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

Guidance on System Design Limitations of ballast water management systems and their monitoring

1 The Marine Environment Protection Committee (MEPC), at its seventy-third session (22 to 26 October 2018), approved the *Guidance on System Design Limitations of ballast water management systems and their monitoring* developed by the PPR Sub-Committee at its fifth session (5 to 9 February 2018), as set out in the annex.

2 Member Governments and international organizations are invited to bring the annexed Guidance to the attention of all parties concerned.

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ANNEX

GUIDANCE ON SYSTEM DESIGN LIMITATIONS OF BALLAST WATER MANAGEMENT SYSTEMS AND THEIR MONITORING

1 The purpose of this document is to expand on the information provided in the Code for approval of ballast water management systems (BWMS Code) concerning the inclusion of System Design Limitations (SDL) on the Type Approval Certificates of ballast water management systems (BWMS).

2 With a view to increasing global consistency in the application of SDL and the implementation of self-monitoring, this document also provides recommendations to Administrations and manufacturers of BWMS concerning:

.1 potential SDL for the various types of technologies used in BWMS; and

.2 self-monitoring parameters that may be associated with these SDL.

System Design Limitations approach

3 BWMS used to comply with the Convention are approved by the Administration taking into account the BWMS Code. This Code include standardized tests (e.g. specifying salinity ranges and other challenge water parameters) that are designed to demonstrate the proper function of BWMS in these conditions, and thereby screen out those systems that would not meet the ballast water performance standard described in regulation D-2.

4 However, an approved BWMS might not be appropriate for all ships or all situations. Also, some ships need assurances that BWMS will be capable of operating in conditions that are more challenging than those included in the standardized tests. The SDL approach is intended to complement the standardized tests in the BWMS Code by providing validated information on the conditions for which an individual BWMS is designed. This information is communicated transparently on the Type Approval Certificate to stakeholders, such as the shipowners who are required by the Convention to meet the D-2 standard during every ballast water discharge and crew members who will operate BWMS.

5 SDLs should be identified and validated for each specific BWMS presented for approval. The SDL approach provides a process to identify and provide information to the end user on performance expectations for the system. The SDL approach has two objectives:

.1 to ensure that the performance of the BWMS has been transparently assessed with respect to the known water quality and/or operational parameters that are important to its proper function, including those that may not otherwise be provided for in the Code;

.2 to provide transparent oversight of manufacturer's BWMS performance claims that may go beyond the specific criteria in the Code.

6 The term "System Design Limitations" refers to the physical and/or operational limitations inherent in the design of the BWMS itself, as opposed to the minimum criteria within the BWMS Code. The term does not refer to regulatory restrictions on when the BWMS may or may not be used.

7 The SDL approach unfolds through the following steps:

.1 the manufacturer identifies the parameters to which the BWMS is sensitive and that are important to the proper operation of the BWMS, together with claimed high and/or low values for which the BWMS is capable of achieving the D-2 standard, and the proposed methods for validating these claims (paragraph 1.3.5 of the annex to the BWMS Code;

.2 the Administration evaluates the basis for the manufacturer's claims and the suitability and reliability of the methods proposed to validate the claims (paragraphs 1.14 to 1.15 of the annex to the BWMS Code;

.3 the Administration oversees the validation of the manufacturer's claimed SDLs through a rigorous evidence-based assessment, which may include testing integrated with the specific tests identified in the BWMS Code and/or the use of existing data and/or models (part 6 of the annex to the BWMS Code);

.4 the Administration includes SDLs on the Type Approval Certificate, listed under the heading "*This equipment has been designed for operation in the following conditions*" (paragraph 7.1.6 of the annex to the BWMS Code), and the manufacturer integrates the SDLs into the self-monitoring system of the BWMS where appropriate and practical (paragraph 4.17 of the body of the BWMS Code); and

.5 the Administration includes all documentation associated with the validation of applicable SDLs in the type approval report of the BWMS (paragraph 6.6 of the annex to the BWMS Code).

8 On the model Type Approval Certificate shown in the appendix to the BWMS Code, the heading "*This equipment has been designed for operation in the following conditions*" is distinct from the headings pertaining to "Limiting Operational Conditions" and "other restrictions." If no other restriction is to be imposed, the Administration should write the word "nil" in the "other restrictions" sections in order to clearly indicate that SDLs do not directly constitute a restriction.

System Design Limitations identification

9 Essentially, SDLs are the BWMS-specific water quality parameters (environmental factors) and/or operational parameters (arising from the BWMS design) that are important to the operation of the system and for which the BWMS is designed to achieve the D-2 standard.

10 SDLs should be developed using measures and units that are as accessible as possible to the end user, that are relevant to the operation of ships, and that may be displayed, monitored, recorded and alarmed by the BWMS self-monitoring system.

11 While SDLs should be specific to each BWMS, potential SDLs for various types of ballast water management technologies are provided in the annex to this document in order to provide guidance to BWMS manufacturers and Administrations. They are given as examples of what has been used during type approval of BWMS. This annex should be updated based on the experience gained in the implementation of the BWMS Code by Administrations. As experience is gained, the potential SDL applicable to different technology may also change.

12 For each SDL, a low and/or high value should be claimed by the manufacturer and validated by the Administration to provide information on the range in which the BWMS is designed to work properly. These values are reported on the Type Approval Certificate. As BWMS manufacturers may include a margin of error in claiming System Design Limitations, the SDL should not necessarily be interpreted as the exact parameter values beyond which the BWMS is incapable of operation. The Administration should take this into account in considering whether to include any additional restrictions on the Type Approval Certificate in connection with the validation of System Design Limitations.

13 In the case of SDL parameters that are also subject to specific criteria in part 2 of the annex to the BWMS Code, the procedure set out in part 2 shall be followed. For such parameters, the SDL approach may be used only to the extent that the performance claim goes beyond the specific criteria in part 2.

14 In claiming and validating SDLs, manufacturers and Administrations are advised to bear in mind that the SDLs will be communicated to the end user of the equipment for information under the heading "*This equipment has been designed for operation in the following conditions*." It is therefore advisable that the list focuses only on the key parameters that are most important to the proper operation of the BWMS.

15 In selecting SDLs, parameters that are important to the operation of the system should be included even if such parameters are also assessed specifically by the BWMS Code. This can provide information on the ability (or non-ability) of the system to operate in conditions more challenging than the standardized tests in the BWMS Code. For example, a BWMS that depends on the salinity of ballast water should have an SDL for salinity, for which the manufacturer might claim performance beyond the minimum required under the BWMS Code. The Administration would validate any such claim before including the information on the Type Approval Certificate.

16 It is recommended to only claim SDL which are relevant to the specific technology and that can be measured (directly or indirectly) and be used for regulating or controlling the performance and/or functioning of the BWMS. This is because if no measurement is available, the SDL cannot be verified during test or operation and consequently is not relevant for BWMS operation by the end user.

17 Correlations and potential interactions between parameters do exist. Administrations and BWMS manufacturers are encouraged to report on these correlations to the Organization. SDLs affected by any known or applicable interactions should be identified.

Self-monitoring of System Design Limitations

18 The BWMS Code stipulates that control equipment of a BWMS should incorporate a continuous self-monitoring function during the period in which the system is in operation. The monitoring equipment should record and produce a report of the proper functioning or failure of the ballast water management system in accordance with part 5 of the annex to the BWMS Code (resolution MEPC.300(72)).

19 The self-monitoring function of the BWMS should make the data pertaining to the SDL readily accessible to the end user. The monitoring parameters may be measured directly or indirectly. It is preferable to use direct measurements when feasible. Sensors should be appropriately located to provide a representative reading of the functioning of the BWMS.

20 Potential control and monitoring parameters associated with SDL are provided in the annex to this document. Self-monitoring parameters are given as examples of what has been observed in type-approved BWMS.

21 The BWMS Code also provides that any additional parameters that are necessary to ascertain BWMS performance and safety should be determined by the Administration and stored in the system.

ANNEX

POTENTIAL CONTROL AND MONITORING PARAMETERS ASSOCIATED WITH SYSTEM DESIGN LIMITATIONS

1 The table below sets out information about the technologies commonly used in ballast water management, together with potential SDLs and control and monitoring parameters that the Administration may wish to take into account in connection with the BWMS Code (resolution MEPC.300(72)).

2 The table does not include all potential factors or interactions, nor all self-monitoring parameters as detailed in part 5 of the BWMS Code, but instead is intended to identify known parameters that can be monitored and may be important to the operation of the BWMS.

3 The table is not intended to be exhaustive. It is intended that this remain a living document and that information be added based on experience gained. In particular, more experience is needed on parameters that cannot currently be monitored directly (e.g. suspended solids in the case of filtration).

Table: List of potential System Design Limitations and related self-monitoring parameters

Technology	Principles	Potential SDL		Control and monitoring parameters seen in BWMS	Design elements / related information
		Environmental / water quality parameters	Technical / operational parameters		
Filtration	- Removal of particles and organisms greater than the filter mesh size (disk, basket, candle, etc.) - Automatic cleaning	- Suspended solids (size, quality, quantity) - Salinity and temperature	- Maximum flow rate - Minimum backwash pressure	- Flow rate - Inlet/outlet pressure or differential pressure (dP) - Minimum backwash pressure	- Mesh size or retention threshold (nominal or absolute) - Filtration capacity (flow rate) - Cleaning capacity (backflush) - Number or frequency of backwashes or cleaning cycles
Hydrocyclone	- Gravitational separation of particles by centrifugal force (removal of organisms)	- Suspended solids (specific gravity, quantity) - Salinity and temperature	- Minimum and maximum flow rate	- Flow rate - Inlet/outlet pressure	- Capacity - Separation percentage
Ultraviolet (UV) irradiation	- UV irradiation (low pressure / medium pressure) damages cells	- UVT - Salinity and temperature	- UVI - Minimum and maximum flow rate - Minimum holding time	- UVI, UVT, and/or UV dose - Power, or current and voltage - Minimum and maximum flow rate	- UV dose

Technology	Principles	Potential SDL		Control and monitoring parameters seen in BWMS	Design elements / related information
		Environmental / water quality parameters	Technical / operational parameters		
Electro-chlorination	- Generation of Active Substance through electrolysis of seawater (electric current)	- Salinity and temperature, or conductivity, of the electrolytic feedwater and/or the ambient water to be treated	- Active Substance dose (quantity or concentration) - Maximum flow rate - Minimum holding time	- Power, or current and voltage - Active Substance dose, TRO, and/or ORP - Feedwater (side stream, or full flow) conductivity, or salinity and temperature - Flow rate - Holding time	- Active Substance production rate
	- Neutralizing agent may be used (as per Procedure (G9) requirements)	- Salinity and temperature	- Neutralization dose - Maximum flow rate	- Neutralizing agent flow rate or quantity - Flow rate - Active Substance - Concentration at discharge	- Neutralizing agent storage quantity and dosing rate
Chemical injection (e.g. ozone, sodium hypochlorite, ClO_2, etc.)	- Storage or generation of Active Substance and injection of the created biocide in ballast water	- Salinity and temperature	- Active Substance dose (quantity or concentration) - Maximum flow rate - Minimum holding time	- Power, or current and voltage - Temperature of ozone generator - Active Substance dose - Salinity and/or water conductivity - Water temperature - Flow rate - Holding time	- Active substance production rate, storage quantity, and/or dosing rate
	- Neutralizing agent may be used (as per Procedure (G9) requirements)	- Salinity and temperature	- Neutralization dose - Maximum flow rate	- Neutralizing agent flow rate or quantity - Flow rate - Active Substance concentration at discharge	- Neutralizing agent storage quantity and dosing rate

Technology	Principles	Potential SDL		Control and monitoring parameters seen in BWMS	Design elements / related information
		Environmental / water quality parameters	Technical / operational parameters		
Heat	- Disruption of chemical bonds, denaturing of enzymes and structures through heat energy	- Salinity and temperature	- Temperature range and minimum holding time - Maximum flow rate	- Temperature and holding time - Flow rate	- Heating capacity
Cavitation	- Cell membrane is damaged by shear forces	- Salinity and temperature	- Minimum differential pressure - Inlet and outlet pressure - Maximum flow rate	- Differential pressure - Flow rate	- Available differential pressure
Ultrasound	- Ultrasound waves generate cavitation bubbles in water resulting in intense shear forces and high stress to cell membranes	- Salinity and temperature	- Minimum ultrasound power - Maximum flow rate - Minimum exposure time	- Power, or current and voltage - Flow rate	- Frequency, amplitude and exposure time of ultrasound delivery
Deoxygenation	- Inert gas injection or creation (e.g. CO_2 or N_2) to reduce the available oxygen for organisms in water	- Salinity and temperature	- Minimum inert gas purity (in %) - Minimum injection rate - Minimum holding time	- Dissolved oxygen content - Inert gas purity (%) - Injection rate - Holding time	- Inert gas production rate and purity - Rate of gas injection and mixing
In tank treatment systems – chemicals	- Application of Active Substance into ballast water tanks	- Salinity and temperature - As appropriate for the Active Substance in use	- Minimum uniformity of tank mixing - Minimum holding time per tank	- Active Substance dose or concentration in tank - Holding time	- Mixing device placement - Circulation flow rate/volume - Holding time

Technology	Principles	Potential SDL		Control and monitoring parameters seen in BWMS	Design elements / related information
		Environmental / water quality parameters	Technical / operational parameters		
	- Neutralizing agent may be used (as per Procedure (G9) requirements)	- Salinity and temperature	- Neutralization dose	- Neutralizing agent flow rate or quantity - Active Substance - Concentration in ballast tank	- Neutralizer storage quantity and dosing rate
In tank treatment systems – non-chemicals	- Application of mechanism into ballast water tanks	- Salinity and temperature - As appropriate for the treatment mechanism in use	- Fraction of the tank water being circulated - Minimum uniformity of mechanism application - Minimum holding time per tank	- Measurement of mechanism to the ballast tank or in the ballast tank - Holding time	- Mixing device placement - Circulation flow rate/volume - Holding time

Note: all parameters refer to properties of the ballast water unless otherwise noted (e.g. feedwater).

Legend for the table:
ORP = Oxidant Reduction Potential
TRO = Total Residual Oxidant
UVI = UV intensity
UVT = UV transmittance
The heading "principles" means a summary of the main process used by the technology to manage the ballast water.
The heading "technical/operational parameters" means design parameters of the BWMS that impact or define its performance and/or operation.
The heading "environmental/water quality parameters" means external factors (e.g. water quality) that may directly impact the functioning of the system.
The heading "control and monitoring parameters seen in BWMS" means parameters that may be monitored/logged by BWMS in relation to the SDL. The intention is to give a list of examples, not to prescribe certain kind of measurements that must be included. These examples come from observed control and monitoring parameters in approved BWMS.

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