verify operation with the different sediment loads under which the BWMS will operate;

.4 sufficient information to verify operation of the minimum effective treatment flow rate as well as the maximum Treatment Rated Capacity (TRC) including the duration of these tests; and

.5 suggestions for improvements of the installation related to safety or additional testing R&D;

.15 made all laboratory-scale and, if appropriate, full-scale land-based test results and documentation available, including all unsuccessful, failed and invalid tests, to the Administration; and

.16 made all shipboard test results and documents available, including all unsuccessful, failed and invalid tests as well as detailed information of the test set up and flow rate at each test cycle, to the Administration.

3.2 In accordance with paragraphs 4.10 to 4.14 of Guidelines (G8), Administrations should ensure that type approved BWMS have a suitable self-monitoring system that will monitor and record sufficient data to verify correct operation of the system. Administrations should make every effort to ensure that newly installed BWMS that have already been granted Type Approval meet this recommendation within one year following approval of this circular. Administrations should issue treatment system particulars, including details of the self-monitoring system (as described in document MEPC 61/INF.19), for all type approved systems.

4 RECOMMENDATIONS FOR FACILITATING A TYPE APPROVAL EVALUATION

4.1 For those Administrations using third party quality assurance organizations, due care should be taken to ensure all such arrangements are in place prior to initiating the Type Approval programme.

4.2 The Administration should provide the applicant with a document outlining contact details, the expected amount of time between submission and decision and any other requirements separate from the procedures and requirements outlined in the documents listed in section 2 of this document.

4.3 The Administration should verify that any recommendations made by the Committee during Basic and Final Approval have been addressed prior to issuing the Type Approval Certificate. In accordance with resolution MEPC.175(58), the Administration should submit the final report of land-based and shipboard tests with the notification of type approval to IMO. The reports should be available to Member States.

4.4 The Administration may certify a range of the BWMS capacities employing the same principles and technology, but due consideration should be given to limitations on performance which might arise from scaling up or scaling down.

4.5 The Administration should, in particular, review Standard Operating Procedures (SOP) for which an international standard has not been established yet.

5 APPROVAL PROCESS

5.1 Under the provisions of the BWM Convention, a BWMS is to be approved in accordance with Guidelines (G8) and, where appropriate, Procedure (G9).

5.2 The Administration should verify that the following issues have been specifically addressed by the manufacturer and, if the evaluation of the system is carried out by a third party organization, these issues should be relayed to the Administration to enable a decision on:

.1 a comprehensive explanation of the physical and/or biochemical treatment processes used by the BWMS to meet the D-2 Standard in the BWM Convention. This should be undertaken by the manufacturer and any supporting data should be submitted in writing. Any system which makes use of, or generates, Active Substances, Relevant Chemicals, or free radicals during the treatment process to eliminate organisms in order to comply with the Convention should be submitted to the Organization for review under Procedure (G9), (Procedure (G9), paragraph 3.3);

.2 whether a BWMS makes use of an Active Substance or not remains the prerogative of the responsible Administration. In making that determination, Administrations should take into account relevant GESAMP-BWWG recommendations and Committee decisions as to whether a system should be subject to approval under Procedure (G9). When an Administration is unsure of whether a BWMS is subject to Procedure (G9), it may choose to submit such system for review under that Procedure (G9) (MEPC 59/24, paragraph 2.16);

.3 the BWMSs that the Administration determines are not subject to Procedure (G9), as provided in paragraphs 2.3.6 and 2.3.30.4 of the annex to Guidelines (G8), the toxicity testing procedures in paragraphs 5.2.2 to 5.2.7 of Procedure (G9) should be used when the system could reasonably be expected to result in changes to the treated water such that adverse impacts to receiving waters might occur upon discharge;

.4 the approval documents that should include a piping and instrumentation diagram (P&ID) with parts list and material specification. Furthermore, wiring diagrams, function description of the control and monitoring equipment and description of regulator circuit of the BWMS;

.5 information on the preliminary testing (methodology, test water composition, salinities tested, sampling, analysis laboratories, etc.);

.6 accreditation of Guidelines (G8) land-based testing facility or body including their quality management plan (QMP) and quality assurance project plan (QAPP) to be used by the manufacturer for land-based testing;

.7 approval and subsequent verification of the design, construction, operation and functioning of the equipment used for land-based and shipboard testing;

.8 approval and subsequent verification of the land-based and shipboard test methodology, including the composition of the test water, and specific salinities to be tested which should be in line with Guidelines (G8), Procedure (G9) and the Methodology for information gathering and conduct of work of the GESAMP-BWWG as appropriate (waiver for multiple testing required);

.9 approval and subsequent verification of the methodology used to take and store samples, the laboratory testing, the frequency of sampling, and the analysis procedure for samples from land-based and shipboard testing;

.10 approval and subsequent verification of the design, construction, operation and functioning of the equipment used for testing;

.11 if the system is using an Active Substance, then the applications for Final Approval will have to be checked and approved by the Administration prior to making a proposal for approval to the Organization. In addition, the cost-recovery fee for the scientific services provided by the GESAMP-BWWG will have to be submitted;

.12 a safety assessment of the storage and handling of any chemicals is undertaken and approved in line with the technical guidance developed by the Organization;

.13 a safety and hazard assessment of the installation, operation and maintenance of the BWMS on the shipboard test is undertaken and approved in line with the technical guidance developed by the Organization (BWM.2/Circ.20), and includes as a minimum:

.1 any potential impact on the crew health and safety; and

.2 references to the classification society safety and hazard rules and recommendations;

.14 all electrical equipment used to operate the BWMS should be of a certified safety type required by the applicable national or international standard in respect of the hazardous areas where it is located; and

.15 results of environmental testing as specified in part 3 of the annex to Guidelines (G8).

5.3 For issuance of the Type Approval Certificate, the Administration should set the following requirements and provisions:

.1 the validity of the approval should be revisited as appropriate;

.2 in due time before the expiration of the approval, the manufacturer should prepare a report detailing the experiences with the system, including the results of any scientific research relevant to the system, as well as any results of port State controls, if available;

.3 the occurrence of any unexpected harmful consequences of the operation of the BWMS should be reported by the manufacturer to the Administration immediately;

.4 in accordance with Guidelines (G8), the appendix of the Type Approval Certificate should include details on all imposed limiting conditions on the operation of the BWMS. Such limiting conditions to include any applicable environmental conditions (e.g. salinity, UV transmittance, temperature, etc.) and/or system operational parameters (e.g. min/max pressure, pressure differentials, min/max Total Residual Oxidants (TRO), etc.);

.5 an annex to the Type Approval Certificate should contain the test results of each land-based and shipboard test run. Such test results shall include at least the numerical salinity, temperature, flow rates, and where appropriate UV transmittance. In addition, these test results shall include all other relevant variables;

.6 the Type Approval Certificate should specify the components of the BWMS that are type approved, including the manufacturer of each component; their operating ranges, including temperature, specific salinity and specify the possibility to use other similar components (like filters for example) and the criteria for allowing such use;

.7 a separate Type Approval Certificate should be provided for each type or model of the BWMS. However, if Administrations wish to do otherwise, it is recommended that the different types and models are clearly stated, the test each type and model has undergone clearly referred to with test results, operating ranges, salinity, TRC, etc.;

.8 all accidents (e.g. accidental exposure, leakage) related to the BWMS should be reported;

.9 any indications that the system is not performing up to the standards set by the BWM Convention, the guidelines and/or any additional provisions set by the Administration should be reported by the manufacturer to the Administration immediately;

.10 the Administration should have the opportunity to revoke the approval if these requirements are not met; and

.11 MSC circular MSC.1/Circ.1221 – "Validity of Type Approval Certification for marine products" should apply.

6 REPORTING OF THE TYPE APPROVAL

6.1 The Administration should forward a report of the Type Approval process to the Organization including the relevant documentation as specified in resolution MEPC.228(65).

6.2 In particular, where under Procedure (G9) the Final Approval has been granted with recommendations by the GESAMP-BWWG, evidence that these recommendations have been satisfactorily addressed at Type Approval should be provided to the Organization. The report should specify the findings of the Administration together with any non-confidential information according to Procedure (G9).

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INTERNATIONAL CONVENTION FOR THE CONTROL AND MANAGEMENT OF SHIPS' BALLAST WATER AND SEDIMENTS, 2004

Options for ballast water management for Offshore Support Vessels in accordance with the BWM Convention

1 The Marine Environment Protection Committee, at its sixty-fourth session (1 to 5 October 2012), instructed the BLG Sub-Committee to initiate the development of a circular on implementation of the BWM Convention for offshore support vessels.

2 MEPC 65 (13 to 17 May 2013) approved the Options for ballast water management for Offshore Support Vessels in accordance with the BWM Convention, agreed by BLG 17 (4 to 8 February 2013), as set out in the annex.

3 Member Governments are invited to bring this circular to the attention of all parties concerned.

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ANNEX

OPTIONS FOR BALLAST WATER MANAGEMENT FOR OFFSHORE SUPPORT VESSELS IN ACCORDANCE WITH THE BWM CONVENTION

1 INTRODUCTION

1.1 These procedures are intended to relate to the activities of Offshore Support Vessels. Operationally, these vessels differ from the operational models associated with deep-sea trading vessels by being designed to operate in near coastal waters characterized by carrying materials to facilities and vessels working in offshore energy fields.

1.2 The purpose of these procedures is to provide options available for complying with the requirements of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (the Convention).

1.3 Ballast water management should be consistent with the objectives of the Convention – "to prevent, minimize and ultimately eliminate the risks to the environment, human health, property and resources arising from the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments, as well as to avoid unwanted side effects from that control, and to encourage developments in related knowledge and technology". Depending on the option used, verification for approvals could differ from those specified in paragraph 1.7 of resolution MEPC.206(62), but keep the same level of protection.

1.4 Resolution MEPC.127(53) contains the *Guidelines for ballast water management and development of ballast water management plans (G4)*, which includes part A, chapter 1, "Ship operational procedures".

1.5 The application of the current measures should be decided considering the principles of risk analysis and taking into account the operational condition of the ship.

2 APPLICATION

2.1 The methods of compliance contained in paragraph 3 below are intended to provide options for meeting the functional goals of the Ballast Water Management Convention for Offshore Support Vessels.

2.2 The Offshore Support Vessels' approved Ballast Water Management Plans should meet the requirements and follow the form set out by resolution MEPC.127(53). An Administration approved plan may address circumstances specific to operation in waters under the jurisdiction of another party subject to the authorization of that party with the functional premise describing the vessel and the operational model that the vessel is operating under and present viable methods of complying with the objectives of the Convention.

2.3 In line with the Convention, Administrations may allow other ship types to apply the optional methods identified in this document, if found appropriate.

3 METHODS OF COMPLIANCE

3.1 Generally the options for compliance for Offshore Support Vessels will be identified on the ships' International Ballast Water Management Certificate and in the Ballast Water Management Plan. The general understanding is that the options may include the following:

.1 use of an "other method" of ballast water management as per regulation B-3.7 of the Convention following resolution MEPC.206(62);

.2 exemption, as per regulation A-4 of the Convention, following the *Guidelines for risk assessment under regulation A-4 (G7);*

.3 use of ballast water determined by the coastal State as being sourced from the "same location" as the point of discharge (as per regulation A-3.5);

.4 use of temporary ballast water management systems may be allowed for the purposes of undertaking activities outside those considered normal, routine support activities for compliance with the objectives of the Convention. If, or when available, a temporary BWMS appliance is installed, the unit should comply with the relevant approval processes promulgated by the flag Administration in accordance with the Convention and associated guidelines;

.5 use of permanent or temporary BWMS installed aboard another vessel operating from the same port or locality as a local reception facility, with the approval of the flag Administration and the acceptance of the local coastal State Administration, for the treatment of unmanaged ballast water; and

.6 meeting the regulation D-2 discharge standard through permanent installation of a Type Approved ballast water management system.

3.2 Drill water or water taken and stored on board for the purpose of protecting low flash point liquid (LFL) tanks, which is not discharged into the environment, is not subject to the requirements of the Convention.

4 SURVEY AND CERTIFICATION REQUIREMENTS

4.1 Generally, the process of survey and certification follows section E of the Convention.

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30 May 2013

INTERNATIONAL CONVENTION FOR THE CONTROL AND MANAGEMENT OF SHIPS' BALLAST WATER AND SEDIMENTS, 2004

Clarification of "major conversion" as defined in regulation A-1.5 of the BWM Convention

1 The Marine Environment Protection Committee, at its sixty-fourth session (1 to 5 October 2012), concurred with the clarification proposed by Japan (document MEPC 64/2/11) with regard to the definition of "major conversion" contained in regulation A-1.5 of the BWM Convention, and instructed the Secretariat to prepare a draft circular to facilitate the dissemination of this clarification for consideration by MEPC 65.

2 The Marine Environment Protection Committee, at its sixty-fifth session (13 to 17 May 2013), considered the proposal by IACS (document MEPC 65/2/12), agreed to include a further clarification of "major conversion" with respect to changing of ship type, and approved the text of the circular as set out in the annex.

3 Member Governments are invited to bring this circular to the attention of all parties concerned.

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ANNEX

CLARIFICATION OF "MAJOR CONVERSION" AS DEFINED IN REGULATION A-1.5 OF THE BWM CONVENTION

1 Regulations A-1 of the International Convention for Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention) provides:

> "4 ***Constructed*** in respect of a ship means a stage of construction where:
>
> .1 the keel is laid; or
>
> .2 construction identifiable with the specific ship begins; or
>
> .3 assembly of the ship has commenced comprising at least 50 tonnes or 1 per cent of the estimated mass of all structural material, whichever is less; or
>
> .4 the ship undergoes a major conversion.
>
> 5 ***Major conversion*** means a conversion of a ship:
>
> .1 which changes its ballast water carrying capacity by 15 per cent or greater, or
>
> .2 which change the ship type, or
>
> .3 which, in the opinion of the Administration, is projected to prolong its life by ten years or more, or
>
> .4 which results in modifications to its ballast water system other than component replacement-in-kind. Conversion of a ship to meet the provisions of regulation D-1 shall not be deemed to constitute a major conversion for the purpose of this annex."

2 The BWM Convention does not, however, stipulate clearly whether the new installation of ballast water management systems should be treated as a "major conversion".

3 The Marine Environment Protection Committee, at its sixty-fourth session, agreed that new installation of ballast water management systems should not be treated as a "major conversion" as defined in regulation A-1.5 of the BWM Convention.

4 The Marine Environment Protection Committee, at its sixty-fifth session, with respect to paragraph 5.2 of regulation A-1, agreed that a change of ship type should be considered to refer to a conversion that:

.1 substantially alters the dimensions or carrying capacity of the ship; or

.2 changes the type of cargo carried through a major alteration of the ship.

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BWM.2/Circ.46
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INTERNATIONAL CONVENTION FOR THE CONTROL AND MANAGEMENT OF SHIPS' BALLAST WATER AND SEDIMENTS, 2004

Application of the BWM Convention to Mobile Offshore Units

1 The Marine Environment Protection Committee, at its sixty-fifth session (13 to 17 May 2013), approved the circular on Application of the BWM Convention to Mobile Offshore Units, as set out in the annex.

2 Member Governments are invited to bring this circular to the attention of all parties concerned.

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ANNEX

APPLICATION OF THE BWM CONVENTION TO MOBILE OFFSHORE UNITS

International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004

Article 1.12 "Ship means a vessel of any type whatsoever operating in the aquatic environment and includes submersibles, floating craft, floating platforms, FSUs and FPSOs."

Regulation A-3
Exceptions

"The requirements of regulation B-3, or any measures adopted by a Party pursuant to article 2.3 and section C, shall not apply to:

.5 the discharge of ballast water and sediments from a ship at the same location where the whole of that ballast water and those sediments originated and provided that no mixing with unmanaged ballast water and sediments from other areas has occurred. If mixing has occurred, the ballast water taken from other areas is subject to ballast water management in accordance with this annex."

INTERPRETATION

At the location of operation

1 Preload tanks – for preloading of self-elevating units' (SEU) leg foundation, seawater is taken on board into the preload tanks. This seawater may be discharged, without management, at the same location provided that no mixing with unmanaged seawater and sediments from other areas has occurred.

2 Column stabilized units (CSU) – at its location of operation, seawater is taken on board the CSU into the ballast tanks to achieve the required operational draft. The seawater and sediment in the ballast tanks may be discharged, without management, at the same location provided that no mixing with unmanaged seawater and sediments from other areas has occurred.

3 Management of residual seawater and sediment in preload tanks of SEUs and ballast tanks of CSUs – residual seawater and sediments in the tanks should be managed if these tanks are to be ready for a different area of operation. A possible method for management is by means of internal recirculation. Other methods of ballast water management capable of achieving the D-2 standard are also acceptable.

Transit to other areas

4 SEUs and CSUs take on board ballast water and discharge it for transit to other areas. The transit ballast water and sediments remaining in the preload and operational ballast tanks of the mobile offshore units may be treated by an appropriately approved internal circulation method. Other methods of ballast water management, capable of providing the same level of protection to the environment, human health, property or resources as described in regulations B-3.1 to B-3.5, may also be acceptable.

Regulation D-2
Ballast Water Performance Standard

"1 Ships conducting ballast water management in accordance with this regulation shall discharge less than 10 viable organisms per cubic metre greater than or equal to 50 micrometres in minimum dimension and less than 10 viable organisms per millilitre less than 50 micrometres in minimum dimension and greater than or equal to 10 micrometres in minimum dimension; and discharge of the indicator microbes shall not exceed the specified concentrations described in paragraph 2.

2 Indicator microbes, as a human health standard, shall include:

.1 Toxicogenic *Vibrio cholerae* (O1 and O139) with less than 1 colony-forming unit (cfu) per 100 millilitres or less than 1 cfu per 1 gram (wet weight) zooplankton samples;

.2 *Escherichia coli* less than 250 cfu per 100 millilitres;

.3 Intestinal Enterococci less than 100 cfu per 100 millilitres."

INTERPRETATION

Internal circulation method

5 Treatment of any residual seawater, and sediments as well as any transit ballast water using a ballast water management system, approved in accordance with the Convention, incorporating internal circulation may be accepted. This method does not treat the ballast water during the uptake or discharge cycles, but would treat the water only after it has been pumped into the tanks. Other methods of ballast water management, capable of providing the same level of protection to the environment, human health, property or resources as described in regulations B-3.1 to B-3.5, may also be acceptable. If the ballast water management system employs Active Substances, measures such as neutralization may be needed prior to final discharge of the managed ballast water.

Regulation E-1
Surveys

"1 Ships of 400 gross tonnage and above to which this Convention applies, excluding floating platforms, FSUs and FPSOs, shall be subject to surveys specified below:

2 The Administration shall establish appropriate measures for ships that are not subject to the provisions of paragraph 1 in order to ensure that appropriate provisions of this Convention are complied with."

INTERPRETATION

6 Mobile offshore units should comply with the provisions of the Convention and should be surveyed and issued with an International Ballast Water Management Certificate, according to regulations E-1 and E-2 of the Convention, as applicable.

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MEPC.1/Circ.809
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REVISED GUIDANCE ON THE MANAGEMENT OF SPOILT CARGOES*

1 The Marine Environment Protection Committee, at its sixty-fifth session (13 to 17 May 2013), approved the *Revised Guidance on the management of spoilt cargoes*, prepared by the Joint London Convention and Protocol/MEPC Correspondence Group, as set out in the annex hereto.

2 Member Governments are invited to bring the Guidance to the attention of all parties concerned.

3 Member Governments and international organizations are also invited to provide information on the outcome and experiences in applying the Guidance to future sessions of the governing bodies of the LC/LP and to the MEPC.

4 This circular revokes MEPC.1/Circ.688.

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* The revised Guidance is also circulated through LC-LP.1/Circ.58.

ANNEX

REVISED GUIDANCE ON THE MANAGEMENT OF SPOILT CARGOES

Introduction

1 Occasionally during a voyage, cargo may spoil and mariners are faced with the need to manage the problem. This Guidance on managing spoilt cargoes is intended to provide guidance to Governments, shipowners, ship operators, ships' crew, cargo owners, port reception facility operators, insurance agents and equipment operators.

2 The ideal way to manage cargo that spoils during a voyage would be to offload it from the ship to be managed on land – either to sell for an alternate use, recycle salvageable materials, or to be disposed of in an environmentally safe manner. Spoilt cargo should only be considered for disposal at sea when there is a marked degree of urgency, facilities on land are unavailable, and it will not cause harm to the environment or human health.

Applicability of the London Convention and Protocol (LC/LP) and MARPOL Annex V to the management of spoilt cargoes

3 The London Convention and Protocol regulate the dumping of wastes or other matter at sea. The London Convention was one of the first global conventions to protect the marine environment from human activities and has been in force since 1975. A so-called "black- and grey-list" approach is applied for wastes, which can be considered for disposal at sea according to the hazard they present to the environment. For the blacklist items, dumping is prohibited. Dumping of the grey-listed materials requires a special permit from a designated national authority under strict control and provided certain conditions are met. All other materials or substances can be dumped after a general permit has been issued. The London Protocol was adopted to modernize the Convention and, eventually, replace it. The purpose of the Protocol is similar to that of the Convention, but the Protocol is more restrictive: application of a "precautionary approach" is included as a general obligation; and a "reverse list" approach is adopted, whereby all dumping is prohibited unless explicitly permitted. Only those materials listed in annex I of the Protocol can be permitted for dumping at sea. Under the Convention and Protocol, dumping does not include the disposal at sea of wastes or other matter incidental to, or derived from, the normal operations of vessels.

4 MARPOL Annex V regulates the prevention of pollution by garbage from ships. Amendments to Annex V were adopted in 2011 (resolution MEPC.201(62)) and enter[ed] into force on 1 January 2013. Under the amended MARPOL Annex V, discharge of all garbage is now prohibited, except as specifically permitted in the regulations of MARPOL Annex V. (Before these amendments, discharge of garbage was generally allowed unless provided otherwise in MARPOL Annex V, depending on the nature of the garbage and defined distances from shore.) Regulation 7 provides limited exceptions to the MARPOL Annex V restrictions in emergency and non-routine situations. Generally, discharge is restricted to food wastes, identified cargo residues, animal carcasses, and identified cleaning agents and additives and cargo residues entrained in washwater which are not harmful to the marine environment. It is recommended that ships use port reception facilities as the primary means of discharge for all garbage.

5 Under regulation 1 of MARPOL Annex V, "garbage" is defined as "*all kinds of food wastes, domestic wastes and operational wastes, all plastics, cargo residues, incinerator ashes, cooking oil, fishing gear, and animal carcasses generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances which are defined or listed in other Annexes to the present Convention. Garbage does not include fresh fish and parts thereof generated as a result of fishing activities undertaken during the voyage, or*

as a result of aquaculture activities which involve the transport of fish including shellfish for placement in the aquaculture facility and the transport of harvested fish including shellfish from such facilities to shore for processing".

6 Spoilt cargo is not considered garbage under MARPOL Annex V, as amended, and so its discharge is not regulated under MARPOL Annex V. Spoilt cargo may be subject to the London Convention and Protocol if dumping at sea is being considered.

7 The London Convention and Protocol regulate ocean dumping of wastes or other matter. They set out a system requiring a permit be obtained in advance of dumping. Thus, a permit needs to be obtained from the State where the cargo was loaded (if that State is a Party to the London Convention or Protocol) or the vessel's flag State (if that State, but not the loading State, is a Party). A permit would also generally be needed from the State in whose jurisdiction (e.g. EEZ) the dumping would occur. Only those materials found to be acceptable under the London Convention or Protocol may be considered for dumping at sea.

Specific spoilt cargoes

8 Types of spoilt cargoes and the conditions in which cargo may spoil vary widely, and may depend on the cargo type, length of voyages, types of vessels and environmental conditions involved. Factors that may contribute to cargo spoilage include faulty operation or management of equipment designed to secure cargo holds, weather, or other environmental conditions. Examples of cargo spoilage include cereals, grains, fruit, frozen cargo (meat, dairy, fish), non-comestible cargoes (coal, fertilizers and cement). Some animal carcasses may, however, be treated as garbage under Annex V as discussed further in paragraphs 32 to 38 below. Environmental risks from disposal of spoilt cargo vary depending on the type of cargo and quantities. Safety of crew members can be a factor if hazardous or poisonous gases are generated from the spoilt cargo. A list of spoilt cargoes that have been considered for sea disposal and permits issued are included in the annex.

Treatment of spoilt food cargoes (cereals, grains, fruits and vegetables)

9 There are many circumstances in which food cargoes may spoil, such as water damage, contamination, equipment failure or catastrophic events. In the case of contaminated food or over-ripe fruit, removal from the cargo hold can prevent further contamination. Options for management of spoilt food cargo may depend on availability of onboard storage facilities; need to prevent further contamination and quantities of spoilt food cargo.

Treatment of spoilt frozen cargo

10 Spoilt frozen cargo may result from equipment failure and subsequent thawing and can often involve the entire cargo.

Treatment of spoilt non-comestible cargoes such as coal, fertilizers and cement

11 Non-comestible cargoes may spoil due to catastrophic events or non-catastrophic loss of hull integrity. The environmental risk of disposal of spoilt non-comestible cargoes depends on the type and quantity of spoilt cargo.

Treatment of cargo residues

12 Cargo residues, whether from cargo that is spoiled or not, are considered garbage under MARPOL Annex V. Under regulations 4.1.3 and 6.1.2 of Annex V, cargo residues may only be discharged under certain conditions and only when they cannot be recovered using commonly available methods for unloading and they do not contain any substances classified as harmful to the marine environment.

Contingency plans for the management of spoilt cargo

13 The shipowner or their representative may consider developing contingency plans to facilitate timely decision-making by State regulatory authorities and minimize delays to a ship.

14 It would be useful for ships, especially those carrying the same cargo type over time, to have contingency plans established for dealing with their specific type of cargo should it spoil. Ships engaged in spot contract services could have general contingency plans in the event of cargo spoilage. Contingency plans should consider:

.1 an assessment of the potential for cargo spoilage to occur over a given route, including the risks, potential quantities and measures available to reduce spoilage;

.2 a process to notify the cargo owner, port authorities and regulatory authorities of the port State or the ship's flag State;

.3 a process to decide if the spoilt cargo is to be managed as waste for disposal on land or sold for an alternative use;

.4 a process to determine available land-based facilities that are authorized to receive the spoilt cargo, and make arrangements;

.5 if land-based options are not available or practicable, a communications process setting out who is to be contacted for a permit for dumping at sea; and

.6 if dumping is selected, a process and the information needed to obtain a permit.

Considerations for documenting spoilt cargo

15 Existing documents that ships carry can provide much of the information needed for managing spoilt cargo. Key documents include bills of lading, cargo manifests, ship's logs, and the Garbage Record Book under regulation 10 of Annex V.

16 Otherwise, documentation should include information necessary to obtain a dumping permit under the London Convention or Protocol, including descriptions of:

.1 the quantities and properties of the waste or other matter;

.2 how the cargo was spoiled;

.3 how the spoilt cargo is packaged and how it would be released;

.4 the proposed dumping site including geographical position (latitude and longitude), depth of water and distance from nearest coast; and

.5 the potential effects and expected human health and environmental consequences of the disposal of the spoilt cargo.

State regulatory authorities may request additional information

17 The master or ship's owner should consult with the cargo owner to ensure information on the nature of the cargo is complete. A local shipping agent may be able to obtain advice on selecting a suitable dumpsite. Dumpsite selection is part of the permitting process and, therefore, it is necessary to consult the Government issuing the permit on the selection of a suitable dumpsite.

Applying for a permit

18 The London Convention requires consideration of the practical availability of alternative land-based methods of treating, disposal or elimination. The London Protocol states that ocean dumping permits shall be refused if the permitting authority determines that appropriate opportunities exist to reuse, recycle or treat the waste without undue risk to human health or the environment or disproportionate costs. Therefore, options to manage spoilt cargo other than ocean dumping need to be considered. Such options may include resale for alternate use, recycling, landfill, secure landfill, incineration, composting and treatment for use or landfill.

19 The ship's owner, master or a designated officer in consultation with the owner of the cargo should prepare the permit application. The owner of the cargo may prefer to apply for the permit. It should be submitted to the Government of the State in whose jurisdiction (e.g. EEZ) the dumping is planned to occur. If the dumping is planned to take place in waters outside of national jurisdiction, the permit application should be submitted to the State where the cargo was loaded (if that State is a Party to the London Convention or Protocol), or the vessel's flag State (if that State, but not the loading State, is a Party). Contacts for the appropriate State Government can be obtained from the Office for the London Convention and Protocol at the International Maritime Organization (IMO) at olcp@imo.org.

Emergency permits

20 In emergencies posing an unacceptable threat to human health, safety or the marine environment and admitting no other feasible solution, an emergency permit may be issued. Disposal at sea under an emergency permit would need to be conducted in a manner that minimizes the impact on the marine environment. State regulatory authorities may wish to consult "Procedures and criteria for determining and addressing emergency situations", 2006 (see LC 28/15 annex 11, refer to: http://www.imo.org/blast/blastData.asp?doc_id=13647&filename=Emergency%20procedures.pdf), which addresses *force majeure* and emergency situations.

21 A disposal at sea permit requires a detailed assessment of the waste and other requirements and can take a significant amount of time to obtain. Contingency measures should be in place to temporarily allow for storage of the material to be disposed of while a permit is obtained, allowing the transporting vessel to proceed with its normal activities.

22 Another aspect to consider, if disposal at sea is the preferred option to manage a spoilt cargo, is that the configuration of the ship where the cargo spoiled may not be amenable to dumping it at sea. In such a case, contingency plans could consider arrangements for temporary storage either on land or another vessel, and subsequent loading onto suitable equipment for dumping.

23 Plans for temporary storage would need to be considered in any permit application review and should include location, logistics for transportation and handling, expected time frames, containment measures, emergency response (if needed) and contingencies.

Mitigation for invasive species and pathogens in some spoilt cargoes

24 Some spoilt cargoes pose concerns for transferring invasive species or harmful pathogens, potentially from living organisms present in the cargo, or transported as the cargo. Invasive species of concern could be terrestrial species potentially transferred from port to port or marine species introduced through contamination of the cargo with seawater, a concern if the material is dumped at sea. Management measures may include special considerations for disposal or storage site selection, containment if storage is required, and containment at the disposal site including capping or other confined disposal. Treatment such as comminution or land-based incineration could also be considered depending on facilities and type of organism suspected.

25 Mariners engaged in the transport of cargo that presents risks for transferring invasive species should include measures in their management plans to manage spoilt cargo. Advice may be available from regulatory authorities in the importing country.

26 Mortalities of live animal cargoes such as certain shellfish and livestock can be a key concern, notably for countries that rely on maritime shipping for trading livestock. In case of livestock, advice of the Food and Agriculture Organization is that livestock mortalities should be stored for landing ashore and incineration. Onboard storage of mortalities should be segregated to prevent pathogen transmission among the other animals on board.

27 Managing risks of disease transmission on land may also involve some specific considerations. In some cases, land-based disposal options may present a higher risk to human health and the environment. The comparative risks between land disposal and sea disposal should be assessed as related to the specific circumstances and potential impacts posed to human health and the environment. Local regulatory authorities in the port State receiving the mortalities should be contacted for advice. Shipping agents, prior to arrival, should facilitate contact with the port State.

28 Other measures may include mechanical handling to avoid exposure to seafarers and dockside workers, site selection considerations (avoiding potential conflicts with other users of the sea), containment if storage is required, and containment on site including capping or other confined disposal. If the pathogen is known, measures may be set for monitoring worker health (for human health risks) or for monitoring the local environment (if the material presents a risk to wildlife). Treatment could also be considered depending on the facilities and type of organism suspected.

Alternative options when dumping at sea is not allowed

29 State regulatory authorities may make a decision not to allow dumping at sea based on the type of spoilt cargo or a sensitivity of the receiving environment, even in cases where practical or appropriate options are not available.

30 Where a dumping permit would not be allowed for a type of spoilt cargo, plans should be made for offloading in port. If there are no available facilities at a given port, as part of the contingency planning process, ports and local authorities should be consulted either on:

.1 the potential to establish facilities;

.2 options for the potential spoilt cargo to be used in local industry; or

.3 feasibility of transport to an authorized facility within the jurisdiction.

31 If no facilities are available within a port State, contingency plans should consider retention of the spoilt cargo on board and sailing to the nearest port with facilities for offloading either on a direct route or on the planned route for other cargo shipments. To manage costs, these plans should be developed in consultation with insurance organizations and cargo owners.

Treatment of animal carcasses

32 There may be circumstances where MARPOL Annex V will apply to the regulation and treatment of animal carcasses, and other circumstances in which the London Convention and Protocol may apply. The regulation and treatment of animal carcasses will, therefore, need to be managed on a case-by-case basis and according to the particular circumstances and relevant guidelines.

33 The *2012 Guidelines for Implementation of MARPOL Annex V* (adopted by resolution MEPC.219(63) includes special guidance on the treatment of animal carcasses. The master of the ship is expected to have responsibility for shipboard livestock operational issues, animal health and welfare, and conditions for the control and reporting of animal mortality on board. Ships carrying live animal cargo consignments are expected to have animals that die during voyage. The mortality numbers are generally low and are operational issues to be controlled as part of cargo management practice. These mortalities are considered to be generated during the normal operation of the ship and liable to be discharged of continually or periodically and, therefore, subject to Annex V regulations and guidelines.

34 Regulation 4.1.4 of MARPOL Annex V permits the discharge into the sea of animal carcasses generated during the normal operation of a ship, but only if the ship is en route, outside a special area, as far as possible from the nearest land and taking into account IMO guidelines. To comply with regulation 4.1.4 of MARPOL Annex V, it is recommended that the discharge into the sea should take place greater than 100 nautical miles (nm) from the nearest land and in the maximum water depth possible. Discharge of animal carcasses needs to be recorded in the Garbage Record.

35 Carcasses of animals resulting from mortalities in excess of those generated during the normal operation of a ship are not "garbage" under Annex V and are not covered under the Annex V guidelines. "Mortalities in excess of those generated during the normal operation of a ship" refers to animal mortalities in excess of those expected to die during a voyage. While this could be a number of animals dying at the same time or within a short period of time, the number of mortalities that exceed those generated during the normal operation of a ship will depend upon the animal species and the total number and/or species carried in the consignment.

36 Circumstances that may result in mortalities that exceed those generated during the normal operation of the ship include:

- malfunctioning of ventilation or watering systems;
- weather events such as heat waves or storm systems;
- infectious disease outbreaks; and
- refusal of cargo offloading by authorities at destination, leading to the need to euthanize some or all of the live animal cargo.

37 In the case of animal mortalities in excess of those generated during the normal operation of a ship, the animal carcasses may be considered as spoilt cargo and may be subject to the London Convention and Protocol when dumping at sea is being considered. To assist in managing these situations, masters should contact the flag State of the ship and, where appropriate, port and/or coastal State(s) to seek guidance on the appropriate legal regimes and requirements, as well as consult relevant IMO guidelines and circulars.

38 Fish, including shellfish, carried on board as cargo that have died or been euthanized on board during the voyage are considered to be animal carcasses and should, to the extent practicable, be treated in the manner set out in section 2.12 of the *2012 Guidelines for Implementation of MARPOL Annex V*. Governments may want to consider additional actions to reduce the risk of spreading parasitic or pathogenic organisms.

* * *

ANNEX

SPOILT CARGOES CONSIDERED FOR SEA DISPOSAL

1 The following list illustrates the spoilt cargoes that have been considered for sea disposal in recent years and have been brought to the attention of IMO. However, it should be noted that not all these materials have actually been dumped at sea:

.1 sheep and cattle that had died when being transported on board a vessel specialized in livestock transport;

.2 frozen beef in a damaged container;

.3 spoilt kidney beans;

.4 wheat cargo that had been infected with a fungus and the import of which had been refused;

.5 cement packed in bags spoilt by water ingress;

.6 water contaminated magnesite granules;

.7 corn saturated by ingress of water;

.8 citrus pellets, the sugar contents of which had started fermenting following injection with seawater;

.9 alumina spoilt by water ingress;

.10 bagged sugar spoilt by water ingress;

.11 spoilt vinegar carried in bulk;

.12 bagged garlic spoilt by ingress of seawater;

.13 spoilt rice;

.14 lentils spoilt by ingress of seawater;

.15 steam coal spoilt by ingress of seawater;

.16 stearine that had become semi-solid after failure of heating equipment;

.17 ruined condensed milk;

.18 spoilt potatoes;

.19 fire-extinguishing water containing coal dust;

.20 contaminated iron ore;

.21 hardened Portland cement;

.22 rotting mink fodder (mincemeat);

.23 fertilizers spoilt by ingress of seawater;

.24 wheat cargo spoilt by ingress of seawater; and

.25 sulphuric acid diluted in seawater.

2 The following table shows the permits issued for sea disposal of spoilt cargoes, as notified to IMO:

YEAR	COUNTRY	CARGO
2009	Philippines[1]	4,890,000 tonnes of damaged bulk cement
2008	Malta	5 permits issued for a total of 5,526 tonnes of water damaged rice
2007	Greece	81.5 tonnes of damaged corn
2007	Malta	5,000 tonnes of water damaged corn
2007	Liberia	100 tonnes of damaged frozen chicken
2007	Liberia	716 tonnes of water damaged corn
2007	Russian Federation	135 tonnes of water damaged wheat
2006	Cyprus	55 tonnes of damaged rice
2006	Panama	300 tonnes of damaged soy beans
2004	Cyprus	700 tonnes of spoilt wheat
2004	Malta	370 tonnes of spoilt wheat and soy beans
2004	Malta	24,000 tonnes of bulk cement
2003	Saint Vincent and the Grenadines	10,000 tonnes of diammonium phosphate on board a stranded vessel
2003	Antigua and Barbuda	70 tonnes of lentils spoilt by seawater
2002	Cyprus	1,300 tonnes of steam coal spoilt by seawater
2002	Norway	350 tonnes of rotting mink fodder (mincemeat) dumped in internal waters
2001	South Africa	15,000 tonnes of potassium nitrates, sulphates and chlorides on board a stranded vessel
2000	Liberia	800 tonnes of fire-extinguishing water containing coal dust
2000	United States	14,000 tonnes of hardened Portland cement
1999	South Africa	800 tonnes of spoilt wheat grain
1999	Brazil	Damaged tanker containing 3,700 tonnes of sulphuric acid diluted with seawater
1997	Panama	280 tonnes of spoilt bananas
1996	South Africa	68 tonnes of spoilt kidney beans
1996	South Africa	156 tonnes of wheat infected with a fungus
1995	Panama	6,581 tonnes of spoilt potatoes in natural jute bags
1993	Canada	305 tonnes of spoilt sugar
1988	South Africa	3,242 tonnes of spoilt rice
1984	Canada	1,200 tonnes of spoilt grain

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[1] Permit was not utilized as material was offloaded to a landward destination.

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IMPLEMENTATION OF MARPOL ANNEX V

Adequate port reception facilities for cargoes declared as harmful to the marine environment under MARPOL Annex V

1 The Marine Environment Protection Committee (the Committee), at its sixty-fourth session (1 to 5 October 2012), noting the short time between publishing criteria for solid bulk cargoes considered harmful to the marine environment (HME) under the revised MARPOL Annex V and the entry into force of the Annex (on 1 January 2013), and recognizing the difficulties this would cause for shippers to classify cargoes, agreed to issue circular MEPC.1/Circ.791 on Provisional classification of solid bulk cargoes under the revised MARPOL Annex V between 1 January 2013 and 31 December 2014.

2 At its sixty-fifth session (13 to 17 May 2013), the Committee acknowledged that, as a result of the difficulties experienced by shippers, consequential problems are being experienced by shipowners and operators in obtaining HME declarations and, when cargoes have been classified as HME, finding adequate reception facilities at receiving terminals.

3 In light of the above, the Committee agreed that, until 31 December 2015, cargo hold washwater from holds previously containing solid bulk cargoes classified as HME may be discharged outside special areas, providing:

.1 based upon the information received from the relevant port authorities, the master determines that there are no adequate reception facilities either at the receiving terminal or at the next port of call;

.2 the ship is en route and as far as practicable from the nearest land, but not less than 12 nautical miles;

.3 before washing, solid bulk cargo residue is removed (and bagged for discharge ashore) as far as practicable and holds are swept;

.4 filters are used in the bilge wells to collect any remaining solid particles and minimize solid residue discharge; and

.5 the discharge is recorded in the Garbage Record Book and the flag State is notified utilizing the Revised Consolidated Format for Reporting Alleged Inadequacies of Port Reception Facilities (MEPC.1/Circ.469/Rev.2).

4 In addition, the Committee urged Parties to MARPOL Annex V to:

.1 ensure the provision of adequate facilities at ports and terminals for the reception of solid bulk cargo residues including those contained in washwater;

.2 ensure shippers within their jurisdiction provide complete and accurate cargo declarations in accordance with MARPOL Annex V (and circular MEPC.1/Circ.791) and section 4 of the IMSBC Code; and

.3 notify the Organization for transmission to the Parties concerned of all cases where the facilities are alleged to be inadequate.

5 Further, ports and terminals receiving cargoes classified as HME are urged to provide adequate port reception facilities, including for residues contained in washwater. In the absence of such facilities, to minimize residues discharged under paragraph 3, terminals should facilitate the discharge of all solid bulk cargo residues ashore, including hold sweepings.

6 Member Governments are invited to bring the content of this circular to the attention of those interested, including port State control authorities, coastguard and maritime surveillance services, as appropriate.

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13 June 2013

GUIDANCE FOR EVALUATING THE 2011 GUIDELINES FOR THE CONTROL AND MANAGEMENT OF SHIPS' BIOFOULING TO MINIMIZE THE TRANSFER OF INVASIVE AQUATIC SPECIES

1 The Marine Environment Protection Committee, at its sixty-fifth session (13 to 17 May 2013), approved the Guidance for evaluating the *2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species* (see MEPC 65/22, paragraph 11.14), developed by the Sub-Committee on Bulk Liquids and Gases at its seventeenth session (4 to 8 February 2013), as set out in the annex.

2 Member Governments are invited to bring the circular to the attention of all parties concerned.

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ANNEX

GUIDANCE FOR EVALUATING THE 2011 GUIDELINES FOR THE CONTROL AND MANAGEMENT OF SHIPS' BIOFOULING TO MINIMIZE THE TRANSFER OF INVASIVE AQUATIC SPECIES

1 Context

1.1 The Marine Environment Protection Committee (MEPC), at its sixty-second session, adopted, by resolution MEPC.207(62), the *2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species,* (the Guidelines). The aim of the Guidelines is to provide a globally consistent approach to managing biofouling by providing useful recommendations on general measures to minimize the risks associated with biofouling for all types of ships.

1.2 MEPC 62 requested that members take urgent action in applying the Guidelines, including: disseminating the Guidelines to the shipping industry and other interested parties, taking the Guidelines into account when adopting measures to minimize the risk of introducing invasive aquatic species via biofouling, and reporting to the MEPC on any experience gained in their implementation. MEPC agreed to keep the Guidelines under review based on experience gained in their implementation. This would include consideration as to whether the voluntary Guidelines are effective in influencing biofouling management practices.

1.3 This Guidance is provided to assist Member States and observers who wish to collect information needed to undertake future reviews of the Guidelines, and to do this in a more consistent way. The Guidance identifies the types of performance measures (section 3) that could help to assist in evaluating the different recommendations in the Guidelines. A party wishing to collect information may do so for all or only some of these measures.

1.4 It is anticipated that the information needed to review the Guidelines could be collected by Member States and/or observers and submitted to the appropriate Sub-Committee.

2 Evaluation process

2.1 A process for evaluating the information collected could include annual reviews of the implementation of the Guidelines by the Sub-Committee with a more comprehensive review undertaken after the Guidelines have been in place for five years. The first review of available information could occur in a meeting of the Sub-Committee in early 2014 with a more comprehensive review at a meeting of the Sub-Committee in early 2017. It may also be useful to take stock of available information at year three (2015) to determine whether sufficient information is likely to be available to undertake a more comprehensive review after five years. If it is determined that further information is likely to be required, the Sub-Committee could actively encourage collection of the necessary information. The proposed process is further detailed in the appendix.

The focus of the review is likely to change over time. Initially the information available is likely to be on the level of dissemination and awareness of the Guidelines: whether there are any impediments (including omissions and errors) to the implementation of the Guidelines that need to be addressed and evidence of early implementation, e.g. use of biofouling management plans and record books or in-water inspection. In subsequent reviews, the focus could shift more towards evaluating the extent and level of implementation and evidence of change in the extent of biofouling on ships. New research and/or technology developments related to the Guidelines would be relevant for all reviews. If, as a result of the review, modifications to the Guidelines are considered necessary, the Sub-Committee could recommend these to the MEPC.

2.2 The comprehensive review of all available information at year five could help determine whether the Guidelines are having sufficient impact on biofouling management using the performance measures outlined in this guidance. If the Guidelines are determined to have sufficient impact, they could continue to be implemented in their current form with the Sub-Committee determining the nature and regularity of ongoing reviews. If the Guidelines, or elements of the Guidelines, are determined to have insufficient impact the Sub-Committee could provide advice to MEPC on whether other actions may need to be taken to enhance the effectiveness of the Guidelines in preventing the transfer of invasive aquatic species.

3 Performance measures

3.1 Performance measures can help to evaluate whether the *2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species* are improving biofouling management practice in the maritime industry, and thereby reducing the likelihood of invasive aquatic species being transferred through ships' biofouling. It is not considered feasible at this time to directly measure the environmental benefits of the Guidelines, i.e. to assess whether the Guidelines result in fewer biological invasions by aquatic species as a result of transfer via biofouling of ships.

3.2 The following types of performance measures could be used to help evaluate the different recommendations in the Guidelines:

.1 Awareness and dissemination of the Guidelines – have the Guidelines been disseminated to relevant parties and are they aware of the Guidelines?

.2 Impediments to implementation of the Guidelines – are there any omissions and errors with the Guidelines that need to be corrected and/or are appropriate facilities and tools available to effectively implement the Guidelines?

.3 Application of the Guidelines – is there evidence of use of the Guidelines?

.4 Change in level of biofouling – is there evidence of changes in the level of biofouling from in-water or dry-dock inspections and/or data on the net benefits from managing biofouling?

.5 Extent of research and development – what research and technology development, related to the Guidelines, is available?

3.3 Performance measures for the different components of the Guidelines are outlined in table 1. Each performance measure consists of the criteria being considered, an indicator for the criteria and a goal that the Guidelines are trying to achieve. Note that the "Year(s)" column in table 1 refers to the year following implementation when information is likely to be available for the relevant performance measure. Table 2 outlines a questionnaire that could be used to provide a uniform, but voluntary, approach to collecting information.

3.4 In collecting information for performance measures it is useful to collect information not only on progress towards the specified goal but also information on why a particular goal is or is not being achieved. This would help the Sub-Committee to determine if actions, such as modifying the Guidelines, are required.

3.5 The high level goal across all performance measures is to see an increase in the uptake of the recommendations of the Guidelines over time.

Table 1: Performance measures

Part 1: Awareness and dissemination of the Guidelines				
	Criteria	**Indicator**	**Goal**	**Year(s)**
1.1	The Guidelines, or communications based on the Guidelines, have been disseminated to: shipowners and operators and shipping agents; maintenance/recycling facility owners and operators; in-water inspection and cleaning service providers; ship designers, naval architects and builders; anti-fouling coating companies; Harbour Masters; and organizations involved in maritime/seafarer education and training.	Number and proportion of Member States and Recognized Organizations that have disseminated the Guidelines or communications based on the Guidelines.	Most Member States and Recognized Organizations have disseminated the Guidelines or communications based on the Guidelines.	Year 1 Year 2
1.2	The following are known to be aware of, and understand the Guidelines: shipowners and operators and shipping agents; maintenance/recycling facility owners and operators; in-water inspection and cleaning service providers; ship designers, naval architects and builders; anti-fouling coating companies; Harbour Masters; and organizations involved in maritime/seafarer education and training.	Number and proportion of ships/facilities/etc. that are known to be aware of the Guidelines.	Most ships/ facilities are aware of the Guidelines.	Year 1 Year 2
1.3	Biofouling management is known to be included in relevant training and education programmes for: shipowners and operators and shipping agents; maintenance/recycling facility owners and operators; in-water inspection and cleaning providers; ship designers, naval architects and builders; anti-fouling coating companies; Harbour Masters; and organizations involved in maritime/seafarer education and training.	Number and proportion of known relevant training and education programmes that include biofouling management content.	Most relevant programmes include biofouling management content.	Year 2 Year 3
1.4	Member States are notifying the Organization of other measures being applied for biofouling management. For example, national regulations or emergency measures.	Information related to other biofouling management measures being applied by Member States is being provided to, and disseminated by, the Organization.	Member States and the maritime industry are aware of other biofouling management measures being undertaken by IMO Member States.	Year 3 Year 4

Part 2 Impediments to implementation of the Guidelines				
	Criteria	**Indicator**	**Goal**	**Year(s)**
2.1	The Guidelines can be implemented by: shipowners and operators; maintenance/recycling facilities; in-water inspection and cleaning providers; and ship designers, naval architects and builders.	Feasibility issues, omissions and errors are identified in the use of the Guidelines.	Feasibility issues, omissions and errors are addressed in the review and revision of the Guidelines.	Year 1 Year 2 Year 3
		Number and proportion of ships/facilities/etc. that have indicated lack of facilities or tools as reasons for not aligning their practices with the Guidelines.	Availability of facilities and tools addressed through market demand and research initiatives.	Year 1 Year 2 Year 3 Year 4
2.2	Use of the Guidelines does not present a safety issue for: ship's crew; maintenance and recycling workers; in-water service providers; and any other entities directly applying the Guidelines.	Any safety issues or concerns raised by use of the Guidelines are identified in the use of the Guidelines.	Safety issues are addressed in the review and revision of the Guidelines.	Year 2 Year 3

Part 3 Application of the Guidelines				
	Criteria	**Indicator**	**Goal**	**Year(s)**
3.1	Ships have biofouling management plans and are maintaining biofouling record books or equivalent documentation.	Number and proportion of ships known to have biofouling management plans and maintaining biofouling management record books.	Most ships have biofouling management plans and record books.	Year 1 Year 2
3.2	Ships are conducting the following activities in line with the Guidelines: - in-water inspections - in-water cleaning, if appropriate.	Number and proportion of ships known to be conducting in-water inspections and, if appropriate, in-water cleaning.	Most ships are conducting in-water inspections, and in-water cleaning, if appropriate.	Year 2 Year 3
3.3	Facilities are adopting appropriate measures for capture of waste.	Number and proportion of facilities that have waste capture measures in place aligned with the Guidelines.	Most facilities have adopted appropriate waste capture measures.	Year 2 Year 3

Part 3 Application of the Guidelines				
	Criteria	**Indicator**	**Goal**	**Year(s)**
3.4	The following are known to have practices that follow, or are aligned with, the Guidelines: shipowners and operators and shipping agents; maintenance/recycling facility owners and operators; in-water inspection and cleaning providers; ship designers, naval architects and builders; anti-fouling coating companies; and organizations involved in maritime/seafarer education and training.	Evidence that practices follow, or are substantially aligned with the Guidelines.	Most ships, facilities, etc. are implementing the Guidelines.	Year 2 Year 3 Year 4
3.5	In-water cleaning technologies are able to capture most of the macrofouling debris from in-water cleaning.	Number and availability of in-water cleaning technologies that incorporate capture of debris for all ship types.	In-water technologies, able to capture most of the macrofouling debris, are widely available and sufficient to meet demand.	Year 2 Year 3
3.6	The Guidelines are being taken into account by Member States that apply other measures for biofouling management. For example, national regulations or emergency measures.	Whether other biofouling measures take into account the Guidelines.	All other biofouling management measures take into account the Guidelines.	Year 2 Year 3

Part 4 Change in level of biofouling				
	Criteria	**Indicator**	**Goal**	**Year(s)**
4.1	Ships are maintaining submerged surfaces and internal seawater cooling systems in accordance with the Guidelines to ensure they are as free of biofouling as is practical.	Number and proportion of ships known to have submerged hull surfaces that are as free of biofouling as is practical.	Most ships, adhering to the Guidelines, have submerged hull surfaces as free of biofouling as is practical.	Year 3
		Number and proportion of ships known to have niche areas and internal seawater cooling systems that are as free of biofouling as is practical.	Most ships, adhering to the Guidelines have niche areas and internal seawater cooling systems as free of biofouling as is practical.	
		The effectiveness of control measures applied are evaluated at dry dock.	The effectiveness of measures is verified.	Year 3 Year 4

Part 4 Change in level of biofouling				
	Criteria	**Indicator**	**Goal**	**Year(s)**
		Net costs attributable to implementing the Guidelines (i.e. cost minus benefit, e.g. reduced fuel consumption) as a % of total operating costs.	Net costs attributable to implementing the Guidelines are understood.	Year 2 Year 3
4.2	Indirect or consequential benefits obtained from implementing the Guidelines.	Any known indirect or consequential benefits (such as proven reduced GHG emissions or improved energy efficiency) from the use of the recommendations in the Guidelines.	Indirect or consequential benefits of implementing the Guidelines are understood.	Year 3

Part 5 Research and Development				
	Criteria	**Indicator**	**Goal**	**Year(s)**
5.1	Research and development of technologies to improve biofouling management is being undertaken.	Information on research and technology development, relevant to the Guidelines, can be identified.	Current status of research and technology development, relevant to the Guidelines, is understood.	Year 1 Year 2 Year 3 Year 4
5.2	Research into the indirect or consequential benefits of implementing the Guidelines is being undertaken.	Research into indirect or consequential benefits of implementing the Guidelines can be identified.	Indirect or consequential benefits of implementing the Guidelines are understood.	Year 3 Year 4

4 Performance measure questionnaire

4.1 These questions are provided as guidance for those who may be interested in collecting information on the implementation of the biofouling Guidelines. It is recognized that not all those using the questionnaire will have authority or linkages with all listed audiences.

4.2 The purpose of this voluntary questionnaire is to gather information regarding the implementation of the Guidelines based on the respondent's experience. Specifically, the respondent is asked to provide information regarding a range of issues that include but are not limited to: the clarity of the Guidelines, dissemination and inspection strategies, educational products, inspection, biofouling management plans, etc. The respondent's information will be used to evaluate the effectiveness of the measures within the Guidelines for the control and management of ships' biofouling.

4.3 Where relevant and if possible, additional details and quantitative data should be provided rather than simply yes/no answers.

Table 2: Questionnaire for data collection

Question Have you disseminated the Guidelines, or communications based on the Guidelines, to relevant parties including: shipowners and operators and shipping agents; maintenance/recycling facility owners and operators; in-water inspection and cleaning service providers; ship designers, naval architects and builders; anti-fouling coating companies; Harbour Masters; and organizations involved in maritime/seafarer education and training?	**Audience** Member States
Response (additional comment/explanation)	
Question Are you aware of the Guidelines? Is the information in the Guidelines clear?	**Audiences** Shipowners and operators and shipping agents; maintenance/ recycling facility owners and operators; in-water inspection and cleaning service providers; ship designers, naval architects and builders; anti-fouling coating companies; Harbour Masters; organizations involved in maritime/seafarer education and training; recognized organizations.
Response (if not clear, please provide details)	
Question Are you aware of any information being included in relevant educational programmes?	**Audience** Member States.
Response (if yes, please provide details)	
Question Have you developed biofouling management measures in addition to the Guidelines, e.g. national regulations? Are these measures based on the Guidelines? Has this additional information been provided to IMO?	**Audience** Member States.
Response (please provide details)	
Question Are there any feasibility issues, omissions or errors that have meant that the Guidelines are difficult to implement?	**Audiences** Shipowners and operators; maintenance/recycling facilities; in-water inspection and cleaning providers; ship designers, naval architects and builders; recognized organizations.
Response (if yes, please provide details)	
Question Are facilities and/or tools available to support the implementation of the Guidelines?	**Audiences** Shipowners and operators; maintenance/recycling facilities; in-water inspection and cleaning providers; and ship designers, naval architects and builders; recognized organizations.
Response (please provide details)	

Question Have any safety issues been identified in implementing the Guidelines?	**Audiences** Ship's crew; maintenance and recycling workers; in-water service providers; and any other entities directly applying the Guidelines.
Response (if no, please provide details)	
Question Are ships developing biofouling management plans and maintaining their biofouling record books?	**Audience** Member States; Shipowners and operators.
Response (please provide details)	
Question Are you undertaking in-water inspections and in-water cleaning? Are these activities in line with the Guidelines?	**Audiences** Shipowners and operators and shipping agents; maintenance/ recycling facility owners and operators; and in-water inspection and cleaning service providers.
Response (please provide details)	
Question Does your facility capture hull cleaning waste to minimize the risk of it entering the water?	**Audience** Maintenance/recycling facility owners and operators.
Response (please provide details)	
Question Do your practices follow, or align with, the Guidelines?	**Audiences** Shipowners and operators and shipping agents; maintenance/ recycling facility owners and operators; in-water inspection and cleaning providers; ship designers, naval architects and builders anti-fouling coating companies; and organizations involved in maritime/seafarer education and training.
Response (please provide details)	
Question Is your in-water cleaning technology able to capture most of the macrofouling debris from in-water cleaning?	**Audience** In-water inspection and cleaning providers.
Response (please provide details)	
Question Are the submerged hull surfaces of ships as free of biofouling as is feasible? Have you seen a decrease over time in the amount of biofouling on submerged hull surfaces?	**Audience** Member States; maintenance/ recycling facility owners and operators; anti-fouling coating companies.
Response (please provide details)	
Question Are the niche areas and internal seawater cooling systems of ships as free of biofouling as is feasible? Have you seen a decrease over time in the amount of biofouling in niche areas and internal seawater cooling systems of ships?	**Audience** Member States; maintenance/ recycling facility owners and operators; anti-fouling coating companies .
Response (please provide details)	

Question Have you collected information about the effectiveness of specific measures in the Guidelines through dry dock inspections of ships?	**Audiences** Member States; shipowners and operators; and maintenance/ recycling facility owners and operators.
Response (please provide details)	
Question Do you have any information on the direct or indirect benefits associated with implementing with the Guidelines, e.g. reduced fuel consumption as a % of total operating costs?	**Audience** Shipowners and operators.
Response (if yes, please provide details)	
Question Do you have any information on the additional costs associated with implementing the Guidelines?	**Audience** Member States; and shipowners and operators.
Response (if yes, please provide details)	
Question Are you aware of any research and/or development of technologies to improve biofouling management?	**Audiences** Member States; organizations involved in maritime/seafarer education and training; and research organizations.
Response (if yes, please provide details)	
Question Are you aware of any research into indirect or consequential benefits of implementing the Guidelines?	**Audiences** Member States; organizations involved in maritime/seafarer education and training; and research organizations.
Response (if yes, please provide details)	

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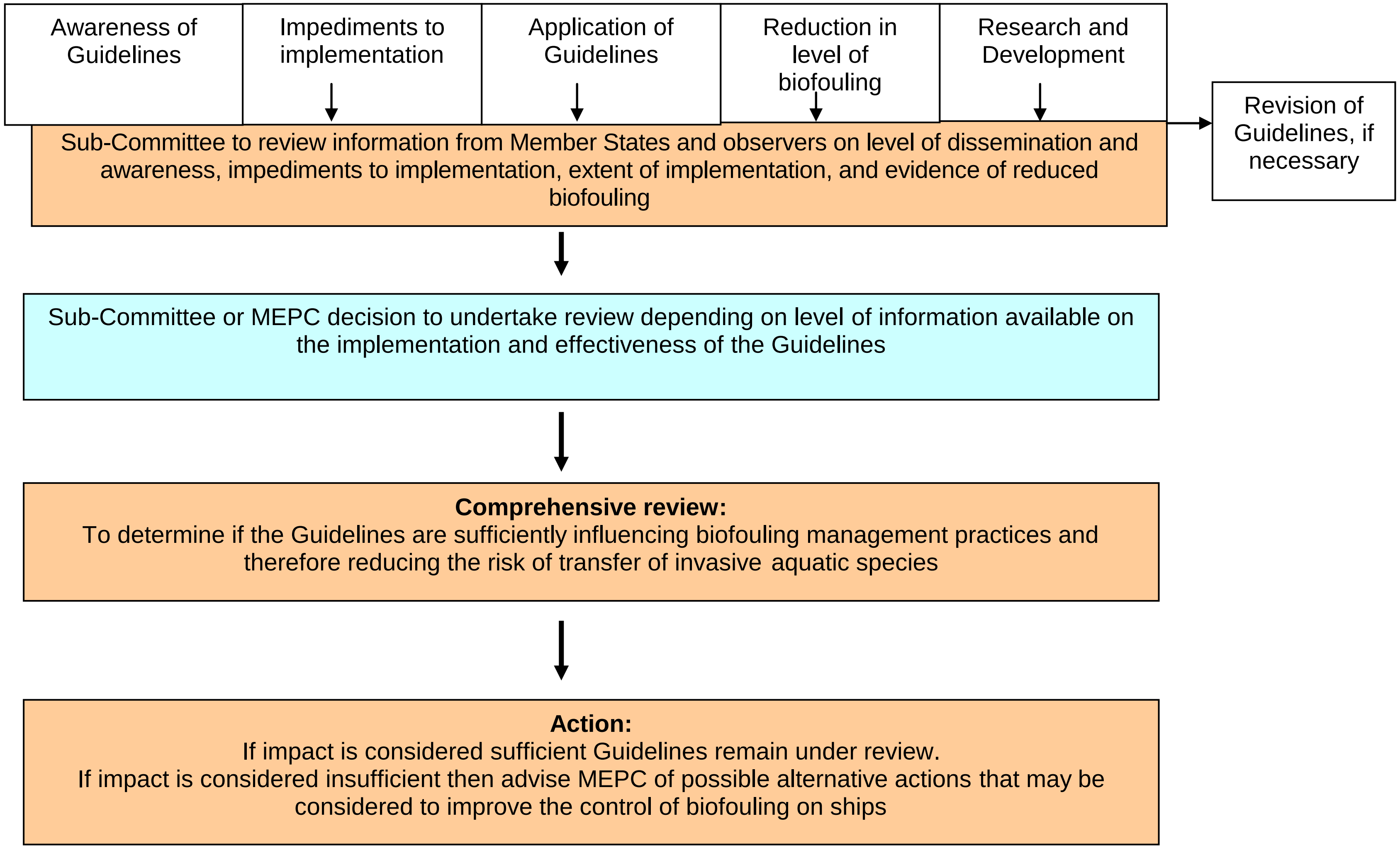
APPENDIX: AN OVERVIEW OF THE EVALUATION PROCESS



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17 June 2013

2013 GUIDANCE ON TREATMENT OF INNOVATIVE ENERGY EFFICIENCY TECHNOLOGIES FOR CALCULATION AND VERIFICATION OF THE ATTAINED EEDI

1 The Marine Environment Protection Committee, at its sixty-fifth session (13 to 17 May 2013), agreed to circulate the *2013 Guidance on treatment of innovative energy efficiency technologies for calculation and verification of the attained EEDI*, as set out in the annex (MEPC 65/22, paragraph 4.134.6).

2 Member Governments are invited to bring the annexed Guidance to the attention of their Administrations, industry, relevant shipping organizations, shipping companies and other stakeholders concerned.

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ANNEX

2013 GUIDANCE ON TREATMENT OF INNOVATIVE ENERGY EFFICIENCY TECHNOLOGIES FOR CALCULATION AND VERIFICATION OF THE ATTAINED EEDI

TABLE OF CONTENTS

1 General

1.1 The purpose of this guidance is to assist manufacturers, shipbuilders, shipowners, verifiers and other interested parties related to Energy Efficiency Design Index (EEDI) of ships to treat innovative energy efficiency technologies for calculation and verification of the attained EEDI, in accordance with regulations 5, 6, 7, 8, 9 and 20 of Annex VI to MARPOL.

1.2 There are EEDI Calculation Guidelines and EEDI Survey Guidelines. This guidance does not intend to supersede those guidelines but provides the methodology of calculation, survey and certification of innovative energy efficiency technologies, which are not covered by those guidelines. In the case that there are inconsistencies between this guidance and these guidelines, those guidelines should take precedence.

1.3 This guidance might not provide sufficient measures of calculation and verification for ships with diesel-electric propulsion, turbine propulsion and hybrid propulsion system on the ground that the attained EEDI Formula shown in EEDI Calculation Guidelines may not be able to apply to such propulsion systems.

1.4 The guidance should be reviewed for the inclusion of new innovative technologies not yet covered by the guidance.

1.5 The guidance also should be reviewed, after accumulating the experiences of each innovative technology, in order to make it more robust and effective, using the feedback from actual operating data. Therefore, it is advisable that the effect of each innovative technology in actual operating conditions should be monitored and collected for future improvement of this guidance document.

2 Definitions

2.1 *EEDI Calculation Guidelines* means "2012 guidelines on the method of calculation of the attained energy efficiency design index (EEDI) for new ships (resolution MEPC.212(63))".

2.2 *EEDI Survey Guidelines* means "2012 guidelines on survey and certification of the energy efficiency design index (EEDI) (resolution MEPC.214(63))".

2.3 P_p is the propulsion power and is defined as ΣP_{ME} (In case where shaft motor(s) are installed, $\Sigma P_{ME} + \Sigma P_{PTI(i),\mathrm{shaft}}$, as shown in paragraph 2.5.3 of EEDI Calculation Guidelines).

2.4 In addition to the above, definitions of the words in this guidance are same as those of MARPOL Annex VI, EEDI Calculation Guidelines and EEDI Survey Guidelines.

3 Categorizing of Innovative Energy Efficiency Technologies

3.1 Innovative energy efficiency technologies are allocated to category (A), (B) and (C), depending on their characteristics and effects to the EEDI formula. Furthermore, innovative energy efficiency technologies of category (B) and (C) are categorized to two sub-categories (category (B-1) and (B-2), and (C-1) and (C-2), respectively).

Category (A): Technologies that shift the power curve, which results in the change of combination of P_P and V_{ref}: e.g. when V_{ref} is kept constant, P_P will be reduced and when P_P is kept constant, V_{ref} will be increased

Category (B): Technologies that reduce the propulsion power, P_P, at V_{ref}, but not generate electricity. The saved energy is counted as P_{eff}

Category (B-1): Technologies which can be used at any time during the operation and thus the availability factor (f_{eff}) should be treated as 1.00.

Category (B-2): Technologies which can be used at their full output only under limited condition. The setting of availability factor (f_{eff}) should be less than 1.00.

Category (C): Technologies that generate electricity. The saved energy is counted as P_{AEeff}

Category (C-1): Technologies which can be used at any time during the operation and thus the availability factor (f_{eff}) should be treated as 1.00.

Category (C-2): Technologies which can be used at their full output only under limited condition. The setting of availability factor (f_{eff}) should be less than 1.00.

(C) Emission reduction through the auxiliary power reduction by generating electricity for normal maximum sea load(P_{AEeff})

(B) Emission reduction through the propulsion power reduction (P_{eff})

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

(A) The combination of P_P and V_{ref} as reflected in the power curve (knot-kW curve)

Innovative Energy Efficiency Technologies				
Reduction of Main Engine Power			Reduction of Auxiliary Power	
Category A	*Category B-1*	*Category B-2*	*Category C-1*	*Category C-2*
Cannot be separated from overall performance of the vessel	Can be treated separately from the overall performance of the vessel		Effective at all time	Depending on ambient environment
	$f_{eff}=1$	$f_{eff}<1$	$f_{eff}=1$	$f_{eff}<1$
– low friction coating – bare optimization – rudder resistance – propeller design	– hull air lubrication system (air cavity via air injection to reduce ship resistance) (can be switched off)	– wind assistance (sails, Flettner-Rotors, kites)	– waste heat recovery system (exhaust gas heat recovery and conversion to electric power)	– photovoltaic cells

4 Calculation and Verification of effects of Innovative Energy Efficiency Technologies

4.1 General

The evaluation of the benefit of any innovative technology is to be carried out in conjunction with the hull form and propulsion system with which it is intended to be used. Results of model tests or sea trials of the innovative technology in conjunction with different hull forms or propulsion systems may not be applicable.

4.2 Category (A) technology

Innovative energy efficiency technologies in category (A) affect P_P and/or V_{ref} and their effects cannot be measured in isolation. Therefore, these effects should not be calculated nor certified in isolation in this guidance but should be treated as a part of vessel in EEDI Calculation Guidelines and EEDI Survey Guidelines.

4.3 Category (B) technology

4.3.1 The effects of innovative energy technologies in category (B) are expressed as P_{eff} which would be multiplied by C_{FME} and SFC_{ME} (in the case of $P_{PTI(i)}$ >0, the average weighted value of ($SFC_{ME} \cdot C_{FME}$) and ($SFC_{AE} \cdot C_{FAE}$)) and f_{eff}, and then be deducted from the EEDI formula. In the case of category (B-1) technology, f_{eff} is 1.00.

4.3.2 Guidance on calculation and verification of effects of Category (B) innovative technologies is given in annex 1.

4.4 Category (C) technology

4.4.1 The effects of innovative energy technologies in category (C) are expressed as P_{AEeff} which would be multiplied by C_{FAE}, SFC_{AE} and f_{eff}, and then be deducted from the EEDI formula. In the case of category (C-1) technology, f_{eff} is 1.00.

4.4.2 Guidance on calculation and verification of effects of Category (C) innovative technologies is given in annex 2.

5 Average weighted value in the case of $P_{PTI(i)}$ >0

In the case of $P_{PTI(i)}$ >0, both Category (B) and Category (C) technologies might deduct the value of $P_{PTI(i)}$. In such case, following values are to be used for average weighted value in calculating $\Sigma(f_{eff(i)} \cdot P_{eff(i)} \cdot C_{F.}\ SFC)$ in attained EEDI formula;

For shaft power(s):
$(\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff}\cdot\eta_{GEN}\cdot\eta_{PTI(i)}) \,/\, (\Sigma P_{ME(i)} + \Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff}\cdot\eta_{GEN}\cdot\eta_{PTI(i)})$,
where, if $(\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff}\cdot\eta_{GEN}\cdot\eta_{PTI(i)})$ is taken negative value, the value $(\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff}\cdot\eta_{GEN}\cdot\eta_{PTI(i)})$ should be fixed to zero; and

For main engine(s):
$\Sigma P_{ME(i)} \,/\, (\Sigma P_{ME(i)} + \Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff}\cdot\eta_{GEN}\cdot\eta_{PTI(i)})$,
where, if $\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff}\cdot\eta_{GEN}\cdot\eta_{PTI(i)}$ is taken negative value, the value $(\Sigma P_{PTI(i),shaft} - \cdot\Sigma P_{AEeff}\cdot\eta_{GEN}\cdot\eta_{PTI(i)})$ should be fixed to zero.

* * *

ANNEX 1[1]

GUIDANCE ON CALCULATION AND VERIFICATION OF EFFECTS OF CATEGORY (B) INNOVATIVE TECHNOLOGIES

Appendix 1

AIR LUBRICATION SYSTEM (CATEGORY (B-1))

1 Summary of innovative energy efficient technology

An air lubrication system is one of the innovative energy efficiency technologies. Ship frictional resistance can be reduced by covering the ship surface with air bubbles, which is injected from the fore part of the ship bottom by using blowers, etc.

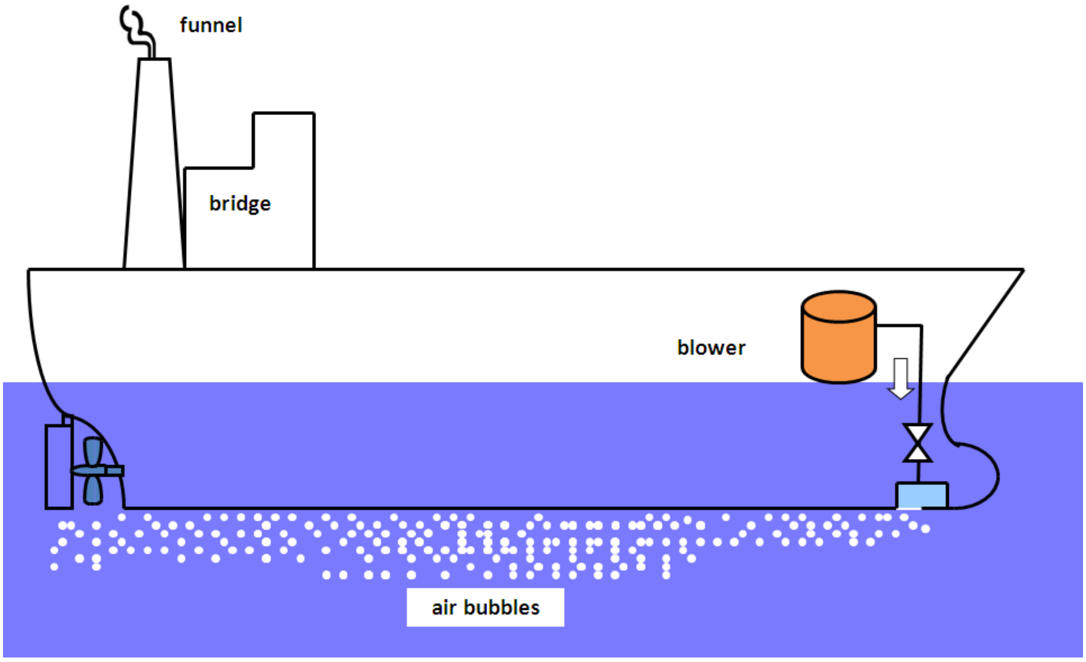

Figure 1 – Schematic illustration of an air lubrication system

2 Method of calculation

2.1 Power reduction due to air lubrication system

Power reduction factor P_{eff} due to an air lubrication system as an innovative energy efficiency technology is calculated by the following formula. The first and second terms of the right hand side represent the reduction of propulsion power by the air lubrication system and the additional power necessary for running the system, respectively. For this system, f_{eff} is 1.0 in EEDI formula.

$$P_{eff} = P_{PeffAL} - P_{AEeffAL} \frac{C_{FAE}}{C_{FME}} \frac{SFC_{AE}}{SFC_{ME}{}^{*}} \quad (1)$$

* In the case of $P_{PTI(i)} > 0$, the average weighted value of ($SFC_{ME} \cdot C_{FME}$) and ($SFC_{AE} \cdot C_{FAE}$)

[1] All examples in appendix are used solely to illustrate the proposed methods of calculation and verification.

2.1.1 P_{eff} is the effective power reduction in kW due to the air lubrication system at the 75 per cent of the rated installed power (MCR). In case that shaft generators are installed, P_{eff} should be calculated at the 75 per cent MCR having after deducted any installed shaft generators in accordance with paragraph 2.5 of EEDI Calculation Guidelines. P_{eff} should be calculated both in the fully loaded and the sea trial conditions.

2.1.2 P_{PeffAL} is the reduction of propulsion power due to the air lubrication system in kW. P_{PeffAL} should be calculated both in the condition corresponding to the *Capacity* as defined in EEDI Calculation Guidelines (hereinafter referred to as "fully loaded condition") and the sea trial condition, taking the following items into account.

.1 area of ship surface covered with air;

.2 thickness of air layer;

.3 reduction rate of frictional resistance due to the coverage of air layer;

.4 change of propulsion efficiency due to the interaction with air bubbles (self propulsion factors and propeller open water characteristics); and

.5 change of resistance due to additional device, if equipped.

2.1.3 $P_{AEeffAL}$ is additional auxiliary power in kW necessary for running the air lubrication system in the fully loaded condition. $P_{AEeffAL}$ should be calculated as 75 per cent of the rated output of blowers based on the manufacturer's test report. For a system where the calculated value above is significantly different from the output used at normal operation in the fully loaded condition, the $P_{AEeffAL}$ value may be estimated by an alternative method. In this case, the calculation process should be submitted to a verifier.

2.2 Points to keep in mind in calculation of attained EEDI with air lubrication system

2.2.1 V_{ref} in paragraph 2.2 of EEDI Calculation Guidelines should be calculated in the condition that the air lubrication system is OFF to avoid the double count of the effect of this system.

2.2.2 In accordance with EEDI Calculation Guidelines, the EEDI value for ships for the air lubrication system ON should be calculated in the fully loaded condition.

3 Method of verification

3.1 General

Attained EEDI for a ship with an innovative energy efficient technology should be verified in accordance with EEDI Survey Guidelines. Additional information on the application of air lubrication system, which is not given in the EEDI Survey Guidelines, is contained below.

3.2 Preliminary verification at the design stage

3.2.1 In addition to paragraph 4.2.2 of EEDI Survey Guidelines, the EEDI Technical File which is to be developed by a shipowner or shipbuilder should include:

.1 outline of the air lubrication system;

.2 P_{PeffAL} : the reduction of propulsion power due to the air lubrication system at the ship speed of V_{ref} both in the fully loaded and the sea trial conditions;

.3 EDR_{full} : the reduction rate of propulsion power in the fully loaded condition due to the air lubrication system. EDR_{full} is calculated by dividing $P_{MEeffAL}$ by P_{ME} in EEDI Calculation Guidelines in the fully loaded condition (See Figure 2);

.4 EDR_{trial} : the reduction rate of propulsion power in a sea trial condition due to the air lubrication system. EDR_{trial} is calculated by dividing $P_{MEeffAL}$ by P_{ME} in EEDI Calculation Guidelines in sea trial condition (see figure 2);

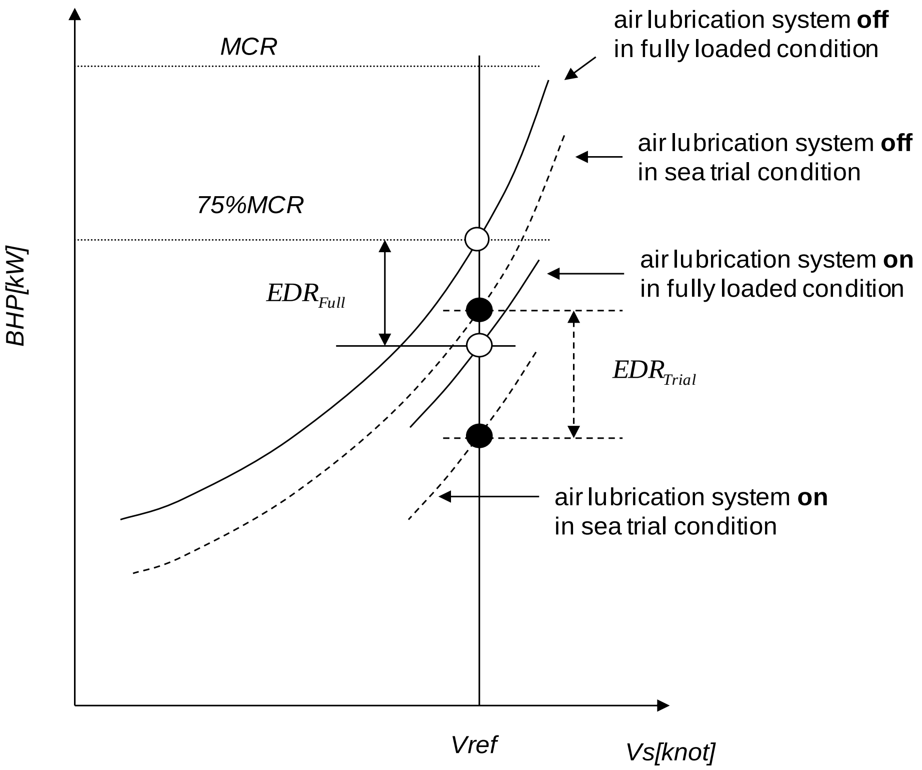

Figure 2 – Calculation of the reduction rate of propulsion power (EDR_{full} and EDR_{trial}) due to air lubrication system

.5 $P_{AEeffAL}$: additional power necessary for running the air lubrication system; and

.6 the calculated value of the EEDI for the air lubrication system ON in the fully loaded condition.

3.2.2 In addition with paragraph 4.2.7 of the EEDI Survey Guidelines, additional information that the verifier may request the shipbuilder to provide directly to it includes:

.1 the detailed calculation process of the reduction of propulsion power due to the air lubrication system : P_{PeffAL} ; and

.2 the detailed calculation process of the additional power necessary for running the air lubrication system : $P_{AEeffAL}$.

3.3 Final verification of the attained EEDI at sea trial

3.3.1 Final verification of the EEDI of ships due to the air lubrication system should be conducted at the sea trial. The procedure of final verification should be basically in accordance with paragraph 4.3 of the EEDI Survey Guidelines.

3.3.2 Prior to the sea trial, the following documents should be submitted to the verifier; a description of the test procedure that includes the measurement methods to be used at the sea trial of the ship with the air lubrication system.

3.3.3 The verifier should attend the sea trial and confirm the items described in paragraph 4.3.3 of the EEDI Survey Guidelines to be measured at the sea trial for the air lubrication system ON and OFF.

3.3.4 The main engine output at the sea trial for the air lubrication system ON and OFF should be set so that the range of the developed power curve includes the ship speed of V_{ref}.

3.3.5 The following procedure should be conducted based on the power curve developed for air lubrication system OFF.

.1 ship speed at 75 per cent MCR of main engine in the fully loaded condition, V_{ref}, should be calculated. In case that shaft generators are installed, V_{ref} should be calculated at 75 per cent MCR having after deducted any installed shaft generators in accordance with paragraph 2.5 of EEDI Calculation Guidelines.

.2 In case that V_{ref} obtained above is different from that estimated at the design stage, the reduction rate of main engine should be recalculated at new V_{ref} both in the fully loaded and the sea trial conditions.

3.3.6 The shipbuilder should develop power curves for the air lubrication system ON based on the measured ship speed and output of the main engine at the sea trial. The following calculations should be conducted.

.1 The actual reduction rate of propulsion power ADR_{trial} at the ship speed of V_{ref} at the sea trial.

.2 If the sea trial is not conducted in the fully loaded condition, the reduction rate of propulsion power in this condition should be calculated by the following formula:

$$1 - ADR_{Full} = (1 - EDR_{Full}) \times \frac{1 - ADR_{Trial}}{1 - EDR_{Trial}},$$

i.e.

$$ADR_{Full} = 1 - (1 - EDR_{Full}) \times \frac{1 - ADR_{Trial}}{1 - EDR_{Trial}} \qquad (2)$$

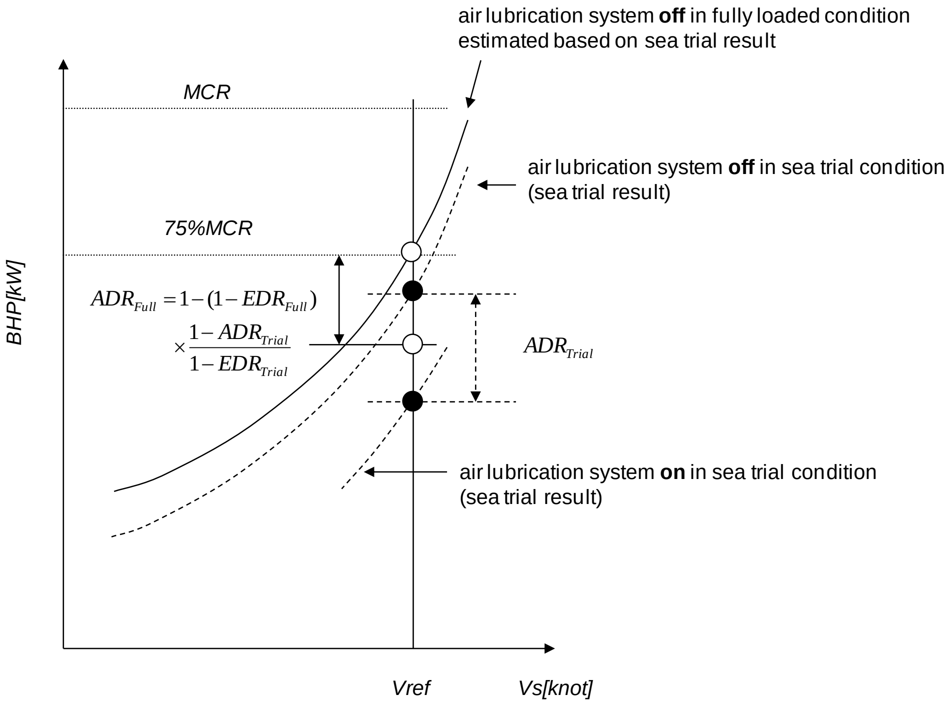

Figure 3 – Calculation of the actual reduction rate of propulsion power (ADR_{full} and ADR_{trial}) due to air lubrication system

3.3.7 The reduction of propulsion power due to the air lubrication system $P_{MEeffAL}$ in the fully loaded and the sea trial conditions should be calculated as follows:

$$P_{PeffAL\_Full} = ADR_{Full} \times P_P \quad (3)$$

$$P_{PeffAL\_Trial} = ADR_{Trial} \times P_P \quad (4)$$

3.3.8 The shipowner or the shipbuilder should revise the EEDI Technical File, as necessary, by taking the result of the sea trial into account. Such revision should include the following contents:

.1 V_{ref} , in case that it is different from that estimated at the design stage;

.2 the reduction of propulsion power P_{PeffAL} at the ship speed of V_{ref} in the fully loaded and the sea trial conditions for the air lubrication system ON.

.3 the reduction rate of propulsion power due to air lubrication system (ADR_{full} and ADR_{trial}) in the fully loaded and the sea trial conditions.

.4 the calculated value of the EEDI for the air lubrication system ON in the fully loaded condition.

Appendix 2

WIND PROPULSION SYSTEM (CATEGORY B-2)

1 Summary of innovative energy efficient technology

1.1 Wind propulsion systems belong to innovative mechanical energy efficient technologies which reduce the CO_2 emissions of ships. There are different types of wind propulsion technologies (sails, wings, kites, etc.) which generate forces dependent on wind conditions. This technical guidance defines the available effective power of wind propulsion systems as the product of the reference speed and the sum of the wind propulsion system force and the global wind probability distribution.

2 Definitions

2.1 For the purpose of these guidelines, the following definitions should apply:

.1 *Available effective power* is the multiplication of effective power P_{eff} and availability factor f_{eff} as defined in the EEDI calculation.

.2 *Wind propulsion systems* belong to innovative mechanical energy efficient technologies which reduce the CO_2 emissions of ships. These proposed guidelines apply to wind propulsion technologies that directly transfer mechanical propulsion forces to the ship's structure (sails, wings, kites, etc.).

.3 *Global wind probability matrix* contains data of the global wind power on the main global shipping routes based on a statistical survey of worldwide wind data. A detailed determination of the global wind probability matrix can be found in a separate submission (INF paper).

3 Available effective power of wind propulsion systems

3.1 The available effective power of wind propulsion systems as innovative energy efficient technology is calculated by the following formula:

$$\left(f_{eff} \cdot P_{eff}\right) = \left(\frac{0.5144 \cdot V_{ref}}{\eta_T} \sum_{i=1}^{m} \sum_{j=1}^{n} F(V_{ref})_{i,j} \cdot W_{i,j}\right) - \left(\sum_{i=1}^{m} \sum_{j=1}^{n} P(V_{ref})_{i,j} \cdot W_{i,j}\right)$$

Where:

.1 (f_{eff} * P_{eff}) is the available effective power in kW delivered by the specified wind propulsion system. f_{eff} and P_{eff} are combined in the calculation because the product of availability and power is a result of a matrix operation, addressing each wind condition with a probability and a specific wind propulsion system force.

.2 The factor 0.5144 is the conversion factor from nautical miles per hour (knots) to metres per second (m/s).

.3 V_{ref} is the ship reference speed measured in nautical miles per hour (knots), as defined in the EEDI calculation guidelines.

.4 η_T is the total efficiency of the main drive(s) at 75 per cent of the rated installed power (MCR) of the main engine(s). η_T shall be set to [0.7], if no other value is specified and verified by the verifier.

.5 $F(V_{ref})_{i,j}$ is the force matrix of the respective wind propulsion system for a given ship speed V_{ref}.

.6 $W_{i,j}$ is the global wind probability matrix (see below).

.7 $P(V_{ref})_{i,j}$ is a matrix with the same dimensions as $F(V_{ref})_{i,j}$ and $W_{i,j}$ and represents the power demand in kW for the operation of the wind propulsion system.

3.2 The first term of the formula defines the additional propulsion power to be considered for the overall EEDI calculation. The term contains the product of the ship specific speed, the force matrix and the global wind probability matrix. The second term contains the power requirement for the operation of the specific wind propulsion system which has to be subtracted from the gained wind power.

4 Wind propulsion system force matrix $F(V_{ref})_{i,j}$

4.1 Every wind propulsion system has a distinctive force characteristic dependent on ship speed, wind speed and the wind angle relative to heading. The force characteristic can be expressed in a two dimensional matrix, holding elements for any combination of wind speed and wind angle relative to heading for a given ship speed V_{ref}.

4.2 Each matrix element represents the propulsion force in kilonewton (kN) for the respective wind speed and angle. The wind angle is given in relative bearings (with 0° on the bow). Table 1 gives guidance for the determination of the wind propulsion system force matrix $\mathbf{F(V_{ref})_{i,j}}$. For the final determination of the CO_2 reduction of a system the force matrix must be approved by the verifier.

Table 1: Lay-out of a force matrix in kN for a wind propulsion system at V_{ref}

wind angle [°] / wind speed [m/s]	**0**	**5**	**…**	**355**
<1	$f_{1,1}$	$f_{1,2}$	…	$f_{1,72}$
<2	$f_{2,1}$	$f_{2,2}$	…	$f_{2,72}$
<3	$f_{3,1}$	$f_{3,2}$	…	$f_{3,72}$
⋮	⋮	⋮	⋱	⋮
≥25	$f_{26,1}$	$f_{26,2}$	…	$f_{26,72}$

5 The global wind probability matrix $W_{i,j}$

5.1 $\mathbf{W_{i,j}}$ represents the probability of wind conditions. Each matrix element represents the probability of wind speed and wind angle relative to the ship coordinates. The sum over all matrix elements equals 1 and is non-dimensional. Table 2 shows the layout of the global wind probability matrix. The wind probability matrix shall be gained from the wind probability on the main global shipping routes[2].

[2] An example on a global wind probability matrix can be found in document MEPC 62/INF.34. This example should be subject to approval in a later session of MEPC.

Table 2: Lay-out of the global wind probability matrix

wind angle [°] / wind speed [m/s]	**0**	**5**	**…**	**355**
<1	$w_{1,1}$	$w_{1,2}$	…	$w_{1,72}$
<2	$w_{2,1}$	$w_{2,2}$	…	$w_{2,72}$
<3	$w_{3,1}$	$w_{3,2}$	…	$w_{3,72}$
⋮	⋮	⋮	⋱	⋮
≥25	$w_{26,1}$	$w_{26,2}$	…	$w_{26,72}$

6 Effective CO_2 reduction by wind propulsion systems

6.1 For the calculation of the CO_2 reduction the resulting available effective power (f_{eff} * P_{eff}) has to be multiplied with the conversion factor C_{FME} and SFC_{ME} as contained in the original EEDI formula.

7 Verification of wind propulsion systems in the EEDI certification process

7.1 General

Verification of EEDI with innovative energy efficient technologies should be conducted according to the EEDI Survey Guidelines. Additional items concerning innovative energy efficient technologies not contained in EEDI Survey Guidelines are described below.

7.2 Preliminary verification at the design stage

7.2.1 In addition to paragraph 4.2.2 **of** EEDI Survey Guidelines, the **EEDI** Technical File which is to be developed by the shipowner or shipbuilder should include:

.1 Outline of Wind propulsion systems; and

.2 Calculated value of EEDI due to the wind propulsion system.

7.2.2 In addition to paragraph 4.2.7 of the EEDI Survey Guidelines, additional information from the shipbuilder may be requested by the verifier. It includes:

.1 Detailed calculation process of the wind propulsion system force matrix $\mathbf{F(V_{ref})_{i,j}}$ and results of performance tests[3].

7.2.3 In order to prevent undesirable effects on the ship's structure or main drive, the influences of added forces on the ship should be determined during the EEDI certification process. Elements in the wind propulsion system force matrix may be limited to ship specific restrictions if necessary. The technical means to restrict the wind propulsion system's force should be verified as part of the performance test[4].

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3 Performance test for the specific type of wind propulsion system are required to determine the wind propulsion system force matrix. Technical guidance for the conduction of performance tests should be subject to approval in a later session of MEPC.

4 Technical guidance for the conduction of performance tests should be subject to approval in a later session of MEPC.

7.2.4 If more than one innovative energy efficient technology is subject to approval in the EEDI certification, interactions between these technologies should be considered. The appropriate technical papers should be included in the additional information submitted to the verifier in the certification process.

7.3 Final verification of the attained EEDI at sea trial

The total net power generated by wind propulsion systems should be confirmed based on the EEDI Technical File. In addition to the confirmation, it should be confirmed prior to the final verification, whether the configuration of the wind propulsion systems on the ship is the same as applied in the pre-verification.

* * *

ANNEX 2[5]

GUIDANCE ON CALCULATION AND VERIFICATION OF EFFECTS OF CATEGORY (C) INNOVATIVE TECHNOLOGIES

Appendix 1

WASTE HEAT RECOVERY SYSTEM FOR GENERATION OF ELECTRICITY (CATEGORY (C-1))

1 Summary of innovative energy efficient technology

This Appendix provides the guidance on the treatment of high temperature waste heat recovery systems (electric generation type) as innovative energy efficiency technologies related to the reduction of the auxiliary power (concerning $P_{AEeff(i)}$). Mechanical recovered waste energy directly coupled to shafts need not be measured in this category, since the effect of the technology is directly reflected in the V_{ref}..

Waste heat energy technologies increase the efficiency utilization of the energy generated from fuel combustion in the engine through recovery of the thermal energy of exhaust gas, cooling water, etc., thereby generating electricity.

There are the following two methods of generating electricity by the waste heat energy technologies (electric generation type).

(A) Method to recover thermal energy by a heat exchanger and to drive the thermal engine which drives an electric generator.

(B) Method to drive directly an electric generator using power turbine, etc. Furthermore, there is a waste heat recovery system which combines both of the above methods.

[5] All examples in appendix are used solely to illustrate the proposed methods of calculation and verification.

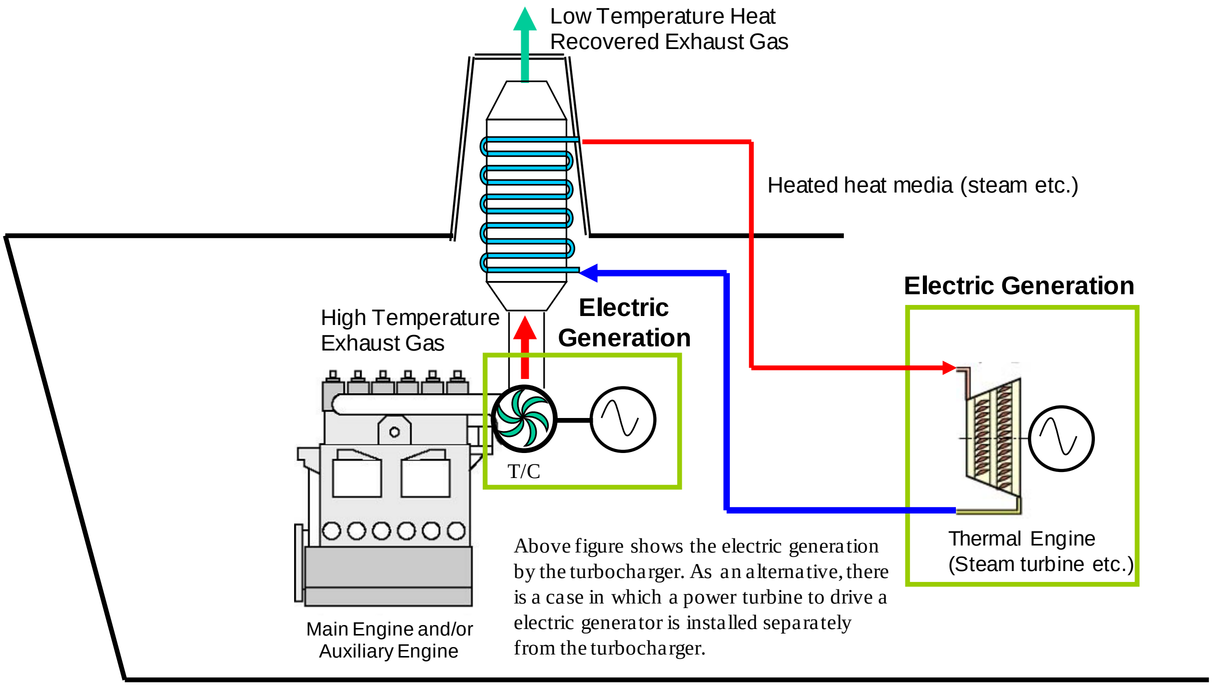

Figure 1 – Schematic illustration of Exhaust Heat Recovery

2 Method of calculation

2.1 Power reduction due to waste heating recovery system

The reduction of power by the waste heat recovery system is calculated by the following equation. For this system, f_{eff} is 1.00 in EEDI formula.

$$P_{AEeff} = P'_{AEeff} - P_{AEeff_{loss}} \tag{1}$$

In the above equation, P'_{AEeff} is power produced by the waste heat recovery system. P_{AEeff_Loss} is the necessary power to drive the waste heat recovery system.

2.1.1 P_{AEeff} is the reduction of the ship's total auxiliary power (kW) by the waste heat recovery system under the ship performance condition applied for EEDI calculation. The power generated by the system under this condition and fed into the main switch board is to be taken into account, regardless of its application on board the vessel (except for power consumed by machinery as described in paragraph 2.1.4).

2.1.2 P'_{AEeff} is defined by the following equation.

$$P'_{AEeff} = \frac{W_e}{\eta_g}, \tag{2}$$

where:

W_e : Calculated production of electricity by the waste heat recovery system
η_g : Weighted average generator efficiency

2.1.3 P_{AEeff} is determined by the following factors:

.1 temperature and mass flow of exhaust gas of the engines, etc.;

.2 constitution of the waste heat recovery system; and

.3 efficiency and performances of the components of the waste heat recovery system.

2.1.4 P_{AEeff_Loss} is the power (kW) for the pump, etc., necessary to drive the waste heat recovery system.

3 Method of verification

3.1 General

Verification of EEDI with innovative energy efficient technologies should be conducted according to the EEDI Survey Guidelines. Additional items concerning innovative energy efficient technologies not contained in EEDI Survey Guidelines are described below.

3.2 Preliminary verification at the design stage

3.2.1 In addition to paragraph 4.2.2 of EEDI Survey Guidelines, the EEDI Technical File which is to be developed by the shipowner or shipbuilder should include:

.1 diagrams, such as a plant diagram, a process flow diagram, or a piping and instrumentation diagram outlining the waste heat recovery system, and its related information such as specifications of the system components;

.2 deduction of the saved energy from the auxiliary engine power by the waste heat recovery system; and

.3 calculation result of EEDI.

3.2.2 In addition to paragraph 4.2.7 of the EEDI Survey Guidelines, additional information that the verifier may request the shipbuilder to provide directly to it includes:

.1 exhaust gas data for the main engine at 75 per cent MCR (and/or the auxiliary engine at the measurement condition of SFC) at different ambient air inlet temperatures, e.g. 5°C, 25°C and 35°C; which consist of:

.1.1 exhaust gas mass flow for turbo charger (kg/h);

.1.2 exhaust gas temperatures after turbo charger (C°);

.1.3 exhaust gas bypass mass flow available for power turbine, if any (kg/h);

.1.4 exhaust gas temperature for bypass flow (C°); and

.1.5 exhaust gas pressure for bypass flow (bar).

.2 in the case of system using heat exchanger, expected output steam flows and steam temperatures for the exchanger, based on the exhaust gas data from the main engine;

.3 estimation process of the heat energy recovered by the waste heat recovery system; and

.4 further details of the calculation method of P_{AEeff} defined in paragraph 2.1 of this appendix.

3.3 Final verification of the attained EEDI at sea trial

3.3.1 Deduction of the saved energy from the auxiliary engine power by the waste heat recovery system should be verified by the results of shop tests of the waste heat recovery system's principal components and, where possible, at sea trials.

3.3.2 In the case of systems for which shop tests are difficult to be conducted, e.g. in case of the exhaust gas economizer, the performance of the waste heat recovery system should be verified by measuring the amount of the generated steam, its temperature, etc. at the sea trial. In that case, the measured vapour amount, temperature, etc. should be corrected to the value under the exhaust gas condition when they were designed, and at the measurement conditions of *SFC* of the main/auxiliary engine(s). The exhaust gas condition should be corrected based on the atmospheric temperature in the engine-room (Measurement condition of *SFC* of main/auxiliary engine(s); i.e. 25°C), etc.

Appendix 2

PHOTOVOLTAIC POWER GENERATION SYSTEM (CATEGORY (C-2))

1 Summary of innovative energy efficient technology

Photovoltaic (PV) power generation system set on a ship will provide part of the electric power either for propelling the ship or for use inboard. PV power generation system consists of PV modules and other electric equipment. Figure 1 shows a schematic diagram of PV power generation system. The PV module consists of combining solar cells and there are some types of solar cell such as "Crystalline silicon terrestrial photovoltaic" and "Thin-film terrestrial photovoltaic", etc.

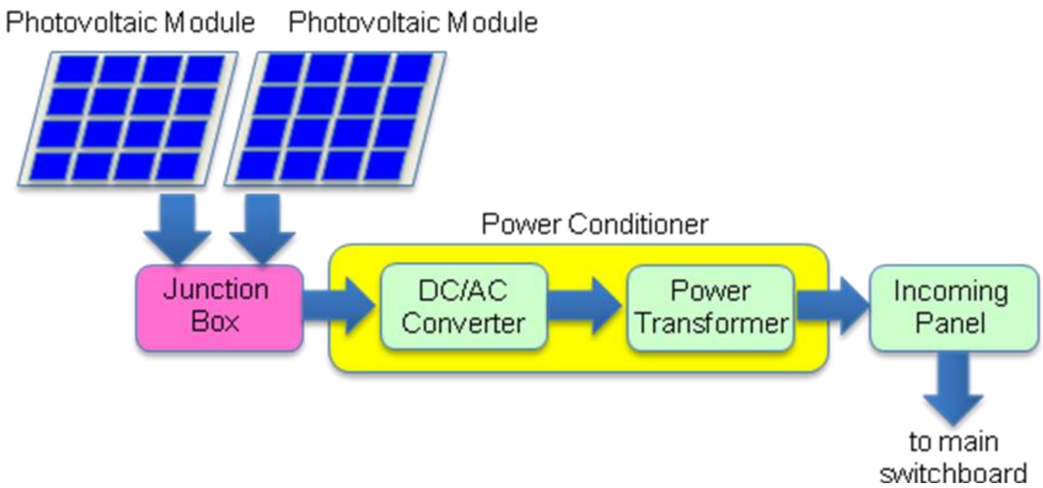

Figure 1 – Schematic diagram of photovoltaic power generation system

2 Method of calculation

2.1 Electric power due to photovoltaic power generation system

The auxiliary power reduction due to the PV power generation system can be calculated as follows:

$$f_{eff} \cdot P_{AEeff} = \{f_{rad} \times (1 + L_{temp} / 100)\} \times \{P_{max} \times (1 - L_{others} / 100) \times N / \eta_{GEN}\} \quad (1)$$

2.1.1 $f_{eff} \cdot P_{AEeff}$ is the total net electric power (kW) generated by the PV power generation system.

2.1.2 Effective coefficient f_{eff} is the ratio of average PV power generation in main global shipping routes to the nominal PV power generation specified by the manufacturer. Effective coefficient can be calculated by the following formula using the solar irradiance and air temperature of main global shipping routes:

$$f_{eff} = f_{rad} \times (1 + L_{temp} / 100) \quad (2)$$

2.1.3 f_{rad} is the ratio of the average solar irradiance on main global shipping route to the nominal solar irradiance specified by the manufacturer. Nominal maximum generating power P_{max} is measured under the Standard Test Condition (STC) of IEC standard[6]. STC specified by manufacturer is that: Air Mass (AM) 1.5, the module's temperature is 25°C, and the solar irradiance is 1000 W/m^2. The average solar irradiance on main global shipping route is 200 W/m^2. Therefore, f_{rad} is calculated by the following formula:

$$f_{rad} = 200\ \mathrm{W/m^2} \div 1000\ \mathrm{W/m^2} = 0.2 \tag{3}$$

2.1.4 L_{temp} is the correction factor, which is usually in minus, and derived from the temperature of PV modules, and the value is expressed in per cent. The average temperature of the modules is deemed 40°C, based on the average air temperature on main global shipping routes. Therefore, L_{temp} is derived from the temperature coefficient f_{temp} (percent/K) specified by the manufacturer (See IEC standard[6]) as follows:

$$L_{temp} = f_{temp} \times (40°\mathrm{C} - 25°\mathrm{C}) \tag{4}$$

2.1.5 P_{AEeff} is the generated PV power divided by the weighted average efficiency of the generator(s) under the condition specified by the manufacturer and expressed as follows:

$$P_{AEeff} = P_{max} \times (1 - L_{others}/100) \times N/\eta_{GEN}, \tag{5}$$

where η_{GEN} is the weighted average efficiency of the generator(s).

2.1.6 P_{max} is the nominal maximum generated PV power generation of a module expressed in kilowatt, specified based on IEC Standards[6].

2.1.7 L_{others} is the summation of other losses expressed by percent and includes the losses in a power conditioner, at contact, by electrical resistance, etc. Based on experiences, it is estimated that L_{others} is 10 per cent (the loss in the power conditioner: 5 per cent and the sum of other losses: 5%). However, for the loss in the power conditioner, it is practical to apply the value specified based on IEC Standards[7].

2.1.8 *N* is the numbers of modules used in a PV power generation system.

3 Method of verification

3.1 General

Verification of EEDI with innovative energy efficient technologies is conducted according to EEDI Survey Guidelines**.** This section provides additional requirements related to innovative technologies.

3.2 Preliminary verification at the design stage

3.2.1 In addition to paragraph 4.2.2 of EEDI Survey guidelines, the EEDI Technical File which is to be developed by the shipowner or shipbuilder should include:

6 Refer to IEC 61215 "Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval" for Crystalline silicon terrestrial PV modules, and to IEC 61646 "Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval" for Thin-film terrestrial PV modules.

7 IEC 61683 "Photovoltaic systems – Power conditioners – Procedure for measuring efficiency".

.1 outline of the PV power generation system;

.2 power generated by the PV power generation system; and

.3 calculated value of EEDI due to the PV power generation system.

3.2.2 In addition to paragraph 4.2.7 of the EEDI survey guidelines, additional information that the verifier may request the shipbuilder to provide directly to it includes:

.1 detailed calculation process of the auxiliary power reduction by the PV power generation system; and

.2 detailed calculation process of the total net electric power ($f_{eff} \cdot P_{AEeff}$) specified in paragraph 2 in this guidance.

3.3 Final verification of the attained EEDI at sea trial

The total net electric power generated by PV power generation system should be confirmed based on the EEDI Technical File. In addition to the confirmation, it should be confirmed whether the configuration of the PV power generation systems on ship is as applied, prior to the final verification.

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MEPC.1/Circ.816
10 May 2013

2013 GUIDELINES ON SURVEY AND CERTIFICATION OF THE ENERGY EFFICIENCY DESIGN INDEX (EEDI)

1 The Marine Environment Protection Committee, at its sixty-fifth session (13 to 17 May 2013), adopted, by resolution MEPC.234(65), amendments to the *2012 Guidelines on survey and certification of the energy efficiency design index (EEDI)* (resolution MEPC.214(63)), and agreed to circulate a consolidated text of the *2013 Guidelines on survey and certification of the energy efficiency design index (EEDI)*, as set out in the annex (MEPC 65/22, paragraph 4.134.9).

2 Member Governments are invited to bring the annexed *2013 Guidelines on survey and certification of the energy efficiency design index (EEDI)* to the attention of their Administrations, industry, relevant shipping organizations, shipping companies and other stakeholders concerned.

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ANNEX

2013 GUIDELINES ON SURVEY AND CERTIFICATION OF THE ENERGY EFFICIENCY DESIGN INDEX (EEDI)

TABLE OF CONTENTS

1 GENERAL

The purpose of these Guidelines is to assist verifiers of Energy Efficiency Design Index (EEDI) of ships in conducting the survey and certification of the EEDI in accordance with regulations 5, 6, 7, 8 and 9 of MARPOL Annex VI, and assist shipowners, shipbuilders and manufacturers being related to the energy efficiency of a ship and other interested parties in understanding the procedures of the survey and certification of the EEDI.

2 DEFINITIONS[1]

2.1 *Verifier* means an Administration or organization duly authorized by it, which conducts the survey and certification of the EEDI in accordance with regulations 5, 6, 7, 8 and 9 of MARPOL Annex VI and these Guidelines.

2.2 *Ship of the same type* means a ship of which hull form (expressed in the lines such as sheer plan and body plan) excluding additional hull features such as fins and of which principal particulars are identical to that of the base ship.

2.3 *Tank test* means model towing tests, model self-propulsion tests and model propeller open water tests. Numerical calculations may be accepted as equivalent to model propeller open water tests or used to complement the tank tests conducted (e.g. to evaluate the effect of additional hull features such as fins, etc., on ship's performance), with approval of the verifier.

3 APPLICATION

These Guidelines should be applied to new ships for which an application for an initial survey or an additional survey specified in regulation 5 of MARPOL Annex VI has been submitted to a verifier.

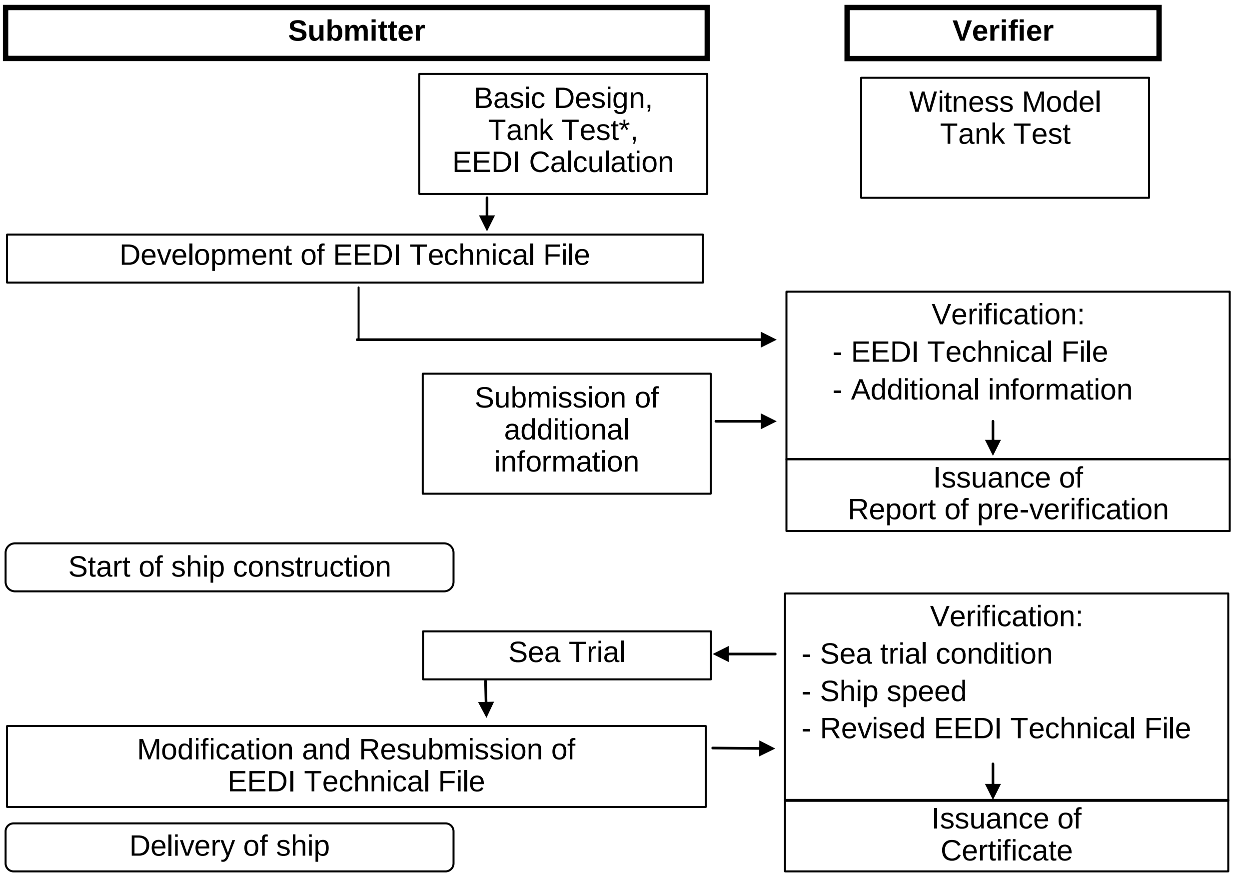
4 PROCEDURES FOR SURVEY AND CERTIFICATION

4.1 General

4.1.1 Attained EEDI should be calculated in accordance with regulation 20 of MARPOL Annex VI and the "Guidelines on the method of calculation of the attained EEDI for new ships" ("EEDI Calculation Guidelines", hereafter). Survey and certification of the EEDI should be conducted on two stages: preliminary verification at the design stage, and final verification at the sea trial. The basic flow of the survey and certification process is presented in figure 1.

4.1.2 The information used in the verification process may contain confidential information of submitters, which requires Intellectual Property Rights (IPR) protection. In the case where the submitter wants a non-disclosure agreement with the verifier, the additional information should be provided to the verifier upon mutually agreed terms and conditions.

[1] Other terms used in these Guidelines have the same meaning as those defined in the EEDI Calculation Guidelines.



* To be conducted by a test organization or a submitter itself.

Figure 1: Basic Flow of Survey and Certification Process

4.2 Preliminary verification of the attained EEDI at the design stage

4.2.1 For the preliminary verification at the design stage, an application for an initial survey and an EEDI Technical File containing the necessary information for the verification and other relevant background documents should be submitted to a verifier.

4.2.2 EEDI Technical File should be written at least in English. The EEDI Technical File should include at least but not limited to:

.1 deadweight (DWT) or gross tonnage (GT) for passenger and ro-ro passenger ships, the maximum continuous rating (MCR) of the main and auxiliary engines, the ship speed (V_{ref}), as specified in paragraph 2.2 of the EEDI Calculation Guidelines, type of fuel, the specific fuel consumption (*SFC*) of the main engine at the 75 per cent of MCR power, the *SFC* of the auxiliary engines at the 50 per cent MCR power, and the electric power table[†] for certain ship types, as necessary, as defined in the EEDI Calculation Guidelines;

.2 power curve(s) (kW – knot) estimated at design stage under the condition as specified in paragraph 2.2 of the EEDI Calculation Guidelines, and in the event that the sea trial is carried out in a condition other than the above condition, then also a power curve estimated under the sea trial condition;

.3 principal particulars, ship type and the relevant information to classify the ship into such a ship type, classification notations and the overview of propulsion system and electricity supply system on board;

.4 estimation process and methodology of the power curves at design stage;

.5 description of energy saving equipment;

.6 calculated value of the attained EEDI including the calculation summary, which should contain, at a minimum, each value of the calculation parameters and the calculation process used to determine the attained EEDI; and

.7 calculated values of the attained $EEDI_{weather}$ and f_w value (not equal to 1.0), if those values are calculated, based on the EEDI Calculation Guidelines.

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† Electric power table should be validated separately, taking into account guidelines set out in appendix 2 to these Guidelines.

A sample of an EEDI Technical File is provided in the appendix 1 to these Guidelines.

4.2.3 If dual fuel engines are installed on the ship, the C_F factor and the Specific Fuel Consumption of gas fuel should be used if gas fuel will be used as the primary fuel on the ship. In order to verify this, the following information should be provided:

.1 The use of boil-off gas or capacities of the gas fuel storage tanks, and the capacities of fuel oil storage tanks.

.2 Arrangements of bunkering facilities for gas fuel in the intended operational area of the ship.

4.2.4 The *SFC* of the main and auxiliary engines should be quoted from the approved NO_x Technical File and should be corrected to the value corresponding to the ISO standard reference conditions using the standard lower calorific value of the fuel oil (42,700kJ/kg), referring to ISO 15550:2002 and ISO 3046-1:2002. For the confirmation of the *SFC*, a copy of the approved NO_x Technical File and documented summary of the correction calculations should be submitted to the verifier. In case NO_x Technical File has not been approved at the time of the application for initial survey, the test reports provided by manufacturers should be used. In this case, at the time of the sea trial verification, a copy of the approved NO_x Technical File and documented summary of the correction calculations should be submitted to the verifier.

Note: *SFC* in the NO_x Technical File are the values of a parent engine, and the use of such value of *SFC* for the EEDI calculation for member engines may have the following technical issues for further consideration:

.1 The definition of "member engines" given in NO_x Technical File is broad and specification of engines belonging to the same group/family may vary; and

.2 The rate of NO_x emission of the parent engine is the highest in the group/family – i.e. CO_2 emission, which is in the trade-off relationship with NO_x emission, can be lower than the other engines in the group/family.

4.2.5 For ships to which regulation 21 of MARPOL Annex VI applies, the power curves used for the preliminary verification at the design stage should be based on reliable results of tank test. A tank test for an individual ship may be omitted based on technical justifications such as availability of the results of tank tests for ships of the same type. In addition, omission of tank tests is acceptable for a ship for which sea trials will be carried under the condition as specified in paragraph 2.2 of the EEDI Calculation Guidelines, upon agreement of the shipowner and shipbuilder and with approval of the verifier. For ensuring the quality of tank tests, ITTC quality system should be taken into account. Model tank test should be witnessed by the verifier.

Note: It would be desirable in the future that an organization conducting a tank test be authorized.

4.2.6 The verifier may request the submitter for additional information on top of those contained in Technical File, as necessary, to examine the calculation process of the attained EEDI. The estimation of the ship speed at the design stage much depends on each shipbuilder's experiences, and it may not be practicable for any person/organization other than the shipbuilder to fully examine the technical aspects of experience-based parameters such as the roughness coefficient and wake scaling coefficient. Therefore, the preliminary verification should focus on the calculation process of the attained EEDI to ensure that it is technically sound and reasonable and follows regulation 20 of MARPOL Annex VI and the EEDI Calculation Guidelines.

Note 1: A possible way forward for more robust verification is to establish a standard methodology of deriving the ship speed from the outcomes of tank test, by setting standard values for experience-based correction factors such as roughness coefficient and wake scaling coefficient. In this way, ship-by-ship performance comparison could be made more objectively by excluding the possibility of arbitrary setting of experience-based parameters. If such standardization is sought, this would have an implication on how the ship speed adjustment based on sea trial results should be conducted in accordance with paragraph 4.3.8 of these Guidelines.

Note 2: A joint industry standard to support the method and role of the verifier will be developed.

4.2.7 Additional information that the verifier may request the submitter to provide directly to it includes but not limited to:

.1 descriptions of a tank test facility; this should include the name of the facility, the particulars of tanks and towing equipment, and the records of calibration of each monitoring equipment;

.2 lines of a model ship and an actual ship for the verification of the appropriateness of the tank test; the lines (sheer plan, body plan and half-breadth plan) should be detailed enough to demonstrate the similarity between the model ship and the actual ship;

.3 lightweight of the ship and displacement table for the verification of the deadweight;

.4 detailed report on the method and results of the tank test; this should include at least the tank test results at sea trial condition and under the condition as specified in paragraph 2.2 of the EEDI Calculation Guidelines;

.5 detailed calculation process of the ship speed, which should include the estimation basis of experience-based parameters such as roughness coefficient, wake scaling coefficient; and

.6 reasons for exempting a tank test, if applicable; this should include lines and tank test results of the ships of same type, and the comparison of the principal particulars of such ships and the ship in question. Appropriate technical justification should be provided explaining why the tank test is unnecessary.

4.2.8 The verifier should issue the report on the "Preliminary Verification of EEDI" after it has verified the attained EEDI at the design stage in accordance with paragraphs 4.1 and 4.2 of these Guidelines.

4.3 Final verification of the attained EEDI at sea trial

4.3.1 Sea trial conditions should be set as conditions specified in paragraph 2.2 of the EEDI Calculation Guidelines, if possible.

4.3.2 Prior to the sea trial, the following documents should be submitted to the verifier: a description of the test procedure to be used for the speed trial, the final displacement table and the measured lightweight, or a copy of the survey report of deadweight, as well as a copy of NO_x Technical File as necessary. The test procedure should include, at a minimum, descriptions of all necessary items to be measured and corresponding measurement methods to be used for developing power curves under the sea trial condition.

4.3.3 The verifier should attend the sea trial and confirm:

.1 propulsion and power supply system, particulars of the engines, and other relevant items described in the EEDI Technical File;

.2 draught and trim;

.3 sea conditions;

.4 ship speed; and

.5 shaft power and RPM of the main engine.

4.3.4 Draught and trim should be confirmed by the draught measurements taken prior to the sea trial. The draught and trim should be as close as practical to those at the assumed conditions used for estimating the power curves.

4.3.5 Sea conditions should be measured in accordance with ITTC Recommended Procedure 7.5-04-01-01.1 Speed and Power Trials Part 1; 2012 revision 1 or ISO 15016:2002[2].

4.3.6 Ship speed should be measured in accordance with ITTC Recommended Procedure 7.5-04-01-01 Speed and Power Trials Part 1; 2012 revision 1 or ISO 15016:2002[2] and at more than two points of which range includes the power of the main engine as specified in paragraph 2.5 of the EEDI Calculation Guidelines.

[2] ITTC Recommended Procedure 7.5-04-01-01 is considered as preferable standard available from URL at ITTC.SNAME.ORG. Revised version of ISO 15016 should be available by early 2014.

4.3.7 The main engine output should be measured by shaft power meter or a method which the engine manufacturer recommends and the verifier approves. Other methods may be acceptable upon agreement of the shipowner and shipbuilder and with approval of the verifier.

4.3.8 The submitter should develop power curves based on the measured ship speed and the measured output of the main engine at sea trial. For the development of the power curves, the submitter should calibrate the measured ship speed, if necessary, by taking into account the effects of wind, tide, waves, shallow water and displacement in accordance with ITTC Recommended Procedure 7.5-04-01-01.2 Speed and Power Trials Part 2; 2012 revision 1 or ISO 15016:2002[2] Upon agreement with the shipowner, the submitter should submit a report on the speed trials including details of the power curve development to the verifier for verification.

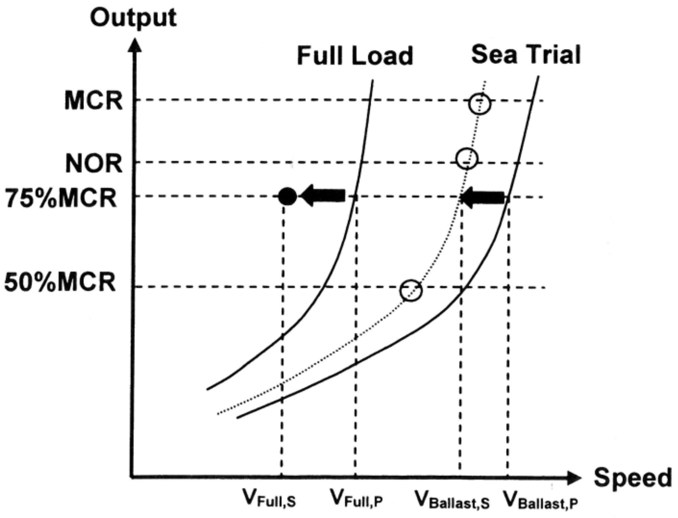
4.3.9 The submitter should compare the power curves obtained as a result of the sea trial and the estimated power curves at the design stage. In case differences are observed, the attained EEDI should be recalculated, as necessary, in accordance with the following:

.1 for ships for which sea trial is conducted under the condition as specified in paragraph 2.2 of the EEDI Calculation Guidelines: the attained EEDI should be recalculated using the measured ship speed at sea trial at the power of the main engine as specified in paragraph 2.5 of the EEDI Calculation Guidelines; and

.2 for ships for which sea trial cannot be conducted under the condition as specified in paragraph 2.2 of the EEDI Calculation Guidelines: if the measured ship speed at the power of the main engine as specified in paragraph 2.5 of the EEDI Calculation Guidelines at the sea trial conditions is different from the expected ship speed on the power curve at the corresponding condition, the shipbuilder should recalculate the attained EEDI by adjusting ship speed under the condition as specified in paragraph 2.2 of the EEDI Calculation Guidelines by an appropriate correction method that is agreed by the verifier.

An example of possible methods of the speed adjustment is given in figure 2:

Note: Further consideration would be necessary for speed adjustment methodology in paragraph 4.3.9.2 of these Guidelines. One of the concerns relates to a possible situation where the power curve for sea trial condition is estimated in an excessively conservative manner (i.e. power curve is shifted in a leftward direction) with the intention to get an upward adjustment of the ship speed by making the measured ship speed at sea trial easily exceed the lower-estimated speed for sea trial condition at design stage.



$$V_{Full,S} = V_{Full,P} \times (V_{Ballast,S} / V_{Ballast,P})$$

$V_{Ballast,P}$:estimated ship speed at sea trial conditions on the power curve estimated at design stage
$V_{Ballast,S}$:ship speed obtained as a result of the sea trial
$V_{Full,S}$: adjusted ship speed by the results of sea trial, in full-loaded condition
$V_{Full,P}$:estimated ship speed in fully loaded condition at design stage.

Figure 2: An Example of Possible Ship Speed Adjustment

4.3.10 In cases where the finally determined deadweight/gross tonnage differs from the designed deadweight/gross tonnage used in the EEDI calculation during the preliminary verification, the submitter should recalculate the attained EEDI using the finally determined deadweight/gross tonnage. The finally determined gross tonnage should be confirmed in the Tonnage Certificate of the ship.

4.3.11 In case where the attained EEDI is calculated at the preliminary verification by using *SFC* based on the manufacturer's test report due to the non-availability at that time of the approved NO_x Technical File, the EEDI should be recalculated by using *SFC* in the approved NO_x Technical File.

4.3.12 The EEDI Technical File should be revised, as necessary, by taking into account the results of sea trial. Such revision should include, as applicable, the adjusted power curve based on the results of sea trial (namely, modified ship speed under the condition as specified in paragraph 2.2 of the EEDI Calculation Guidelines), the finally determined deadweight/gross tonnage and *SFC* described in the approved NO_x Technical File, and the recalculated attained EEDI based on these modifications.

4.3.13 The EEDI Technical File, if revised, should be submitted to the verifier for the confirmation that the (revised) attained EEDI is calculated in accordance with regulation 20 of MARPOL Annex VI and the EEDI Calculation Guidelines.

4.4 Verification of the attained EEDI in case of major conversion

4.4.1 In cases where a major conversion is made to a ship, the shipowner should submit to a verifier an application for an Additional Survey with the EEDI Technical File duly revised based on the conversion made and other relevant background documents.

4.4.2 The background documents should include at least but are not limited to:

.1 documents explaining details of the conversion;

.2 EEDI parameters changed after the conversion and the technical justifications for each respective parameter;

.3 reasons for other changes made in the EEDI Technical File, if any; and

.4 calculated value of the attained EEDI with the calculation summary, which should contain, at a minimum, each value of the calculation parameters and the calculation process used to determine the attained EEDI after the conversion.

4.4.3 The verifier should review the revised EEDI Technical File and other documents submitted and verify the calculation process of the attained EEDI to ensure that it is technically sound and reasonable and follows regulation 20 of MARPOL Annex VI and the EEDI Calculation Guidelines.

4.4.4 For verification of the attained EEDI after a conversion, speed trials of the ship are required, as necessary.

* * *

Appendix 1

SAMPLE OF EEDI TECHNICAL FILE

1 Data

1.1 General information

Shipbuilder	JAPAN Shipbuilding Company
Hull No.	12345
IMO No.	94111XX
Kind of ship	Bulk carrier

1.2 Principal particulars

Length overall	250.0 m
Length between perpendiculars	240.0 m
Breadth, moulded	40.0 m
Depth, moulded	20.0 m
Summer load line draught, moulded	14.0 m
Deadweight at summer load line draught	150,000 tons

1.3 Main engine

Manufacturer	JAPAN Heavy Industries Ltd.
Type	6J70A
Maximum continuous rating (MCR)	15,000 kW x 80 rpm
SFC at 75% MCR	165.0 g/kWh
Number of set	1
Fuel type	Diesel Oil

1.4 Auxiliary engine

Manufacturer	JAPAN Diesel Ltd.
Type	5J-200
Maximum continuous rating (MCR)	600 kW x 900 rpm
SFC at 50% MCR	220.0 g/kWh
Number of set	3
Fuel type	Diesel Oil

1.5 Ship speed

Ship speed in deep water at summer load line draught at 75% of MCR	14.25 knots

2 Power Curves

The power curves estimated at the design stage and modified after the speed trials are shown in figure 2.1.

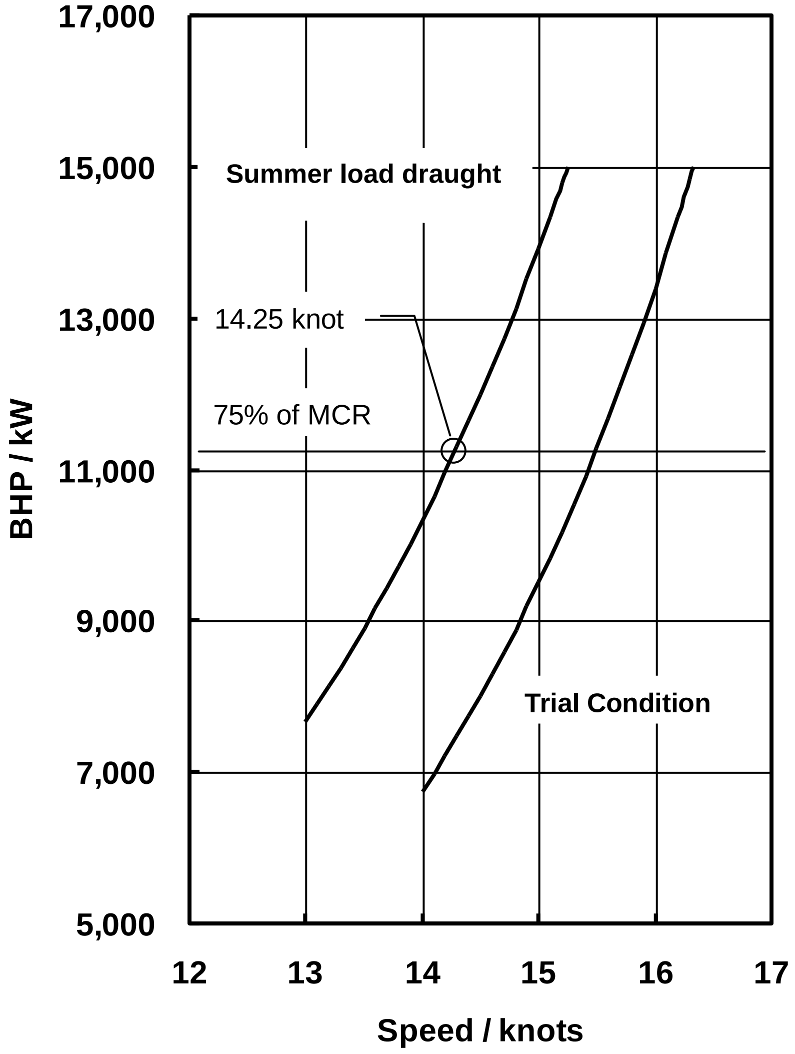


Figure 2.1: Power curves

3 Overview of Propulsion System and Electric Power Supply System

3.1 Propulsion system
3.1.1 Main engine
Refer to subparagraph 1.3.

3.1.2 Propeller

Type	Fixed pitch propeller
Diameter	7.0 m
Number of blades	4
Number of set	1

3.2 Electric power supply system
3.2.1 Auxiliary engines
Refer to subparagraph 1.4.

3.2.2 Main generators

Manufacturer	JAPAN Electric
Rated output	560 kW (700 kVA) x 900 rpm
Voltage	AC 450 V
Number of set	3

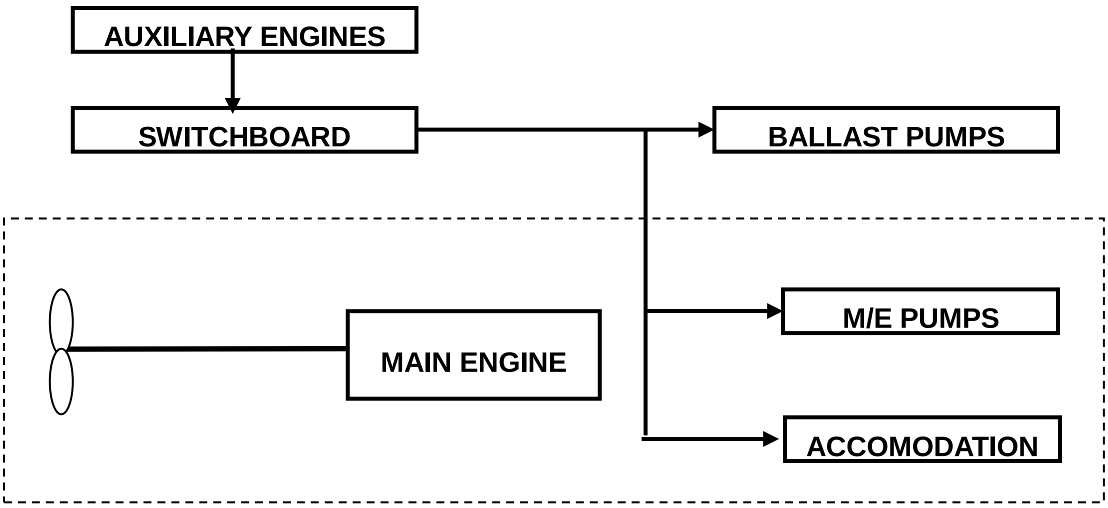


Figure 3.1: Schematic figure of propulsion and electric power supply system

4 Estimation Process of Power Curves at Design Stage

Power curves are estimated based on model test results. The flow of the estimation process is shown below.

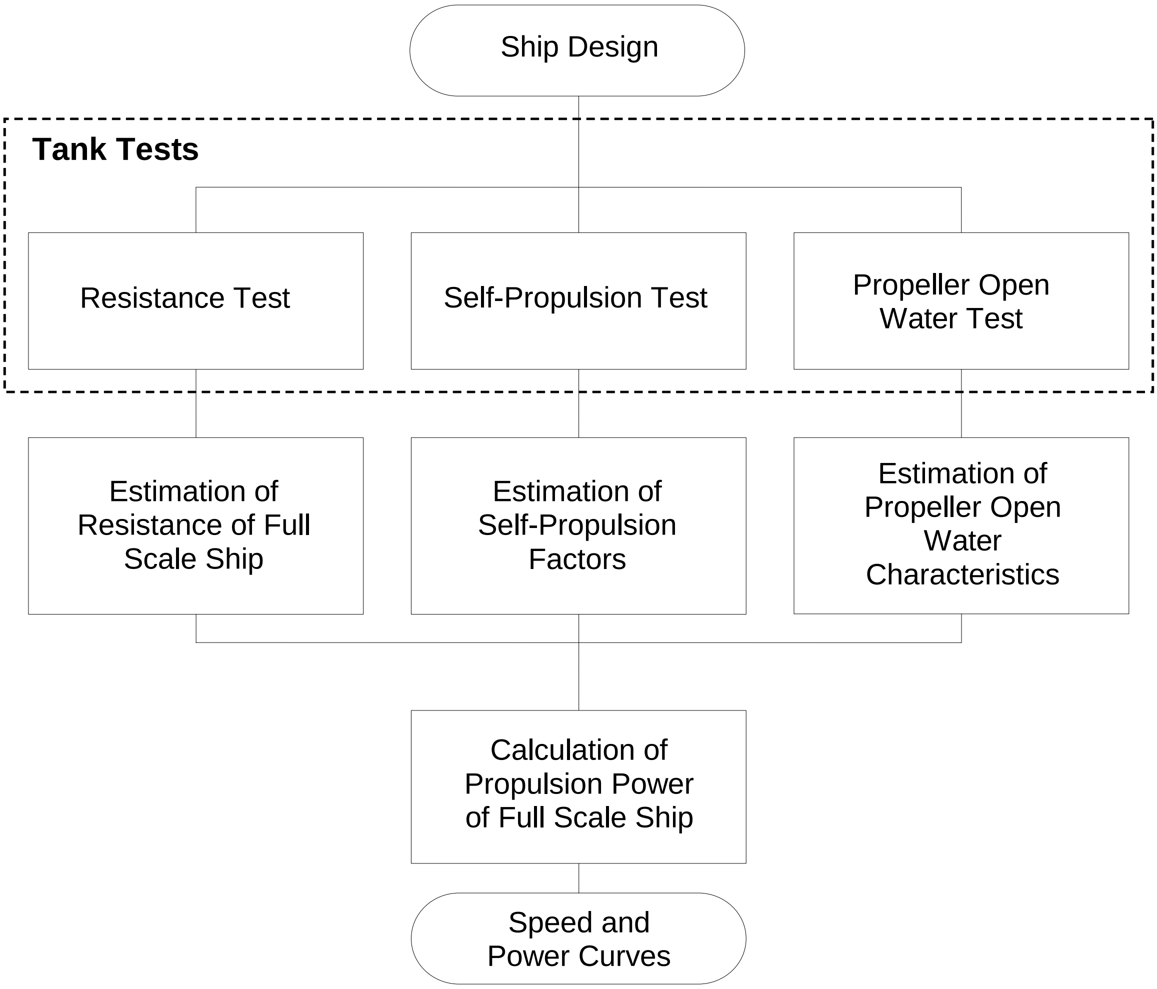


Figure 4.1: Flow-chart of process for estimating power curves

5 Description of Energy Saving Equipment

5.1 Energy saving equipment of which effects are expressed as $P_{AEeff(i)}$ and/or $P_{eff(i)}$ in the EEDI calculation formula

N/A

5.2 Other energy saving equipment

(Example)
5.2.1 Rudder fins

5.2.2 Propeller boss cap fins

……

(Specifications, schematic figures and/or photos, etc., for each piece of equipment or device should be indicated. Alternatively, attachment of the commercial catalogue may be acceptable.)

6 Calculated Value of attained EEDI

6.1 Basic data

Type of Ship	Capacity DWT	Speed V_{ref} (knots)
Bulk Carrier	150,000	14.25

6.2 Main engine

MCR_{ME} (kW)	Shaft Gen.	P_{ME} (kW)	Type of Fuel	C_{FME}	SFC_{ME} (g/kWh)
15,000	N/A	11,250	Diesel Oil	3.206	165.0

6.3 Auxiliary engines

P_{AE} (kW)	Type of Fuel	C_{FAE}	SFC_{AE} (g/kWh)
625	Diesel Oil	3.206	220.0

6.4 Ice class

N/A

6.5 Innovative electrical energy efficient technology

N/A

6.6 Innovative mechanical energy efficient technology

N/A

6.7 Cubic capacity correction factor

N/A

6.8 Calculated value of attained EEDI

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

$$= \frac{1 \times (11250 \times 3.206 \times 165.0) + (625 \times 3.206 \times 220.0) + 0 - 0}{1 \cdot 1 \cdot 150000 \cdot 1 \cdot 14.25}$$

$$= 2.99 \quad (\mathrm{g} - CO_2/\mathrm{ton \cdot mile})$$

attained EEDI: 2.99 g-CO_2/ton mile

7 Calculated value of attained $EEDI_{weather}$

7.1 Representative sea conditions

	Mean wind speed	Mean wind direction	Significant wave height	Mean wave period	Mean wave direction
BF6	12.6 (m/s)	0 (deg.)*	3.0 (m)	6.7 (s)	0 (deg.)*

* Heading direction of wind/wave in relation to the ship's heading, i.e. 0 (deg.) means the ship is heading directly into the wind.

7.2 Calculated weather factor, f_w

f_w	0.900

7.3 Calculated value of attained $EEDI_{weather}$

attained $EEDI_{weather}$: 3.32 g-CO_2/ton mile

* * *

Appendix 2

GUIDELINES FOR VALIDATION OF ELECTRIC POWER TABLES FOR EEDI (EPT-EEDI)

1 INTRODUCTION

The purpose of these Guidelines is to assist Recognized Organizations in the validation of ship's Electric Power Tables (EPT) for calculation of Energy Efficiency Design Index (EEDI). As such, these Guidelines support the implementation of "GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY DESIGN INDEX FOR NEW SHIPS" ("EEDI Calculation Guidelines", hereafter) and "GUIDELINES ON SURVEY AND CERTIFICATION OF THE ENERGY EFFICIENCY DESIGN INDEX". This document will also assist shipowners, shipbuilders, ship designers, and manufacturers in relation to aspects of developing more energy efficient ships and also in understanding the procedures for the EPT-EEDI validation.

2 OBJECTIVES

These Guidelines provide a framework for the uniform application of the EPT-EEDI validation process for those ships that come under paragraph 2.5.6.3 of the EEDI Calculation Guidelines.

3 DEFINITIONS

3.1 *Applicant* means an organization, primarily a shipbuilder or a ship designer, which requests the EPT-EEDI validation in accordance with these Guidelines.

3.2 *Validator* means a Recognized Organization which conducts the EPT-EEDI validation in accordance with these Guidelines.

3.3 *Validation* for the purpose of these Guidelines means review of submitted documents and survey during construction and sea trials.

3.4 *Standard EPT-EEDI-Form* refers to the layout given in appendix 3 that contains the EPT-EEDI results that will be the subject of validation. Other supporting documents submitted for this purpose will be used as reference only and will not be subject to validation.

3.5 P_{AE} herein is defined as per definition in paragraph 2.5.6 of the EEDI Calculation Guidelines.

3.6 *Ship Service and Engine-room Loads* refer to all the load groups which are needed for the hull, deck, navigation and safety services, propulsion and auxiliary engine services, engine-room ventilation and auxiliaries and ship's general services.

3.7 *Diversity Factor* is the ratio of the "total installed load power" and the "actual load power" for continuous loads and intermittent loads. This factor is equivalent to the product of service factors for load, duty and time.

4 APPLICATION

4.1 These Guidelines are applicable to ships as stipulated by paragraph 2.5.6.3 of the EEDI Calculation Guidelines.

4.2 These Guidelines should be applied for new ships for which an application for an EPT-EEDI validation has been submitted to a validator.

4.3 The steps of the validation process include:

.1 Review of documents during the design stage

.1.1 Check if all relevant loads are listed in the EPT;
.1.2 Check if reasonable service factors are used; and
.1.3 Check the correctness of the P_{AE} calculation based on the data given in the EPT.

.2 Survey of installed systems and components during construction stage

.2.1 Check if a randomly selected set of installed systems and components are correctly listed with their characteristics in the EPT.

.3 Survey of sea trials

.3.1 Check if selected units/loads specified in EPT are observed.

5 SUPPORTING DOCUMENTS

5.1 The applicant should provide as a minimum the ship electric balance load analysis.

5.2 Such information may contain shipbuilders' confidential information. Therefore, after the validation, the validator should return all or part of such information to the applicant at the applicant's request.

5.3 A special EEDI condition during sea trials may be needed and defined for each vessel and included into the sea trial schedule. For this condition a special column should be inserted into the EPT.

6 PROCEDURES FOR VALIDATION

6.1 General

6.1.1 P_{AE} should be calculated in accordance with the EPT-EEDI Calculation Guidelines. EPT-EEDI validation should be conducted in two stages: preliminary validation at the design stage and final validation during sea trials. The validation process is presented in figure 1.

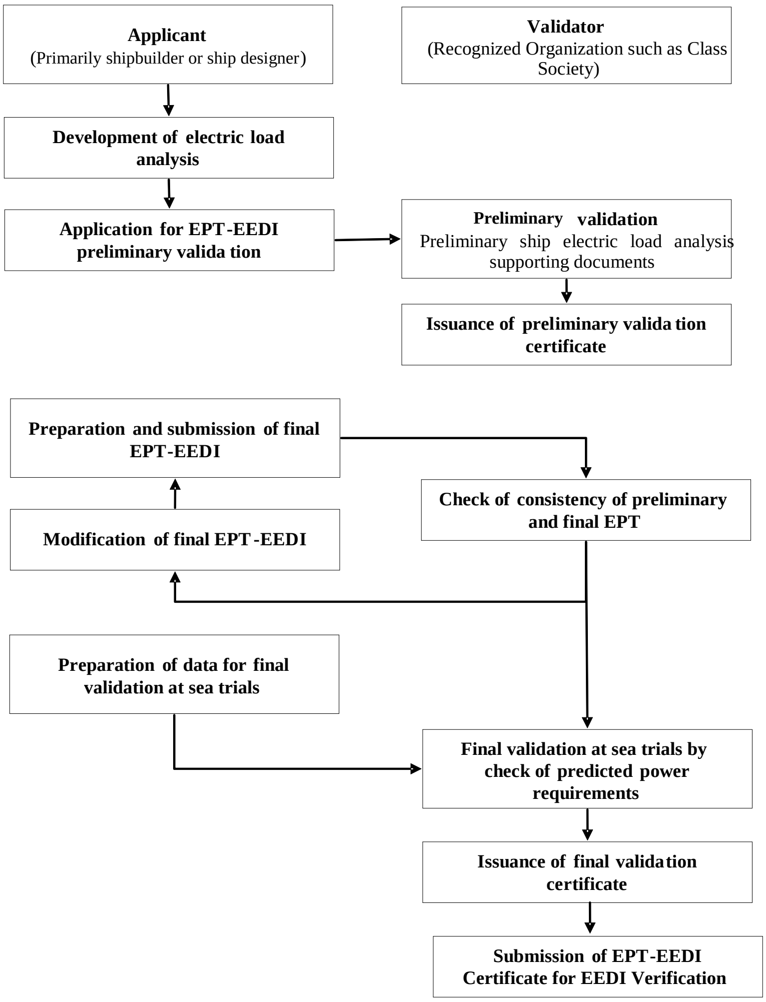


Figure 1: Basic Flow of EPT-EEDI Validation Process

6.2 Preliminary validation at the design stage

6.2.1 For the preliminary validation at the design stage, the applicant should submit to a validator an application for the validation of EPT-EEDI inclusive of EPT-EEDI Form and all the relevant and necessary information for the validation as supporting documents.

6.2.2 The applicant should supply as a minimum the supporting data and information, as specified in appendix A (to be developed).

6.2.3 The validator may request from the applicant additional information on top of those contained in these Guidelines, as necessary, to enable the validator to examine the calculation process of the EPT-EEDI. The estimation of the ship EPT-EEDI at the design stage depends on each applicant's experiences, and it may not be practicable to fully examine the technical aspects and details of each machinery component. Therefore, the preliminary validation should focus on the calculation process of the EPT-EEDI that should follow the best marine practices.

> **Note:** A possible way forward for more robust validation is to establish a standard methodology of deriving the ship EPT by setting standard formats as agreed and used by industry.

6.3 Final validation

6.3.1 The final validation process as a minimum shall include the check of ship electric load analysis to ensure that all electric consumers are listed; their specific data and the calculations in the power table itself are correct and are supported by sea trial results. If necessary, additional information has to be requested.

6.3.2 For final validation the applicant shall revise the EPT-EEDI Form and supporting documents as necessary, by taking into account the characteristics of the machinery and other electrical loads actually installed on board the ship. The EEDI condition at sea trials shall be defined and the expected power requirements in these conditions documented in the EPT. Any changes within the EPT from design stage to construction stage should be highlighted by the shipyard.

6.3.3 The preparation for the final validation includes a desk top check comprising:

.1 consistency of preliminary and final EPT;

.2 changes of service factors (compared to the preliminary validation);

.3 all electric consumers are listed;

.4 their specific data and the calculations in the power table itself are correct; and

.5 in case of doubt, component specification data is checked in addition.

6.3.4 A survey prior to sea trials is performed to ensure that machinery characteristics and data as well as other electric loads comply with those recorded in the supporting documents. This survey does not cover the complete installation but selects randomly a number [to be defined] of samples.

6.3.5 For the purpose of sea trial validation, the surveyor will check the data of selected systems and/or components given in the special column added to the EPT for this purpose or the predicted overall value of electric load by means of practicable measurements with the installed measurement devices.

7 ISSUANCE OF THE EPT-EEDI STATEMENT OF VALIDATION

7.1 The validator should stamp the EPT-EEDI Form "as Noted" after it validated the EPT-EEDI in the preliminary validation stage in accordance with these Guidelines.

7.2 The validator should stamp the EPT-EEDI Form "as Endorsed" after it validated the final EPT-EEDI in the final validation stage in accordance with these Guidelines.

* * *

Appendix 3

ELECTRIC POWER TABLE FORM FOR ENERGY EFFICIENCY DESIGN INDEX (EPT-EEDI FORM) AND STATEMENT OF VALIDATION

Ship ID:
IMO No.: ____________________________
Ship's Name:_________________________
Shipyard:___________________________
Hull No.:5 Miles______________________

Applicant:
Name:_____________________________________
Address:___________________________________
____

Validation Stage:
☐ Preliminary validation
☐ Final validation

Summary Results of EPT-EEDI

Load Group	Seagoing Condition EEDI Calculation Guidelines		Remarks
	Continuous Load (kW)	**Intermittent Load (kW)**	
Ship Service and Engine-room Loads			
Accommodation and Cargo Loads			
Total installed load			
Diversity Factor			
Normal seagoing load			
Weighted average efficiency of generators			
PAE			

Supporting Documents

Title	ID or Remarks

Validator details:
Organization: ____________________________________
Address: ____________________________________
____

This is to certify that the above-mentioned electrical loads and supporting documents have been reviewed in accordance with EPT-EEDI Validation Guidelines and the review shows a reasonable confidence for use of the above PAE in EEDI calculations.

The date of review:____________________ Statement of validation No.______
This statement is valid on condition that the electric power characteristics of the ship do not change.

Signature of Validator

____
Printed Name:

____