

GUIDANCE FOR THE APPROVAL AND TYPE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE

**Guidance for the Approval and Type Approval of Materials and Equipment for
Marine Use** **2019 AMENDMENT NO.1**

Notice No.32 14 June 2019

Resolved by Technical Committee on 30 January 2019

ClassNK
NIPPON KAIJI KYOKAI

Notice No.32 14 June 2019

AMENDMENT TO THE GUIDANCE FOR THE APPROVAL AND TYPE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE

“Guidance for the approval and type approval of materials and equipment for marine use” has been partly amended as follows:

Amendment 1-1

Part 6 MACHINERY

Title of Chapter 8 has been amended as follows.

Chapter 8 APPROVAL OF USE OF DIESEL AND GAS-FUELLED ENGINES

8.1 General

8.1.1 General

Sub-paragraph -1 has been amended as follows.

1 The requirements in this chapter apply to the approval of use of diesel engines required by 2.1.1-3 and 2.6.1-3, Part D of the Rules for the Survey and Construction of Steel Ships, 2.1.1-2, Part 7 of the Rules for High Speed Craft as well as 2.1.1-2, Part 9 and 2.6.1-3, Part 7 of the Rules for the Survey and Construction of Inland Waterway Ships. They also apply to the approval of use of low pressure gas-fuelled engines required by 4.1 of Annex 4, Part GF or 5.1 of Annex 4, Part N of the Guidance for the Survey and Construction of Steel Ships (in such cases, the term “diesel engine” is to be read as “gas-fuelled engine”). In addition, they apply mutatis mutandis to the approval of use of high pressure gas fuelled engines (as required by 3.1 of Annex 3, Part GF or 4.1 of Annex 3, Part N of the Guidance for the Survey and Construction of Steel Ships).

EFFECTIVE DATE AND APPLICATION (Amendment 1-1)

1. The effective date of the amendments is 14 June 2019.

Part 6 MACHINERY

Chapter 8 APPROVAL OF USE OF DIESEL ENGINES

Section 8.1 has been amended as follows.

8.1 General

8.1.1 General

(-1 to -3 are omitted.)

4 The requirements in this chapter apply, in general, to each engine type of which either of the following is different to that of an approved engine type.

((1) to (10) are omitted.)

(11) For low pressure gas-fuelled engines, the following (a) to (d) are to be considered in addition to (1) to (10) above.

(a) Gas admission method (direct cylinder injection, charge air space or pre-mixed)

(b) Gas supply valve operation (mechanical or electronically controlled)

(c) Ignition system (pilot injection, spark ignition, glow plug or gas self-ignition)

(d) Ignition system (mechanical or electronically controlled)

5 Notwithstanding ~~4(6)~~, the following (1) to (3) engines may be regarded as being of the same type:

((1) and (2) are omitted.)

(3) Engines which are manufactured according to approved drawings and documents, and internal testing per Stage A are documented to have a rating higher than the approved power, mean effective pressure or speed and the increase is within such ratings. In such cases, the tests given in the following (a) and (b) are to be documented at the increased power, mean effective pressure or speed.

(a) The overspeed test specified in **8.45.2-2(1)** (only if nominal speed has increased)

(b) The operation at the load points given in **8.45.2-2(2)(a) to (c)**

(-6 and -7 are omitted.)

8.1.2 Terminology

(-1 to -3 are omitted.)

4 The terminology used in the application of ~~-6~~ and ~~-7~~ of **8.1.1**, **8.2.2**, **8.2.3**, ~~8.56.3~~, ~~8.56.4~~ and ~~8.56.5(6)~~ is as specified in the **2.1.2, Part D of the Rules for the Survey and Construction of Steel Ships**, **2.1.2, Part 9 of the Rules for High Speed Craft** or **2.1.2, Part 7 of the Rules for the Survey and Construction of Inland Waterway Ships**.

5 For low pressure gas-fuelled engines, the terminology is as specified in the **1.4 of Annex 4, Part GF** or **1.4 of Annex 4, Part N of the Guidance for the Survey and Construction of Steel Ships**.

8.2 Application and Approval of Submitted Documents

Paragraph 8.2.2 has been amended as follows.

8.2.2 Drawings and Data

1 Drawings and data to be submitted are as specified in the following (1) and (2), as appropriate for the type of the diesel engine. Upon review and approval of the submitted drawings and data, they are returned to the licensor.

(1) Drawings and data to be submitted for information on an overview of the engine's design, engine characteristics and performance

((a) to (ac) are omitted.)

(ad) For low pressure gas-fuelled engines, the following i) to iii)

i) Safety concept

ii) Report of the risk analysis (see 8.3)

iii) Gas specification

~~(ae)~~ Other drawings and data deemed necessary by the Society

(2) Drawings and data to be submitted for information for approval

((a) to (w) are omitted.)

(x) For low pressure gas-fuelled engines, the following i) to viii)

i) Schematic layout or other equivalent documents of gas system on the engine

ii) Gas piping system (including double-walled arrangement where applicable)

iii) Parts for gas admission systems

Documentation is to include specifications for pressures, pipe dimensions and materials.

iv) Arrangement of explosion relief valves for crankcases (if required by 2.4.3, Part D of the Rules for the Survey and Construction of Steel Ships), charge air manifolds and exhaust gas manifolds, as applicable.

v) List of certified safe equipment and evidence of relevant certification

vi) Schematic layout or other equivalent documents of fuel oil system (main and pilot fuel systems) on the engine (only for dual fuel engines)

vii) Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for dual fuel engines)

viii) Ignition system (only for gas only engines)

(-2 to -5 are omitted.)

Section 8.3 has been added as follows.

8.3 Risk Analysis

For low pressure gas fuelled engines, risk analysis is to be carried out in accordance with the following (1) to (4).

(1) Scope of the risk analysis

The risk analysis is to address the following (a) to (d). With regard to the scope of the risk analysis it is to be noted that failures in systems external to the engine, such as fuel storage or fuel gas supply systems, may require action from the engine control and monitoring system in the event of an alarm or fault condition.

(a) A failure or malfunction of any system or component involved in the gas operation of the engine

- (b) A gas leakage downstream of the gas valve unit
- (c) The safety of the engine in case of emergency shutdown or blackout, when running on gas
- (d) The interactions between the gas fuel system and the engine

(2) Form of the risk analysis

The risk analysis is to be carried out in accordance with international standard ISO 31010:2009 or other recognized standards. The required analysis is to be based on the single failure concept, which means that only one failure needs to be considered at the same time. Both detectable and non-detectable failures are to be considered. Consequences failures, i.e. failures of any component directly caused by a single failure of another component, are also to be considered.

(3) Procedure for the risk analysis

The risk analysis is to be accordance with the following procedure. The results of the risk analysis are to be documented.

- (a) Identify all the possible failures in the concerned equipment and systems which could lead to the following:
 - i) the presence of gas in components or locations not designed for such purpose; and/or
 - ii) ignition, fire or explosion.
- (b) Evaluate the consequences of (a)
- (c) Where necessary, identify the failure detection method
- (d) Where risk cannot be eliminated, identify the corrective measures:
 - i) system design, such as:
 - 1) redundancies
 - 2) safety devices, monitoring or alarm provisions which permit restricted operation of the system
 - ii) system operation, such as:
 - 1) initiation of the redundancy
 - 2) activation of an alternative mode of operation

(4) Equipment and systems to be analysed

The risk analysis required for engines is to cover at least the following aspects. Failures of the gas supply components not located directly on the engine, such as block and bleed valves and other components of the Gas Valve Unit (GVU), are not to be considered in the analysis.

- (a) Failure of the gas-related systems or components, in particular the following i) and ii)
 - i) gas piping and its enclosure, where provided
 - ii) cylinder gas supply valves
- (b) Failure of the ignition system (oil fuel pilot injection or sparking plugs)
- (c) Failure of the air to fuel ratio control system (charge air by-pass, gas pressure control valve, etc.)
- (d) For engines where gas is injected upstream of the turbocharger compressor, failure of a component likely to result in a source of ignition (hot spots)
- (e) Failure of the gas combustion or abnormal combustion (misfiring, knocking)
- (f) Failure of the engine monitoring, control and safety systems
- (g) Abnormal presence of gas in engine components (e.g. air inlet manifold and exhaust manifold of dual fuel or gas only engines) and in the external systems connected to the engines (e.g. exhaust duct).
- (h) Changes of operating modes for DF engines
- (i) Hazard potential for crankcase fuel gas accumulation, for engines where the space below the piston is in direct communication with the crankcase, refer to 10.3.1-2, Part GF of

the Rules for the Survey and Construction of Steel Ships

Section 8.3 has been amended as follows.

8.34 Preparation for Surveys

(-1 to -4 are omitted.)

5 For low pressure gas-fuelled engines, measures to verify that gas fuel piping on engine is gas tight are to be carried out prior to start-up of the engine.

Section 8.4 has been amended as follows.

8.45 Approval Tests

8.45.1 Test Stages

(-1 to -3 are omitted.)

4 During all approval tests, ambient conditions (i.e., air temperature, air pressure and humidity) are to be recorded. At a minimum, the engine data as listed in the following **(1)** to **(8)** are to be measured and recorded. Calibration records for the instrumentation used to collect data listed below are to be presented to the attending surveyor for review. Additional measurements may be required in connection with the design assessment as deemed necessary by the Society.

((1) to (8) are omitted.)

(9) For low pressure gas-fuelled engines, the following **(a)** to **(c)** are to be measured and recorded
(a) Each fuel index for gas and diesel as applicable (or equivalent reading)
(b) Gas pressure and temperature at the inlet of the gas manifold
(c) Gas concentration in the crankcase

5 An integration test demonstrating the response of the complete mechanical, hydraulic and electronic system may be required for acceptance of any sub-systems (turbocharger, engine control system, dual fuel, exhaust gas treatment, etc.) separately approved. The scope of these tests are to be determined by the Society on a cases-by-case basis in consideration of the test items proposed by the designer (licensor) taking the impact on engine into account.

6 For low pressure gas-fuelled engines, the following are also to be applied.

(1) For dual fuel engines, the load tests specified in **8.5.2-1(1)** and **8.5.2-2(2)** are to be carried out in gas mode at the different percentages of the maximum power available in gas mode (see **2.5.1-1(1) of Annex 4, Part N** or **2.5.1-1(1) of Annex 4, Part GF of the Guidance for the Survey and Construction of Steel Ships**). The 110% load tests are not required in the gas mode.

(2) The influence of the methane number and *LHV* of the fuel gas is not required to be verified during the stage *B*. It is, however, to be justified by the engine designer through tests or calculations at the stage *A* and documented in the type approval test report.

(3) The integration tests of **-5** are to be carried out to verify that the response of the complete mechanical, hydraulic and electronic engine system is as predicted for all intended operational modes. The scope of these tests is to be agreed with the Society for selected cases based on the risk analysis required in **8.3**, and is to at least include the following incidents:

- (a) Failure of ignition (spark ignition or pilot injection systems), both for one cylinder unit and common system failure
- (b) Failure of a cylinder gas supply valve
- (c) Failure of the combustion (to be detected by e.g. misfiring, knocking, exhaust

temperature deviation, etc.)

(d) Abnormal gas pressure

(e) Abnormal gas temperature (this test may be carried out using a simulation signal of the temperature)

8.45.2 Details of Tests

1 During the stage A, the following items of tests are to be included:

(1) Operation at the load points 25%, 50%, 75%, 100% and 110% of the maximum rated power for continuous operation and other load points considered important, at the following engine speeds:

(a) along the nominal (theoretical) propeller curve and at constant speed for propulsion engines (if applicable mode of operation, i.e., driving controllable pitch propellers)

(b) at constant speed for engines intended for generating sets or auxiliary machinery (including a test at no load and rated speed)

(2) Operation at the limit points of the permissible operating range. These limit points are to be defined by the engine manufacturer.

((3) to (8) are omitted.)

(9) For low pressure gas fuelled engines, the following (a) to (c) are also to be included.

(a) For dual fuel engines, the engines are to run the load points defined in (1) in both gas and diesel modes (with and without pilot injection in service) as found applicable for the engine type.

(b) For dual fuel engines with variable liquid/gas ratio, the load tests are to be carried out at different ratios between the minimum and the maximum allowable values.

(c) For dual fuel engines, switch over between gas and diesel modes are to be tested at different loads.

~~(10)~~ Other items deemed to be verified by the Society.

2 During the stage B, the following items of tests are to be included. Deviations from the items, if any, are to be agreed with the Society.

(1) Overspeed test

It is to demonstrate that the engine is not damaged by an actual engine overspeed within the overspeed shutdown system set-point. The manufacturer may decide whether the test is to be carried out with or without load during the speed overshoot.

(2) Operation at each load point below (an operating time of two *hours* is to be required at the load point in (a) and two sets of readings are to be taken at a minimum interval of one *hour*. An operating time per each load point other than (a) depends upon the engine size (achievement of steady state condition) and on the time for collection of the operating values, but 0.5 *hour* can be normally assumed. However, sufficient time is to be allowed for visual inspection by the surveyor.)

The data to be measured and recorded when testing the engine at each load point have to include all engine parameters listed in **8.45.1-4**. During all these load points, engine parameters are to be within the specified and approved values. If operation of the engine at the limits defined by its specified alarm system (e.g., at alarm levels of lubrication oil pressure and inlet temperature) is required, the test is to be made at the load point in (a).

((a) to (h) are omitted.)

((3) to (6) are omitted.)

(7) For electronically-controlled diesel engines, integration tests are to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted for all intended operational modes.

The scope of these tests is to be agreed upon with the Society for selected cases based upon the FMEA required in **Annex D2.1.1, Part D of the Guidance for the Survey and**

Construction of Steel Ships.

((8) to (10) are omitted.)

(11) For low pressure gas-fuelled engines, the following are also to be applied.

- (a) For dual fuel engines, all load points of (2) are to be run in both gas and diesel modes that apply for the engine type as defined by the engine designer (see 8.5.1-6(1)).
- (b) For dual fuel engines, the overspeed test of (1) is to be carried out in both gas and diesel modes that apply for the engine type as defined by the engine designer (see 8.5.1-6(1)).
- (c) For dual fuel engines with variable liquid/gas ratios, the load tests of (a) are to be carried out at different ratios between the minimum and the maximum allowable values.
- (d) For dual fuel engines, the lowest specified speed is to be verified in diesel mode and gas mode.
- (e) For dual fuel engines, switch over between gas and diesel modes are to be tested at different loads.
- (f) The efficiency of the ventilation arrangement of the double walled gas piping system is to be verified.
- (g) Simulation of a gas leakage in way of a cylinder gas supply valve.
- (h) For engines intended to produce electrical power, the characteristics of governors specified in 2.4.2-1(1) and (2), Part H of the Rules for the Survey and Construction of Steel Ships are to be verified.
- (i) For gas only and pre-mixed engines intended to produce electrical power, the influences of LHV, methane number and ambient conditions on the governor test results are to be theoretically determined and specified in the test report. Referring to the limitations as specified in 2.1-5(1) and (2) of Annex 4, Part N or 2.1-5(1) and (2) of Annex 4, Part GF of the Guidance for the Survey and Construction of Steel Ships, the margin for satisfying characteristics of governors are to be determined.

(11~~2~~) Other test items deemed necessary by the Society

3 During the stage C, the following items are to be included.

((1) is omitted.)

(2) Upon completion of the test run, the components of one cylinder for in-line engines and two cylinders for V-engines are to be presented for inspection as follows.

For V-engines, the cylinder units are to be selected from both cylinder banks and different crank throws. For high-speed engines, two cylinders are normally to be stripped down for a complete inspection after the type test.

((a) to (h) are omitted.)

(i) For low pressure gas-fuelled engines, the following i) to iii) are also to be included.

i) Gas supply valve including pre-chamber as found applicable

ii) Spark igniter (for gas only engines)

iii) Pilot fuel injection valve (for dual fuel engines)

(~~j~~) Further components deemed necessary by the Society

Section 8.5 has been amended as follows.

8.56 Handling after Approval

8.56.1 Notification and Announcement of Approval

After the requirements in the preceding sections have been satisfactorily completed, the Society will issue a certificate of approval specifying the approval number, date and conditions, etc. upon examination of the submitted documents and surveyor's reports and make announcement the

approval per the list published annually.

8.56.2 Term of Validity

The term of validity of the approval will be five *years* from the date of approval.

8.56.3 Modification of Approval Conditions

In cases where an approval in advance is granted by the Society in accordance with **8.56.5(5)**, when partial technical modifications which will affect the function and safety of an engine already approved, the Society may require tests and inspection concerned to the modifications.

8.56.4 Renewal of Approval

1 The manufacturer, who intends to have a continuation of the approval already expired or to make partial technical modifications of the engine, is to submit an application in accordance with the requirements of **8.2.1** newly. In this case, in lieu of the data required by **8.2.2**, the drawings and data for reference specified in the following **(1)** or **(2)** are to be submitted.

- (1) The submission of modified documents or new documents with substantive modifications replacing former documents compared to the previous submission(s) for design approval; or
- (2) A declaration that no substantive modifications have been applied since the last design approval issued.

2 Where approval is given for the partial modifications in the contents of approval, expiration date will not be renewed, in principle.

8.56.5 Revocation of Approval

In case where either of the following **(1)** to **(5)** applies, the Society will revoke the approval and give notice to the manufacturer.

- (1) Where the tests required in **8.56.3** is not conducted without any reasonable cause.
- (2) Where the result of the tests required in **8.56.3** is found inappropriate to continue the approval.
- (3) Where an applicant for revocation is made by the manufacturer.
- (4) Where the Society considers that the continuation of the approval is inappropriate.
- (5) Where there are substantive modifications in the design, in the manufacturing or control processes or in the characteristics of the materials of diesel engines unless approved in advance by the Society.

EFFECTIVE DATE AND APPLICATION (Amendment 1-2)

1. The effective date of the amendments is 1 July 2019.
2. Notwithstanding the amendments to the Guidance, the current requirements apply to the same type of gas-fuelled engine as that for which the application for approval of use is submitted to the Society before the effective date.
3. Notwithstanding the provision of preceding **2**, the amendments to the Guidance applies to gas-fuelled engines for which the application for renewal of approval of use is submitted on or after the effective date.

Part 2 EQUIPMENT

Chapter 11 has been amended as follows.

Chapter 11 BALLAST WATER MANAGEMENT SYSTEMS

11.1 General

11.1.1 Scope

1 This chapter applies to the procedures and testing requirements for the approval of manufacturing processes of ballast water management systems (*BWMS*) which are to be equipped on ships in accordance with the requirements of in **3.3-1(1), Part 3 of the Rules for Ballast Water Management Installations**. Furthermore, the characters in brackets (“[]”) specified in this chapter refers to the regulation numbers used in *IMO Res. MEPC.279/300(70/72)* “~~2016 Guidelines for Approval of Ballast Water Management Systems (G8)~~ *BWMS Code*”, as amended.

2 A *BWMS* approved taking into account the “*2016 Guidelines for Approval of Ballast Water Management Systems (G8)*” adopted by *IMO Res. MEPC.279(70)* is deemed to be in accordance with the *BWMS Code*. [1.13]

11.1.2 Definitions

The definitions of terms which appear in this chapter are to be as specified in **Chapter 2, Part 1 of the Rules for Ballast Water Management Installations** and according to the following:

- (1) “Ballast water performance standard” means **3.2, Part 3 of the Rules for Ballast Water Management Installations**.
- (2) “Land-based testing” is a test of the *BWMS* carried out in a laboratory, equipment factory or pilot plant including a moored test barge or test ship in order to confirm that the *BWMS* meets the ballast water performance standards. [~~G8/~~ 3.8]
- (3) “Shipboard testing” means a full-scale test of a complete *BWMS* carried out on board a ship to confirm that the system meets the ballast water performance standards. [~~G8/~~ 3.12]
- (4) “Full-scale test” means shipboard testing carried out on a ship with ballast tanks having enough capacity for the treatment of ballast water as well as the *BWMS* without affecting normal ballast operation.
- (5) “Minimum dimension” is the smallest dimension of width, length or thickness of the organisms.
- (6) “Treatment Rated Capacity” (*TRC*) means the maximum continuous capacity expressed in cubic meters per hour for which the *BWMS* is type approved. It states the amount of ballast water that can be treated per unit time (m^3/h) by the *BWMS* to meet the ballast water performance standard. The *TRC* is to be measured at the inlet of the *BWMS*. [~~G8/~~ 3.17]
- (7) “Viable organisms” mean organisms that have the ability to successfully generate new individuals in order to reproduce the species. [~~G8/~~ 3.19]
- (8) “Test plan” describes the detailed schedule of all testing, including environmental testing, land-based testing and shipboard testing.
- (9) “Valid test cycle” means a test cycle in which all the required test conditions and arrangements, including challenge conditions, test control, and monitoring arrangements

- (including piping, mechanical and electrical provisions) and test analytical procedures were achieved by the testing organisation. [~~GS~~ 3.18]
- (10) “Invalid test cycle” is a test cycle in which, due to circumstances outside the control of the *BWMS*, the requirements for a valid test cycle are not met. When a test cycle is invalid, it does not count as one of the required consecutive test cycles in a test and the test can be continued. [~~GS~~ 3.7]
 - (11) “Failed test cycle” is a valid test cycle in which the performance of the *BWMS* resulted in treated water that is determined to be non-compliant with the ballast water performance standard. A failed test cycle interrupts the required consecutive test cycles and terminates the test. [~~GS~~ 3.6]
 - (12) “Replicate sample” means a sample which is taken by repeating the same action.
 - (13) “Major components” means those components that directly affect the ability of the system to meet the ballast water performance standard. [~~GS~~ 3.9]
 - (14) “Representative sampling” means sampling that reflects the relative concentrations (chemicals) and numbers and composition of the populations (organisms) in the volume of interest. Samples are to be taken in a time-integrated manner and the sampling facility is to be installed, ~~in accordance with~~ taking into account the annex, Part 1 of *IMO* ~~Resolution~~ *MEPC.173(58) “Guidelines for Ballast Water Sampling (G2)”*, as amended. [~~GS~~ 3.10]
 - (15) “Successful test cycle” means a valid test cycle where the *BWMS* functions to its specifications and treated water is determined to meet the ballast water performance standard. [~~GS~~ 3.13]
 - (16) “System Design Limitations of a *BWMS* (hereinafter referred to as “*SDL*”)” means the water quality and operational parameters, determined in addition to the required type approval testing parameters, that are important to its operation, and, for each such parameter, a low and/or a high value for which the *BWMS* is designed to achieve the ballast water performance standard. The System Design Limitations are to be specific to the processes being employed by the *BWMS* and is not ~~to be~~ to be limited to parameters otherwise assessed as part of the type approval process. The System Design Limitations are to be identified by the manufacturer and validated under the supervision of the Society, taking into account Guidance developed by the *IMO*, and in accordance with this Guidance. [~~GS~~ 3.14]
 - (17) “Test cycle” refers to one testing iteration (to include uptake, treatment, holding and discharge as appropriate) under a given set of requirements used to establish the ability of a *BWMS* to meet the set standards. [~~GS~~ 3.15]
 - (18) “Test” means the set of required test cycles. [~~GS~~ 3.16]
 - (19) “Inline *BWMS*” means *BWMS* which treats on the way of the intake and the discharge of the ballast water.
 - (20) “In-tank *BWMS*” means *BWMS* which treats after the intake of the ballast water in the ballast tank.
 - (21) “Quality Management Plan (hereinafter referred to as “*QMP*”)” means the quality control management structure and policies of the testing body (including subcontractors and outside laboratories). [~~GS~~ Annex / ~~2.1.2.2~~2.3.1]
 - (22) “Quality Assurance Project Plan (hereinafter referred to as “*QAPP*”)” means the methods, procedures, and quality assurance and quality control (*QA/QC*) protocols used by the test facility for testing *BWMS* in general. It identifies the test team members, and it includes all relevant standard operating procedures (*SOPs*), typically as appendices. [~~GS~~ Annex / ~~2.1.2.2~~2.3.2]
 - (23) “Test/Quality Assurance Plan (hereinafter referred to as “*TQAP*”)” means plans including as follows. [~~GS~~ Annex / ~~2.1.2.3~~2.3.3]
 - (a) Specific details for conducting a test of a given *BWMS* at a given site and time.

- (b) Detailed plans for commissioning the *BWMS*, the experimental plan, decommissioning, and reporting the results.
- (c) The *TQAP* identifies all organizations involved in the test and includes the *BWMS* ~~vendor's~~ manufacturer's documentation and performance claims.
- (d) The *TQAP* also identifies the data to be recorded, operational and challenge parameters that define a valid test cycle, data analyses to be presented in the verification report, and a schedule for testing. Appropriate statistical distributions ~~should~~ are to be considered and used to analyse data.

11.1.3 Requirements of International Convention

(Omitted)

11.2 Approval Application

11.2.1 Approval Application Forms

(Omitted)

11.2.2 Documents to be Submitted

1 The drawings and documents listed below are to be submitted in triplicate together with the application specified in 11.2.1. [~~G8 / 5.2, 5.5, 5.7, G8 Annex / 1.3, 2.2~~]

- (1) Documents describing the manufacturing plant outline
- (2) Documents related to the quality control standards of *BWMS*
- (3) Records of manufacture and delivery of the *BWMS*
- (4) Drawings and documents for the *BWMS*
 - (a) Complete description [5.7.1] [Annex / 1.3.1.1]
 - (b) Construction drawings (with all dimensions necessary for evaluation)
 - (c) Drawings of the main components (showing clearly all materials used) [Annex / 1.3.1.3]
 - (d) Diagrammatic drawings (including the pumping and sampling facilities) [5.7.1] [Annex / 1.3.1.2]
 - (e) Drawings for sampling facilities ~~and documents for sampling methods~~ [Annex / 1.3.1.2]
 - (f) Electrical and electronic wiring diagrams (including information for trouble-shooting, etc.) [Annex / 1.3.1.2]
 - (g) Operation, maintenance, ~~emergency~~ and ~~trouble-shooting~~ safety manuals including following items: [5.7.2] [Annex / 1.3.2]
 - i) instructions for the correct operation of the *BWMS*, including procedures for the discharge of untreated water in the event of malfunction;
 - ii) instructions for the correct arrangement of the *BWMS*;
 - iii) maintenance and safety instructions and the need to keep records;
 - iv) trouble shooting procedures;
 - v) emergency procedures necessary for securing the ship;
 - vi) any supplementary information considered necessary for the safe and efficient operation of the *BWMS*, e.g. documentation provided for *IMO* Resolution *MEPC.169(57)* “*Procedure for Approval of Ballast Water Management Systems that Make Use of Active Substances (G9)*”, as amended; and
 - vii) calibration procedures;
 - (h) Process description of the treatment of the ballast water [Annex / 1.3.1.1]
 - (i) Hazard identification [5.7.3] [Annex / 1.3.3]
 - (j) Information regarding environmental and public health impacts including: [5.7.4] [Annex / 1.3.4]

- i) identification of potential hazards to the environment based on environmental studies performed to the extent necessary to assure that no harmful effects are to be expected;
 - ii) sufficient information to enable the test organization to identify any potential health or environmental safety problems, unusual operating requirements (labour or materials), and any issues related to the disposal of treatment by products or waste streams;
- (k) Information regarding *SDL* including: [5.7.5] [Annex / 1.3.5]
- i) the identification of all known parameters to which the design of the *BWMS* is sensitive;
 - ii) for each parameter the manufacturer ~~should~~is to claim a low and/or a high value for which the *BWMS* is capable of achieving the ballast water performance standard; and
 - iii) the proposed method for validating each claimed system design limitation ~~should~~is to be set out, together with information on the source, suitability and reliability of the method;
- (l) ~~Software change handling and revision control document including~~A software change handling and revision control document including all software changes introduced to the system after the pre-test evaluation. These are to be done according to a change handling procedure ensuring traceability. Therefore, the manufacturer is to present a procedure describing how changes are to be handled and how revision control is maintained. As a minimum for a modification request, the following types of information are to be produced and logged: [Annex / 1.3.6]
- i) ~~change handling procedure stipulated by the manufacturer~~reason for modification;
 - ii) ~~revision control procedure stipulated by the manufacture (In case of the revision, reason for modification, specification of the proposed change, authorization of modification, and test record are to be described.)~~specification of the proposed change;
 - iii) authorization of modification; and
 - iv) test record.
- (m) A description of *BWMS* side streams (e.g. filtered material, centrifugal concentrate, waste or residual chemicals) including a description of the actions planned to properly manage and dispose of such wastes [Annex / 1.3.1.7]
- (n) An equipment list showing all components subject to testing including specifications, materials and serial numbers; [Annex / 1.3.1.4]
- (o) An installation specification in accordance with manufacturers installation criteria requirements for the location and mounting of components, arrangements for maintaining the integrity of the boundary between safe and hazardous spaces and the arrangement of the sample piping; [Annex / 1.3.1.5]
- (p) Information regarding the characteristics and arrangements in which the system is to be installed, including scope of the ships (sizes, types and operation) for which the system is intended. This information may form the link between the system and the ship's ballast water management plan; and [Annex / 1.3.1.6]
- (q) Functional description including a textual description with necessary supporting drawings, diagrams and figures to cover: [Annex / 1.3.7]
- i) system configuration and arrangement;
 - ii) scope of supply;
 - iii) system functionality covering control, monitoring, alarm and safety functions;
 - iv) self-diagnostics and alarming functionalities; and

v) safe states for each function implemented.

- (5) Record of the “Basic and Final Approval of Active Substances and Preparations” (in cases where the system results in changes to the chemical composition of the treated water)
- (6) Approval test plan (including information on the place and scheduled date of the test)
- (7) Test records (if any preliminary tests were carried out)
- (8) Evidence of successful compliance with the environmental testing specified in **11.5.4**
- (9) Other information deemed necessary by the Society
- 2 (Omitted)
- 3 (Omitted)

11.3 Preliminary Review

11.3.1 Approval of Test Plan

(Omitted)

11.3.2 Confirmation Survey of Manufacturing Factory or Facility

(Omitted)

11.3.3 Approval Testing for the Testing Facility

- (1) The testing facility is to demonstrate its competency in conducting valid type approval tests in following two ways. It is the responsibility of the Administration, or its authorized delegate, to determine the acceptability of the test facility: [~~GS Annex / 2.1-2.2~~]
 - (a) ~~have by~~ having implemented a rigorous quality control/quality assurance program, approved, certified and audited by an independent accreditation body, or to the satisfaction of the Administration,
 - (b) ~~be able to demonstrate~~ by demonstrating its ability to conduct valid test cycles with appropriate challenge water, sample collection, sample analysis, and method detection limits. ~~It is the responsibility of the Administration, or its authorized delegate, to determine the acceptability of the test facility.~~
- (2) The test facility’s quality control/quality assurance program is to consist of followings: [~~GS Annex / 2.1-23~~]
 - (a) *QMP* specified in **11.1.2(21)**
 - (b) *QAPP* specified in **11.1.2(22)**
 - (c) *TQAP* specified in **11.1.2(23)**
- (3) The testing facility performing the *BWMS* tests is to be independent. It is not to be owned or affiliated with the manufacturer or vendor of any *BWMS*, or by the manufacturer or supplier of the major components of that equipment. [~~GS Annex / 2.1-34~~]

11.3.4 Cautions During the Readiness Evaluation

During the readiness evaluation the major components specified in **11.1.2(13)** of the *BWMS* is to be identified. Major components are considered to be those components that directly affect the ability of the system to meet the ballast water performance standard. Upgrades or changes to major components are not to take place during type approval testing. A change to a major component is to require a new submission of the test proposal and is to involve a new evaluation and repeating of the land-based and shipboard tests. [~~GS Annex / 1.10~~]

11.4 Requirements of Construction and Performance

11.4.1 Ballast Water Management System (BWMS)

- (1) The *BWMS* is to be designed and constructed: [~~CS~~ 4.5]
 - (a) for robust and suitable operation in the shipboard environment;
 - (b) for the service for which it is intended;
 - (c) to mitigate any danger to persons on board when installed. Equipment that could emit dangerous gases/liquids ~~shall~~ is to have at least two independent means of detection and shutdown of the *BWMS* (i.e. hazardous gas level reaching lower explosive limits (*LEL*) or level of toxic concentrations that can result in severe effects on human health); and
 - (d) with materials compatible for the substances used, purpose which it is intended, the working conditions to which it will be subjected and the environmental conditions on board.
- (2) The *BWMS* is not to contain or use any substance of a dangerous nature, unless adequate risk mitigation measures are incorporated for storage, application, installation, and safe handling, acceptable to the Society. [~~CS~~ 4.6]
- (3) In case of any failure compromising the proper operation of the *BWMS*, audible and visual alarm signals are to be given in all stations from which ballast water operations are controlled. [~~CS~~ 4.7]
- (4) All working parts of the *BWMS* that are liable to wear or to be damaged are to be easily accessible for maintenance. [~~CS~~ 4.8]
- (5) To avoid any incorrect operation of the *BWMS*, its specifications and construction are to be as follows.
 - (a) Every access of *BWMS* beyond the essential requirements of (4) above is to require the breaking of a seal. [~~CS~~ 4.9.1]
 - (b) If applicable, ~~the~~ *BWMS* is to be so constructed that a visual alarm is always activated whenever *BWMS* is in operation for purposes of cleaning, calibration or repair, and these events are to be recorded by the control and monitoring equipment. [~~CS~~ 4.9.2]
 - (c) The *BWMS* is to be provided with the necessary connections to ensure that any bypass of the *BWMS* will activate an alarm, and that the bypass event is recorded by the control and monitoring equipment. [~~CS~~ 4.9.3]
- (6) The *BWMS* is to be provided with simple and effective means for its operation and control. It is to be provided with a control system that ~~should~~ is to be such that the services needed for the proper operation of the *BWMS* are ensured through the necessary arrangements. [~~CS~~ 4.11]
- (7) The *BWMS* is to, if intended to be fitted in hazardous area locations, comply with **Part H of the Rules for the Survey and Construction of Steel Ships**. Any electrical equipment that is part of the *BWMS* is to be based in a non-hazardous area, or is to comply with **Part H of the Rules for the Survey and Construction of Steel Ships**. Any moving parts, which are fitted in hazardous areas, are to be arranged so as to avoid the formation of static electricity. [~~CS~~ 4.12]
- (8) The *BWMS* is to be designed so as not to endanger the health and safety of the crew, interact negatively with the ship's systems and cargo or produce any adverse environmental effects. The *BWMS* is not to create long term impacts on the safety of the ship and crew through corrosive effects in the ballast system and other spaces. [~~CS~~ 4.13]
- (9) It is to be demonstrated by using mathematical modelling and/or calculations, that any up or down scaling of the *BWMS* will not affect the functioning and effectiveness on board a ship of

the type and size for which the equipment will be certified. In doing so, the manufacturer of the equipment is to take into account the relevant guidance developed by the Organization. [~~GS~~ 4.14]

- (10) Scaling information is to allow the Society to verify that any scaled model is at least as robust as the land-based-tested model. It is the responsibility of the Society to verify that the scaling used is appropriate for the operational design of the *BWMS*. [~~GS~~ 4.15]
- (11) The design of the *BWMS* is to account for the fact that, regardless of the *BWMS* technology employed, viable organisms remaining after treatment may reproduce in the interval between treatment and discharge. [~~GS~~ 4.4]
- (12) At a minimum, the shipboard test unit is to be of a capacity that allows for further validation of the mathematical modelling and/or calculations for scaling, and preferably selected at the upper limit of the rated capacity of the *BWMS*, unless otherwise approved by the Administration. [~~GS~~ 4.16]

11.4.2 Control and Monitoring Equipment

- (1) The *BWMS* is to incorporate control equipment that automatically monitors and adjusts necessary treatment dosages or intensities or other aspects of *BWMS* of the vessel, which while not directly effecting treatment, are nonetheless required for proper administration of the necessary treatment. [~~GS~~ 4.18]
- (2) The control and monitoring equipment is to record the ~~operation condition automatically, and the proper functioning or failure of the *BWMS*. Where practical, system design limitation~~ SDL parameters are to be monitored and recorded by the *BWMS* to ensure proper operation. [~~GS~~ 4.17]
- (3) The *BWMS* is to be able to produce (e.g. display, print or export) a report of the applicable self-monitoring parameters for official inspections or maintenance, as required. [~~GS~~ 4.19]
- (4) The control and monitoring equipment are to be able to store data for at least 24 months. In the event the control and monitoring equipment is replaced, means are to be provided to ensure the data recorded prior to replacement remains available on board for 24 months. [~~GS~~ 4.20]
- (5) For *BWMS* that could emit dangerous gases, a means of gas detection by redundant safety systems is to be fitted in the space of the *BWMS*, and an audible and visual alarm is to be activated at a local area and at a manned *BWMS* control station in case of leakage. The gas detection device is to be designed and tested in accordance with *IEC* 60079-29-1, or other recognized standards acceptable to the Society. Monitoring measures for dangerous gases with independent shutdown is to be provided on the *BWMS*. [~~GS~~ 4.21]
- (6) All software changes introduced to the system after the pre-test evaluation are to be done according to a change handling procedure ensuring traceability. [~~GS~~ 4.22]

11.4.3 Sampling Facilities and Methods

- (1) The *BWMS* is to be provided with sampling facilities so arranged as to collect representative samples of the ship's ballast water.
- (2) Sampling facilities are to in any case be located on the *BWMS* intake, before the discharging points, and any other points necessary for sampling to ascertain the proper functioning of the equipment as may be determined by the Society.
- (3) The sampling protocol is to ensure organism mortality is minimized, e.g. by using appropriate valves and flow rates for flow control in the sampling facility, submerging nets during sampling collection, using appropriate sampling duration and handling times, and appropriate concentrating methodology. All methods to avoid sampling bias are to be validated to the satisfaction of the Society. [~~GS~~ Annex / 2.25]

11.4.4 Self Monitoring

- (1) The information and applicable self-monitoring parameters to be recorded for all systems are to include, inter alia: [~~G8~~ Annex / 5.3]
 - (a) ~~General~~ information: ship name, *IMO* number, *BWMS* manufacturer and type designation, *BWMS* serial number, date of *BWMS* installation on ship, *BWMS* ~~treatment rated capacity (TRC)~~, and principle of treatment (in-line/in-tank); [~~Annex / 5.3.1~~]
 - (b) ~~Operational~~ parameters: all recorded parameters are to be time tagged if applicable: [~~Annex / 5.3.2~~]
 - i) *BWMS* operational modes and any transition modes, including bypass operations (e.g. uptake, discharge, warming-up, cleaning and startup)
 - ii) ballast water pump in operation (yes/no – if information is available from ship)
 - iii) flow-rate at system outlet
 - iv) Indication of the ballast water tank that is involved in the ballast water operation when practicable
 - (c) It is recommended that positional information on ballast water operations and on the holding time is to be recorded automatically. Otherwise, it is to be entered manually in the ballast water record book as appropriate. The Society is encouraged to apply automatic position information recording to ships which install *BWMS* during a ship's building to the greatest extent possible; [~~Annex / 5.3.3~~]
 - (~~ed~~) ~~System~~ alerts and indications: all systems are to have an alert regime. Every alert is to be logged and time stamped. To assist the inspections it is helpful to record an alert summary after each ballast water operation automatically, if possible; [~~Annex / 5.3.4~~]
 - (~~de~~) ~~General~~ alerts include following **i) to iv)** [~~Annex / 5.3.5~~]
 - i) shutdown of system while in operation
 - ii) when maintenance is required
 - iii) *BWMS* bypass valve status
 - iv) status of *BWMS* valves representing system operational mode as appropriate
 - (~~ef~~) ~~Operational~~ alerts include following **i) to iii)** [~~Annex / 5.3.6~~]
 - i) whenever a relevant parameter exceeds the acceptable range approved by the Society, the system ~~should~~ is to give an alert.
 - ii) If a safety relevant parameter (safety for crew, cargo and/or the ship) related to the *BWMS* exceeds approved limits, an alert/alarm ~~should~~ is to be mandatory (e.g. hydrogen level at appropriate measurement point(s)).
 - iii) In addition, an alert is to be logged and time stamped also when a combination of relevant parameters exceeds system specifications, even if each single parameter does not exceed its approved range.
 - (~~fg~~) ~~The *SDL* parameters and their corresponding data~~ [~~Annex / 5.3.8~~]
 - (~~gh~~) ~~The Society may require additional alerts depending on the design of the system and for future developments~~ [~~Annex / 5.3.7~~]
- (2) ~~The storage and the record of the~~ Data storage and retrieval are to be taking into account ~~and satisfy the following requirements.~~ [~~G8 Annex / 5.5~~]
 - (a) The control and monitoring equipment are to automatically record the proper functioning or failure of a *BWMS* without user interaction and add a time stamp to every entry. Additionally, the system is to have a tool to produce summary text files for each ballast water operation on demand to support inspections work. [~~G8~~ Annex / 5.5]
 - (b) The system is to store the required data in any of *text* format, *pdf* format, *MS Excel* format, *xml* format. [~~G8~~ Annex / 5.6]
 - (c) The equipment is to be so designed that, as far as is practical, it will not be possible to

manipulate either the data being stored by the system or the data which has already been recorded. Any attempt to interfere with the integrity of the data is to be recorded. [~~G8~~ Annex / 5.7]

- (d) Permanent deletion of recordings is not to be possible. The system is to be capable of storing recorded data for at least 24 months to facilitate compliance with **1.2, Part 3 of the Rules for Ballast Water Management Installations**. Where navigation equipment is connected to the monitoring system to provide data for recording, the interfaces are to be developed taking into account ~~comply with~~ applicable parts of International Standard IEC 61162, as amended. [~~G8~~ Annex / 5.8]

11.4.5 System Design Limitations (SDL)

- (1) The low and/or high parameter values for each system design limitation are to be validated to the satisfaction of the Society as follows: [~~G8~~ Annex / 6.2]
 - (a) The validation is to be overseen by the Society and is to consist of a rigorous evidence-based assessment of a specific claim by the *BWMS* manufacturer that the equipment will operate as intended between pre-stated parameter values. Also, such tests may be combined with land-based and/or shipboard testing if the *QAPP* specified in **11.1.2(22)** establishes that the validation tests will not interfere with the specific procedures. Laboratory or bench-scale testing may also be used in the validation of *SDL*; [~~Annex~~ / 6.2.1, 6.2.2]
 - (b) Methods other than testing, such as the use of existing data and/or models, may be used in the validation of *SDL*. The source, suitability and reliability of such methods are to be reported. [~~Annex~~ / 6.2.3]
 - (c) Validation is not intended as a stress-test of the *BWMS* or as a procedure for identifying equipment failure points. Validation is to be undertaken independently of the *BWMS* manufacturer and is to be separate from *BWMS* research and development activities. Data and models may be supplied by the manufacturer when appropriate but are to be independently assessed. [~~Annex~~ / 6.2.4]
- (2) Claims of open-ended performance (expressed as the lack of either a low or a high parameter value for a *SDL*) are to also be validated. [~~G8~~ Annex / 6.3]
- (3) *BWMS* manufacturers may include a margin of error in claiming *SDL*. For this reason, *SDL* is not necessarily to be interpreted as the exact parameter values beyond which the *BWMS* is incapable of operation. The Society is to take this into account in considering whether to include any additional restrictions on the Type Approval Certificate in connection with the validation of *SDL*. [~~G8~~ Annex / 6.4]
- (4) *SDL* is to be established for all known parameters to which the design of the *BWMS* is sensitive that are important to the operation of the *BWMS*. [~~G8~~ Annex / 6.5]
- (5) A report is to be submitted to the Society containing all documentation (including procedures, methods, data, models, results, explanations and remarks) associated with the validation of *SDL*. The report is to include at least the information identified in paragraph **11.6.1**.

~~11.4.6 Cautions During the Type Approval~~

- ~~(1) The Society may allow replacements of non-major components of equivalent specification (independently approved to a recognized and equal operational standard) during type approval. Replacements of non-major components during testing are to be reported in test records specified in **11.6.1**. [~~G8~~ Annex / 1.11]~~
- ~~(2) Upgrades of the *BWMS* that relate to the safe operation of that system may be allowed during and after type approval by the Society and are to be reported. If such safety upgrades directly affect the ability of the system to meet the ballast water performance standards, it is to be treated as a change of a major component, as **11.3.4**. [~~G8~~ Annex / 1.12]~~

11.4.76 Other

- (1) The routine maintenance of the *BWMS* and troubleshooting procedures are to be clearly defined by the manufacturer in the operation, maintenance and safety manual. All maintenance and repairs are to be recorded. [~~G8~~ 4.8]
- (2) All maintenance and repairs after *BWMS* installation are to be taken into consideration so as to be recorded. [~~G8~~ 4.8]

11.5 Approval Test

11.5.1 General

(Omitted)

11.5.2 Test Witnessing by the Society's Surveyor

(Omitted)

11.5.3 Test Items

(Omitted)

11.5.4 Environmental Testing

~~As for the electrical and electronic sections which make up the *BWMS*, tests are to be carried out in accordance with the test conditions and test methods specified in 1.3, Part 7, and the satisfaction of the acceptance criteria is to be confirmed. Also, the satisfaction of *ISO/IEC 17025*, as amended, and relevant standards are to be confirmed. [~~G8 Annex / 3.1, 3.2, 3.3~~]~~

1 The electrical and electronic sections of the *BWMS* in the standard production configuration are to be subject to the relevant tests specified in -3 below at a laboratory approved for the purpose by the Society or by the accreditation body of the laboratory, with *ISO/IEC 17025* covering the relevant test standards. [Annex / 3.1]

2 Evidence of successful compliance with the environmental tests below is to be submitted to the Society by the manufacturer together with the application for type approval. [Annex / 3.2]

3 Equipment is to be tested taking into test conditions and test methods specified in 1.3, Part 7. [Annex / 3.3]

4 A report on environmental tests is to be submitted to the Society and include at least the information identified in 11.6.1. [Annex / 3.4]

11.5.5 Land-based Testing

1 The test set-up

Land-based testing is to be carried out by using test facilities which satisfy the following specifications.

(1) The following facilities are to be provided in accordance with the typical character and the arrangement of the ship. [~~G8 Annex / 2.4.1-20~~]

(a) The *BWMS*;

(b) Pumps in accordance with the treated capacity and pipping; and

(c) The control and treated simulated ballast tanks to simulate a ballast tank, constructed such that the water in the tank is completely shielded from light.

(2) The requirements for the control and treated simulated ballast tanks that simulates a ballast tank are as follows. [~~G8 Annex / 2.4.1-21~~]

(a) a minimum capacity of 200 m³;

~~(b) normal internal structures, including lightening and drainage holes;~~

~~(c) follow standard industry practices for design, construction and surface coatings~~

~~(Performance standard for protective coatings of dedicated seawater ballast tanks on all~~

new ships and of double-sided skin spaces of bulk carriers (PSPC) for ships; and the use of standard industry practices for design and construction for ships; surface coatings are to be in accordance with the performance standard for protective coatings of dedicated seawater ballast tanks on all new ships and of double-sided skin spaces of bulk carriers (PSPC) (resolution MSC.215(82)); and

(~~dc~~) ~~incorporate~~ the minimum modifications required for structural integrity on land.

- (3) The test set-up is to include facilities to allow sampling and provisions to supply influent test water to the *BWMS*. [~~G8 Annex / 2.4.1524~~]
- (4) The test set-up is to be pressure-washed with tap water, dried and swept to remove loose debris, organisms and other matter before starting the testing procedures, and between test cycles. [~~G8 Annex / 2.4.1423~~]
- (5) Land-based testing of *BWMS* is to be independent of the system manufacturer. [~~G8 Annex / 2.4.715~~]

2 The application of similarity of *BWMS* for land-based testing

With respect to the land-based testing of *BWMS*, similarity may be accepted only if the *BWMS* satisfies the following conditions. Scaling of the *BWMS* is to take into account *BWM.2/Circ.33/Rev.1*. [~~Annex / 2.25~~]

- (1) There is no alternation in the basic design of the *BWMS*. [~~G8 Annex / 2.4.1625~~]
- (2) *BWMS* with at least one model with a *TRC* equal to or smaller than $200 \text{ m}^3/\text{h}$ is not to be downscaled. [~~G8 Annex / 2.4.1726~~]
- (3) For *BWMS* with at least one model that has a *TRC* ~~higher capacity~~ higher than $200 \text{ m}^3/\text{h}$ or $1,000 \text{ m}^3/\text{h}$ the following is to be observed for land-based testing. In-line treatment equipment may be downsized for land-based testing, but only when the following criteria are taken into account: [~~G8 Annex / 2.4.1827~~]
 - (a) *BWMS* with at least one model with a *TRC* ~~larger~~ higher than $200 \text{ m}^3/\text{h}$ but ~~smaller~~ lower than $1,000 \text{ m}^3/\text{h}$ may be downscaled to a maximum of 1:5 scale, but may not be ~~smaller~~ lower than $200 \text{ m}^3/\text{h}$; and
 - (b) *BWMS* with at least one model with a *TRC* equal to, or ~~larger~~ higher than, $1,000 \text{ m}^3/\text{h}$ may be downscaled to a maximum of 1:100 scale, but may not be ~~smaller~~ lower than $200 \text{ m}^3/\text{h}$.
- (4) The performance of an in-tank method *BWMS* is to be tested in the demonstrable similarity range. [~~G8 Annex / 2.4.1928~~]

3 Influent Water

- (1) The source of test water is to be natural water. Any augmentation of test water with dissolved organic carbon (*DOC*), particulate organic carbon (*POC*) or total suspended solids (*TSS*) to achieve the minimum required content is to be validated and approved by the Society. As natural *DOC* constituents are complex and primarily of aromatic character, the type of added *DOC* is particularly critical to the evaluation of *BWMS* performance. The validation is to ensure that relevant properties of the augmented water (such as the oxidant demand/*TRO* decay and *UV* absorption in the range of 200 to 280 *nm*, the production of disinfectant by-products and the particle size distribution of suspended solids) are equivalent, on a ~~mg/L~~ basis, to that of natural water that would quantitatively meet the challenge conditions. In addition, the validation is to ensure that augmentation does not bias a test for or against any specific treatment process. The test report is to include the basis for the selection, use and validation of augmentation. [~~G8 Annex / 2.4.2130~~]
- (2) The influent water is to comply with the following: [~~G8 Annex / 2.4.2433~~]
 - (a) Viable organisms of greater than or equal to $50 \mu\text{m}$ or more in minimum dimension are to be present in a total density of preferably 10^6 but not less than 10^5 individuals per cubic meter, and are to consist of at least 5 species from at least 3 different phyla/divisions ;
 - (b) Viable organisms greater than or equal to $10 \mu\text{m}$ and less than $50 \mu\text{m}$ in minimum

dimension are to be present in a total density of preferably 10^4 but not less than 10^3 individuals per ~~milliliter~~ *ml*, and are to be consisted of at least 5 species from at least 3 different phyla/divisions; and

(c) Heterotrophic bacteria are to be present in a density of at least 10^4 living bacteria per ~~milliliter~~ *ml*.

(d) A variety of organisms which are to be documented according to the size classes mentioned above regardless of whether natural organism assemblages or cultured organisms were used to meet the density and organism variety requirements.

(3) ~~Land based testing is to be carried out taking into account quarantine and discharge regulations.~~ If cultured test organisms are used, local applicable quarantine regulations are to be taken into account during culturing and discharge. [~~GS Annex / 2.4.26~~35]

(4) For any given set of test cycles (five are considered a set) a salinity range is to be chosen for each cycle. Given the salinity of the test set up for a test cycle in fresh, brackish and marine water, each is to have dissolved and particulate content in one of the following combinations in **Table 2.11-1**. Deviations from the marine and brackish salinity ranges of the table are to be reported and justified and the resulting tests are not to be less challenging for the BWMS than would be the circumstance if the deviations had not occurred. [~~GS Annex / 2.4.20~~29]

(5) Use of standard test organisms (hereinafter referred to as “*STO*”) is to comply with the following: [~~GS Annex / 2.4.23~~32]

(a) The use of standard test organisms (*STO*) is permissible if the challenge levels in naturally occurring water at the test facility require supplementation.

(b) Procedures, processes and guidance for the use of *STO* are to be based on the most relevant and up to date available scientific data.

(c) The use of *STO*, including concentrations and species, is to be recorded within the test records specified in **11.6.1**. The test records are to include information pertaining to the evaluation and justification for the use of *STO*, an assessment of the impact of their use on other test parameters and potential impacts on the test being undertaken. ~~The information contained within the records are~~ report is to reflect both the positive and negative impacts of the use of *STO*.

(6) The *BWMS* is to be tested in conditions for which it will be approved. For a *BWMS* to achieve an unlimited Type Approval Certificate specified in **11.6.2** with respect to salinity, one set of test cycles is to be conducted within each of the three salinity ranges with the associated dissolved and particulate content as prescribed in **Table 2.11-2**. Tests under adjacent salinity ranges in the above table are to be separated by at least 10 *PSU* (*Practical Salinity Unit*). [~~GS Annex / 2.4.22~~31]

4 Test Items

The methods and acceptance criteria for land-based testing are specified in **Table 2.11-2**.

Table 2.11-1 Influent Water

	Salinity		
	Marine 28 – 36 <i>PSU</i>	Brackish 10 – 20 <i>PSU</i>	Fresh < 1 <i>PSU</i>
Dissolved Organic Carbon (<i>DOC</i>)	> 1 <i>mg/l</i>	> 5 <i>mg/l</i>	> 5 <i>mg/l</i>
Particulate Organic Carbon (<i>POC</i>)	> 1 <i>mg/l</i>	> 5 <i>mg/l</i>	> 5 <i>mg/l</i>
Total Suspended Solids (<i>TSS</i>)	> 1 <i>mg/l</i>	> 50 <i>mg/l</i>	> 50 <i>mg/l</i>

Table 2.11-2 Methods and Acceptance Criteria for Land-based Testing

Test Items	Test Method	Acceptance Criteria
Land-based Testing	<p>1. A single test cycle is to be as follows: [Annex / 2.12] At At least two test cycles in each salinity tested are to be conducted in order to evaluate compliance with the ballast water performance standard at the minimum holding time specified by the <i>BWMS</i> manufacturer. [GS Annex / 2.4.513]</p> <p>(1) the uptake of ballast water by pumping;</p> <p>(2) the storage of ballast water for at the minimum holding time specified by the <i>BWMS</i> manufacturer.;</p> <p>(3) treatment of ballast water within the <i>BWMS</i>, except the influent water in the simulated ballast water tank*²; and</p> <p>(4) the discharge of ballast water by pumping.</p>	<ul style="list-style-type: none"> • To be carried out in accordance with the test plan. • No incorporating of sea water and tank leakage. • To be performed in accordance with the <i>TRC</i> specified in the test plan.
	<p>2. The following items are to be recorded for each sample taken.</p> <p>(1) The number of viable organisms is to be measured and recorded. The phylum and kind of the organisms is to be based upon size class in accordance with the minimum dimension of the sample.</p> <p>(2) The number of the following bacteria in the sample is to be measured and recorded: [GS Annex / 2.4.2534]</p> <p>(a) Coliform group and coliform;</p> <p>(b) Enterococcus group and enterococcus;</p> <p>(c) <i>Vibrio cholerae</i> and <i>vibrio cholera</i> of toxin production (serotype O-1 and O-139); and</p> <p>(d) Heterotrophic bacteria.</p> <p>(3) Parameters (e.g., treatment flow rate, <i>UV</i> transmission, concentration of injection medicine, filter differential pressure, concentration of total residual oxidants (<i>TRO</i>) and power consumption, etc.) which affected the <i>BWMS</i> during the test cycle are to be recorded. It is to be verified that the treatment equipment performs within its specified parameters, such as power consumption and flow rate, during the test cycle. The range of operational flow rates that a <i>BWMS</i> is expected to achieve in service, at the maximum and minimum operational flow rates (where it is appropriate for that technology), is to be verified after the filter on the discharge side of the pump. [GS Annex / 2.4.2837, 2.4.29]38]</p> <p>(4) When the sample is taken, its <i>pH</i>, temperature, salinity, dissolved oxygen, <i>DOC</i>, <i>POC</i>, <i>TSS</i> and turbidity (<i>NTU: Nominal Turbidity Unit</i>) are to be recorded. [GS Annex / 2.4.3039]</p>	<ul style="list-style-type: none"> • The organism concentration of the influent water is to satisfy 11.5.6-3.

Table 2.11-2 Methods and Acceptance Criteria for Land-based Testing (continued)

Test Items	Test Method	Acceptance Criteria
<p>Land-based Testing</p>	<p>3. Samples are to be taken in accordance with the following, and an analysis of the organisms and bacteria found in each sample is to be carried out.</p> <p>(1) Samples during the test are to be taken immediately before the treatment equipment, immediately after the treatment equipment and upon discharge after the appropriate holding time. [G8 Annex / 2.4.3.4.0]</p> <p>(2) The control*³ and treatment*⁴ cycles may be run simultaneously or sequentially. The influent water is to be taken upon influent and discharge. [G8 Annex / 2.4.3.4.1]</p> <p>(3) The preparation and facilities for samples are to be taken into consideration so as to have as little adverse effects as possible on the organisms. [G8 Annex / 2.4.3.4.2]</p> <p>(4) Samples for measuring the following organism and bacteria are to be collected as separate samples each.</p> <p>(a) organisms greater than or equal to 50 μm in minimum dimension;</p> <p>(b) organisms greater than or equal to 10 μm and less than 50 μm in minimum dimension; and</p> <p>(c) Coliform group and coliform, enterococcus group and enterococcus, vibrio cholerae and vibrio cholera of toxin production (serotype O-1 and O-139) and heterotrophic bacteria.</p>	<ul style="list-style-type: none"> • If in any test cycle the discharge results from the control water is <u>of</u> a concentration less than or equal to 10 times the values in the ballast water performance standard, the test cycle is invalid. [G8 Annex / 2.4.3.4.5] • As for the treated water at the time of discharge, the number of viable organisms greater than or equal to 50 μm in minimum diameter in the replicate sample is to be less than 10 viable organisms per cubic metre. [G8 Annex / 4.7.2] • As for the treated water at the time of discharge, the number of viable organisms of greater than or equal to 10 μm and less than 50 μm in minimum dimension during replicate sampling are to be no greater than 10 per 1 ml. [G8 Annex / 4.7.3] • As for the treated water at the time of discharge, the number of the colony of vibrio cholera of toxin production (serotype O-1 and O-139) is to be less than 1 cfu per 100 ml, or less than 1 cfu per 1 g (wet weight) of zooplankton samples. [G8 Annex / 4.7.4] • As for the treated water at the time of discharge, the number of the colony of coliform in the replicate samples is to be less than 250 cfu per 100 ml. [G8 Annex / 4.7.5] • As for the treated water at the time of discharge, the number of the colony of enterococcus in the replicate samples is to be less than 100 cfu per 100 ml. [G8 Annex / 4.7.6] • No averaging of test runs cycles, or the discounting of failed test runs has occurred. [G8 Annex / 4.7.7] • It is valid in accordance with paragraph 11.5.5-3(1), 11.5.5-3(2), 11.5.5-3(4), and 11.5.7-1(2). [Annex / 4.7.1]
	<p>4. Analysis of the amount of sample water, organism and bacteria is to be carried out in accordance with the following:</p> <p>(1) For the enumeration of viable organisms greater than or equal to 50 μm or more in minimum dimension: [G8 Annex / 2.4.3.4.3.1]</p> <p>(a) Influent water is to be collected over the duration of uptake as one, time-integrated sample. The sample is to be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. The total sample volume is to be at least 1 m^3. If smaller volume is validated to ensure representative sampling of organisms, it may be used. Control and treated discharged water are to be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample</p>	<ul style="list-style-type: none"> • The live/dead judgement of the organism and the measurement of the number of viable organisms are to be according to the methods specified in Part 4 of the Annex of IMO Resolution MEPC.279(70) "2016 Guidelines for Approval of Ballast Water Management Systems (G8)" (as amended) the "BWMS Code" or methods which are deemed equivalent thereto by the Society.

Table 2.11-2 Methods and Acceptance Criteria of Land-based Testing (continued)

Test Items	Test Method	Acceptance Criteria
Land-based Testing	<p>or a composite of sequential samples, e.g. collected throughout the beginning, middle and end the operation. The total sample volume is to be at least 3 m³;</p> <p>(b) If samples are concentrated for enumeration, the organisms are to be concentrated using a mesh with holes no greater than 50 μm in the diagonal dimension. Only organisms greater than 50 μm in minimum dimension should <u>are to be enumerated</u>; and</p> <p>(c) The full volume of the sample is to be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method;</p> <p>(2) For the enumeration of viable organisms greater than or equal to 10 μm and less than 50 μm in minimum dimension: [GS Annex / 2.4.343.2]</p> <p>(a) Influent water is to be collected over the duration of uptake as one, time-integrated sample. The sample is to be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. A sample of at least 10 l is to be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 l. A minimum of three, 1 ml sub-samples is to be analysed in full to enumerate organisms. Control and treated discharged water are to be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end the operation. A sample of at least 10 l is to be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 l. A minimum of six, 1 ml sub-samples are to be analysed in full to enumerate organisms.</p> <p>(b) The sample may not be concentrated for analysis unless the procedure is validated. <u>Only organisms greater than 10 μm and less than 50 μm in minimum dimension are to be enumerated.</u></p>	Ditto

Table 2.11-2 Methods and Acceptance Criteria of Land-based Testing (continued)

Test Items	Test Method	Acceptance Criteria
Land-based Testing	<p>(c) The full volume of the sample is to be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method;</p> <p>(3) For the evaluation of bacteria: [GS Annex / 2.4.343.3]</p> <p>(a) For the influent and discharge samples, a minimum 10 l sample referred to in -2(2)(a) of test method in Table 2.11-3, or another sample at least 10 l in volume and collected in a similar manner, a sub-sample of minimum 1 l may be transferred to a sterile container for analysis;</p> <p>(b) A minimum of three, subsamples of appropriate volume taken from the 1 l subsample described above (a) are to be analysed for colony forming units of bacteria listed in the ballast water performance standard.</p> <p>(4) The samples are to be analysed for viable organisms within 6 hours of being taken or treated in such a way so as to ensure that proper analysis can be performed. [GS Annex / 2.4.3544]</p>	Ditto

Notes:

The order of (*1) and (*2): To be taken using the actual treatment method of the *BWMS*.

(*3) The control cycle: The leading cycle of the influent water from the source tank to the control tank.

(*4) The treatment cycle: The leading cycle of the influent water from the source tank to the control tank through the *BWMS*.

11.5.6 Shipboard Testing

During shipboard testing, it is to be verified that the entire *BWMS* is in good working order and complies with the ballast water performance standard on a ship in which it is actually in use.

1 Testing ~~Conditions~~ Requirements

- (1) Shipboard testing is to be carried out in accordance with the test plan. Shipboard testing of *BWMS* is to be conducted by the test facility, independent of the *BWMS* manufacturer, with the system being operated and maintained by the ships' crew as per ~~the operational manual~~ the operation, maintenance and safety manual. [~~G8 Annex / 2.3.27~~]
- (2) ~~Following documents are to be submitted~~ In evaluating the performance of *BWMS* installation(s) on a ship or ships, the following information and results are to be supplied to the satisfaction of the Society. [Annex / 2.8]
 - (a) Test plan to be provided prior to testing; [Annex / 2.8.1]
 - ~~(a)~~ (b) Documentation that an inline *BWMS* is of a capacity to reflect the flow rate of the ballast water pump for the full rated capacity range *TRC* of the *BWMS*; [~~G8 Annex / 2.3.38.2~~]
 - ~~(b)~~ (c) Documentation that an in-tank *BWMS* is of a capacity to reflect the ballast water volume that it is intended to treat within a specified period of time; [~~G8 Annex / 2.3.38.3~~]
 - ~~(3)~~ (d) The amount of ballast water tested during shipboard testing is to be consistent with the normal ballast operations of the ship; [~~G8 Annex / 2.3.38.4~~]
 - (e) Documentation showing that the discharge of each valid test cycle was in compliance with the ballast water performance standards. For a test to be valid, the uptake water for the ballast water to be treated is to contain a density of viable organisms exceeding 10 times the maximum permitted values in 3.2(1) and (2), Part 3 of the Rules for Ballast Water Management Installations; [Annex / 2.8.5]
 - (f) Sampling regime and volumes for analysis (refer to -2 in Table 2.11-3); [Annex / 2.8.6]
- ~~(43)~~ The discharge of treated ballast water in three consecutive valid test cycles is to be in compliance with the ballast water performance standard. Three consecutive test cycles in compliance with the ballast water performance standard are to be performed. Any invalid test cycle does not affect the consecutive sequence. [~~G8 Annex / 2.3.398.8~~]
- ~~(5)~~ The uptake water for the ballast water to be treated is to contain a density of viable organisms exceeding 10 times the maximum permitted values in the ballast water performance standard. [~~G8 Annex / 2.3.3.6~~]
- ~~(65)~~ (5) The test cycles, including invalid and unsuccessful test cycles, are to span a trial period of not less than six months. The six-month shipboard test period starts and ends with the completion of a successful test cycle or invalid test cycle that meets the ballast water performance standard. The three consecutive and valid test cycles that are required in specified in (43) above are to be suitably separated across the six-month period. [~~G8 Annex / 2.3.38.7, 2.3.3.108.9~~]
- ~~(76)~~ (6) The quality of water such as *pH*, temperature, salinity, dissolved oxygen, *DOC*, *POC*, *TSS* and turbidity is to be measured and recorded at the time the samples are taken. The source water for test cycles is to be characterized by measurement of salinity, temperature, *POC*, *TSS* and *DOC*. [~~G8 Annex / 2.3.3.118.10~~]
- ~~(87)~~ (7) The following items relevant to the *BWMS* are to be recorded provided during the shipboard testing: [~~G8 Annex / 2.3.3.128.11~~]
 - (a) Documentation of *B*allast water operations including the volumes and locations (port or location information) of uptake and discharge, and if heavy weather was encountered; [Annex / 2.8.11.1]
 - (b) Investigations and reports of the possible reasons for the occurrence of an ~~unsuccessful~~ invalid test cycle, or a test cycle discharge failing the ballast water performance standard; [Annex / 2.8.11.4]

- (c) ~~A record~~ Documentation of any scheduled maintenance and repairs performed on the *BWMS* during the testing; [Annex / 2.8.11.5]
- (d) ~~The operation record~~ Documentation of any engineering parameters (e.g., treatment flow rate, *UV* transmission, concentration of injection medicine, filter differential pressure, concentration of total residual oxidants (*TRO*) and power consumption, etc.) which affected the *BWMS*; [Annex / 2.8.11.7]
- (e) A report detailing the functioning of the control and monitoring equipment of the *BWMS*; [Annex / 2.8.11.8]
- (f) Documentation that the *BWMS* was operated continuously throughout the test period for all ballasting and deballasting of the ship; ~~and~~ [Annex / 2.8.11.2]
- (g) Documentation detailing water quality parameters identified by the testing organization, that should be measured as appropriate and practicable. [Annex / 2.8.11.3]
- (h) Documentation of unscheduled maintenance and repair performed on the *BWMS* during the test period; [Annex / 2.8.11.6]

2 Test Items

The test method and acceptance criteria are shown in **Table 2.11-3**.

Table 2.11-3 Test Method and Acceptance Criteria of Shipboard Testing

Test items	Test method	Acceptance criteria
Shipboard testing	<p>1 A shipboard test cycle includes steps (1) to (4) below: [G8 Annex / 2.3.3.6]</p> <p>(1) The uptake of ballast water of the ship;</p> <p>(2) The storage of ballast water on the ship during a voyage*¹;</p> <p>(3) The treatment of the ballast water <u>in accordance with paragraph 11.5.6-1(3)</u>, except in control tanks*²; and</p> <p>(4) The discharge of ballast water from the ship.</p>	<ul style="list-style-type: none"> • No contamination by sea water and leakage from tanks, etc. is observed. • The <i>BWMS</i> is operated at the <i>TRC</i> described in the test plan.
	<p>2 Samples are to be taken in accordance with the following, and the analysis of the organisms and bacteria included in each sample is to be carried out.</p> <p>(1) For the enumeration of viable organisms greater than or equal to 50 μm or more in minimum dimension: [G8 Annex / 2.3.3.78.6.1]</p> <p>(a) Influent water is to be collected over the duration of uptake as one, time-integrated sample. The sample is to be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. The total sample volume should <u>is to be</u> at least 1 m^3. If a smaller volume is validated to ensure representative sampling of organisms, it may be used. Treated discharged water is to be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end the operation. The total sample volume is to be at least 3 m^3.</p> <p>(b) If samples are concentrated for enumeration, the organisms are to be concentrated using a mesh with holes no greater than 50 μm in the diagonal dimension. Only organisms greater than 50 μm in minimum dimension are to be enumerated.</p> <p>(c) The full volume of the sample is to be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method.</p> <p>(2) For the enumeration of viable organisms greater than or equal to 10 μm and less than 50 μm in minimum dimension: [G8 Annex / 2.3.3.78.6.2]</p> <p>(a) Influent water is to be collected over the duration of uptake as one, time-integrated sample.</p>	<ul style="list-style-type: none"> • The viable organism concentration contained in the uptake water (limited to organisms greater than or equal to 50 μm in minimum dimension and organisms greater than or equal to 10 μm and less than 50 μm) exceeds 10 times the value of the ballast water performance standard. [G8 Annex / 2.3.3.68.5, 4.7.1] • The density of organisms greater than or equal to 50 μm in minimum diameter in the replicate samples is less than 10 viable organisms per cubic meter upon discharge. [G8 Annex / 4.7.2] • The density of organisms less than 50 μm and greater than or equal to 10 μm in minimum diameter in the replicate samples is less than 10 viable organisms per milliliter <u>ml</u> upon discharge. [G8 Annex / 4.7.3] • The density of vibrio cholera (serotype O-1 and O-139) is less than 1 <i>cfu</i> per 100 <i>ml</i>, or less than 1 <i>cfu</i> per 1 g (wet weight) zooplankton samples upon discharge. [G8 Annex / 4.7.4] • The density of <i>E.coli</i> in the replicate samples is less than 250 <i>cfu</i> per 100 <i>ml</i> upon discharge. [G8 Annex / 4.7.5] • The density of intestinal enterococci in the replicate samples is less than 100 <i>cfu</i> per 100 <i>ml</i> on discharge. [G8 Annex / 4.7.6] • Determination of the viability and the enumeration of viable organism concentration is to be carried out in accordance with Part 4 of the IMO Res. MEPC.279(70) "2016 Guidelines for Approval of Ballast Water Management Systems (G8)", as amended "<i>BWMS Code</i>" or by methods which are deemed equivalent by the Society. • No averaging of test runs <u>cycles</u>, or the discounting of failed test runs has occurred. [G8 Annex / 4.7.7]

Table 2.11-3 Test Method and Acceptance Criteria of Shipboard Testing (continued)

Test items	Test method	Acceptance criteria
Shipboard testing	<p>The sample is to be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. A sample of at least 10 l is to be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 l. A minimum of three, 1 ml sub-samples should <u>is to</u> be analysed in full to enumerate organisms. Treated discharged water is to be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end the operation. A sample of at least 10 l is to be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 l. A minimum of six, 1 ml subsamples are to be analysed in full to enumerate organisms.</p> <p>(b) The sample may not be concentrated for analysis unless the procedure is validated. <u>Only organisms greater than 10 µm and less than 50 µm in minimum dimension are to be enumerated; and</u></p> <p>(c) The full volume of the sample is to be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method.</p> <p>(3) For the evaluation of bacteria: [68 Annex / 2.2.2.78.6.3]</p> <p>(a) For the influent and discharge samples, the minimum 10 l sample referred to in paragraph above 2(2)(a), or another sample at least 10 l in volume and collected in a similar manner <u>is to be used</u>, a sub-sample of minimum 1 l may be transferred to a sterile container for analysis.</p> <p>(b) A minimum of three, subsamples of appropriate volume taken from the 1 l subsample described above (a) are to be analysed for colony forming units of bacteria listed in the ballast water performance standard.</p>	Ditto

Note:

The order of (*1) and (*2) : To be taken using the actual treatment method of the BWMS.

11.5.7 Temperature Testing

1 The effective performance of *BWMS* through a ballast water temperature range of 0°C to 40°C (2°C to 40°C for fresh water) is to be verified as follows.

- (1) Testing on a low-range temperature (the lowest possible temperature between 0°C and 10°C), a mid-range temperature (between 10°C and 20°C) and a high-range temperature (the highest possible between 20°C and 40°C) [~~GS Annex / 2.5.146~~]
- (2) Testing during land-based, shipboard, laboratory or bench-scale testing and/or the use of existing data and/or models, provided that their source, suitability and reliability is reported. [~~GS Annex / 2.5.247~~]

2 The report submitted to the Society is to contain all documentation (including procedures, methods, data, models, results, explanations and remarks) associated with the temperature assessment. The report is to include at least the information identified in 11.6.1.

11.5.8 Evaluation of Regrowth Testing

1 Evaluation of regrowth testing is to be conducted as follows. The evaluation of it is not intended to evaluate contamination in ballast tanks or piping, such as may arise from the presence of untreated water or residual sediments. Moreover, any neutralization of ballast water required by the *BWMS* is to occur at the end of the holding time, and immediately before the enumeration of organisms. [~~GS Annex / 2.6.53, 2.6.654~~]

- (1) The evaluation of the regrowth of organisms is to be undertaken to the satisfaction of the Society in land-based and/or shipboard testing in at least two test cycles in each salinity. [~~GS Annex / 2.6.449~~]
- (2) In the case of land-based testing being performed with a holding time of less than five days, a sufficient volume of treated uptake water is to be held under conditions similar to conditions in the relevant holding tank. In the case of shipboard testing, water is to be retained on board for the evaluation of regrowth during a shipboard test cycle. Additional bench-scale testing may be used to supplement the land-based and/or shipboard testing. [~~GS Annex / 2.6.250~~]
- (3) In the case of a *BWMS* that includes mechanical, physical, chemical, and/or biological processes intended to kill, render harmless, or remove organisms within ballast water at the time of discharge or continuously between the time of uptake and discharge, regrowth is to be assessed in accordance with section land-based testing specified in 11.5.5 ~~and~~ shipboard testing specified in 11.5.6 with a holding time of at least five days. [~~GS Annex / 2.6.351~~]
- (4) Otherwise, the enumeration of organisms to assess regrowth is to be undertaken at least five days after the completion of all of the mechanical, physical, chemical, and/or biological processes intended to kill, render harmless, or remove organisms within ballast water. [~~GS Annex / 2.6.452~~]

2 A report is to be submitted to the Society containing all documentation (including procedures, methods, data, models, results, explanations and remarks) associated with the evaluation of regrowth. The report is to include at least the information identified in 11.6.1.

11.5.9 Cautions During the Type Approval

- (1) The Society may allow replacements of non-major components of equivalent specification (independently approved to a recognized and equal operational standard) during type approval. Replacements of non-major components during testing are to be reported in test records specified in 11.6.1. [Annex / 1.11]
- (2) Upgrades of the *BWMS* that relate to the safe operation of that system may be allowed during and after type approval by the Society and are to be reported. If such safety upgrades directly affect the ability of the system to meet the ballast water performance standards, it is to be treated as a change of a major component, as 11.3.4. [Annex / 1.12]

11.6 Approval

11.6.1 Test Records

1 The manufacturer is to prepare records of the approval test after completion of the test, to obtain verification by the Society's attending surveyor and then to submit them, in triplicate, to the Society. Then, following items are to be incorporated. [~~G8 Annex / 2.6.7, 2.7.1, 2.7.2, 2.7.4, 6.6~~]

- (1) The name and address of the laboratory performing or supervising the inspections, tests or evaluations, and its national accreditation or quality management certification, if appropriate; [Annex / 2.57.1]
- (2) The name of the manufacturer, and the trade name, product designation (such as model numbers), and a detailed description of the equipment or material inspected, tested or evaluated; [Annex / 2.57.2, 2.57.3]
- (3) The time, date, and place of each approval inspection, test or evaluation; [Annex / 2.57.4]
- (4) The name and title of each person performing, supervising, and witnessing the tests and evaluations; [Annex / 2.57.5]
- (5) Executive summary, introduction and background; [Annex / 2.57.6, 2.57.7]
- ~~(6) All test results related to 11.5.3;~~
- ~~(7)~~ Test results for each test cycle including followings. [Annex / 2.57.8]
 - (a) Experimental design, methods and procedures; [Annex / 2.57.8.1, 2.57.8.2]
 - (b) Results and discussion, including a description of any invalid test cycle and a comparison to the expected performance; [Annex / 2.57.8.3]
 - (c) In the case of land-based testing, test conditions including details on challenge water preparation in line with 11.5.5-3; [Annex / 2.57.8.4]
- ~~(8)~~ Any of the following documents related to the inspections, tests or evaluation. [Annex / 2.57.9]
 - (a) A description or photographs of the procedures and apparatus;
 - (b) A reference to another document that contains an appropriate description or photographs;
- ~~(9)~~ At least one photograph that shows an overall view of the equipment or material tested, inspected or evaluated and design details. [Annex / 2.57.10, 2.57.10.1]
- ~~(10)~~ Photographs that show each occurrence of damage or deformation to the equipment or material that occurred during the approval tests or evaluations. [Annex / 2.57.10.2]
- ~~(11)~~ The operational safety requirements of the *BWMS* and all safety related findings that have been made during the inspections, tests or evaluations. [Annex / 2.57.11]
- ~~(12)~~ An attestation that the inspections, tests or evaluations were conducted as required and that the report contains no known errors, omissions, or false statements. The attestation must be signed by the chief officer of the laboratory, or the chief officer's representative. [Annex / 2.57.12]
 - ~~(a) The manufacturer or manufacturer's representative, if the inspection, tests or evaluations are conducted by the manufacturer; or~~
 - ~~(b) The chief officer of the laboratory, or the chief officer's representative, if the inspection or tests were conducted by an independent laboratory;~~
- ~~(13)~~ Appendices, including: [Annex / 2.57.13]
 - (a) The complete test plan and the data generated during tests and evaluations reported under above ~~(7)~~, including at least: [Annex / 2.57.13.1]
 - i) For land-based tests, whether ambient, cultured or a mixture of test organisms have been used (including a species-level identification for cultured organisms, and an identification to the lowest possible taxonomic level for ambient organisms); [Annex / 2.57.13.1.1]
 - ii) For shipboard tests, the operating parameters of the system during successful

treatment operations (e.g. dosage rates, ultraviolet intensity and the energy consumption of the *BWMS* under normal or tested ~~Treatment Rated Capacity~~ *TRC*, if available); [Annex / 2.57.13.1.2]

iii) For ~~System Design Limitations~~ *SDL*, details of all procedures, methods, data, models, results, explanations and remarks, leading to validation; and [Annex / 2.57.13.1.3]

iv) Invalid test information; [Annex / 2.57.13.1.4]

(b) The *QMP*, the *QAPP* and Quality Assurance and Quality Control records; [Annex / 2.57.13.2]

(c) Maintenance logs including a record of any consumable components that were replaced; and [Annex / 2.57.13.3]

(d) Relevant records and tests results maintained or created during testing. [Annex / 2.57.13.4]

(13) The test report is to include all test specified in **11.5.3**. [Annex / 2.59]

(14) Other documents deemed necessary by the Society

2 The results of biological efficacy testing of the *BWMS* are to be accepted if during the land-based and shipboard testing conducted as specified in sections “Shipboard tests” specified in **11.5.6** and “Land-based testing” specified in **11.5.5** it is shown that the system has met the ballast water performance standards and that the uptake water quality requirements were met in all individual test cycles as provided in [Annex / 4.7.1] to [Annex / 4.7.2] in **Table 2.11-2** and **Table 2.11-3**. [Annex / 2.58]

11.6.2 Notification of Approval

‡ The Society, when satisfied upon examination of the submitted documents and the attending surveyor’s report, will issue a certificate of approval specifying the approval number, approval date, items of approval (the model name, manufacture, type, relevant drawings name and relevant drawings number of the *BWMS*) and approval conditions (operating condition and *SDL* etc). ~~In addition, the Society will affix approval stamps onto documents it deems necessary out of those submitted in accordance with **11.2**, and return them back to the applicant. [~~G8~~ 5.4, 5.5, 6.1, 6.2, 6.3, 6.4, 6.5]~~ [~~G8~~ Annex / 7.1]

11.6.3 Renewal of Approval

1 The term of validity of approval in the preceding **11.6.2** will be 5 years. [~~G8~~ 6.8]
(-2 and -3 are omitted.)

11.6.4 Revocation of Approval

(Omitted)

11.7 Examination of Products

11.7.1 Examination of Products

(Omitted)

11.8 Announcement of Approval

11.8.1 Announcement of Approval

(Omitted)

EFFECTIVE DATE AND APPLICATION (Amendment 1-3)

1. The effective date of the amendments is 13 October 2019.

Part 4 NON-METALLIC MATERIALS AND COATING MATERIALS FOR HULL

Chapter 1 APPROVAL OF FIRE PROTECTION MATERIALS

1.1 General

Paragraph 1.1.1 has been amended as follows.

1.1.1 Scope

The requirements of this Chapter apply to the tests and inspections for the approval of fire protection material specified in (1) through (~~10~~**11**) below in accordance with the requirements of **Part P and Part R of the Rules for the Survey and Construction of Steel Ships** (hereinafter referred to as “the Rules”).

- (1) Non-combustible materials
- (2) “A” class divisions
- (3) “B” class divisions
- (4) Continuous “B” class divisions
- (5) Fire retardant base materials
- (6) Fire retardant veneers
- (7) Fire retardant surface floorings
- (8) Primary deck coverings
- (9) Fire retardant coatings
- (10) Low smoke generation materials
- (11) “H” class divisions

1.2 Definitions

Paragraph 1.2.14 has been added as follows.

1.2.14 “H” class divisions

1 “H” class divisions are the divisions defined in 1.2.35, Part P of the Rules.

2 “H” class divisions are classified into four ratings according to temperature conditions: “H-60” rating, “H-30” rating, “H-15” rating and “H-0” rating.

1.3 Requirements

Paragraph 1.3.13 has been added as follows.

1.3.13 “H” class divisions

1 The test procedures for “H” class divisions are in accordance with “Test for “H” Class Divisions” specified in 1.13.9.

2 Documents specified in 1.3.2-2 are to be submitted.

1.4 Application Procedure for Approval

1.4.3 Submission of Attached Documents to the Application

Sub-paragraph -1(7) has been amended as follows.

1 When obtaining the approval of fire protection materials other than fire retardant coatings, the documents including the following data are submitted to the Society together with the application specified in **1.4.1**:

((1) to (6) are omitted.)

(7) Test report of the required fire tests specified in **1.3.1** through **1.3.123**

((8) to (10) are omitted.)

1.10 Periodical Test

1.10.2 Periodical Tests for Approved Materials other than Fire Retardant Coatings

Sub-paragraph -2 has been amended as follows.

2 The tests specified in **1.3.1** to **1.3.8** as well as **1.3.10** to **1.3.123** are to be carried out. However, the tests may be omitted in accordance with the provision 5.2 or 8.3 of the *FTP* Code if the Society considers appropriate.

1.13 Test Procedures

Paragraph 1.13.9 has been added as follows.

1.13.9 Test for “H” Class Divisions

Test procedures for “H” class divisions are to be equivalent to the requirements specified in 1.13.3 “Test for “A” class divisions”. However, with respect to these requirements, one of the furnace control temperature curves specified in the following standards is to be used.

(1) *BS EN 1363-2:1999 “Fire resistance tests Alternative and additional procedures”*

(2) *ASTM E1529-14a “Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies”*

(3) *ISO 20902-1 “Fire test procedures for divisional elements that are typically used in oil, gas and petrochemical industries – Part 1: General requirements”*

EFFECTIVE DATE AND APPLICATION (Amendment 1-4)

1. The effective date of the amendments is 1 January 2020.
2. Notwithstanding the amendments to the Guidance, the current requirements apply to ships the keels of which were laid or which were at *a similar stage of construction* before the effective date.

(Note) The term “*a similar stage of construction*” means the stage at which the construction identifiable with a specific ship begins and the assembly of that ship has commenced comprising at least 50 tonnes or 1% of the estimated mass of all structural material, whichever is the less.