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Ships and marine technology — Aquatic nuisance species —

Part 2: Ballast water sample collection and handling

Navires et technologie maritime — Espèces aquatiques nuisibles —

Partie 2: Prélèvement et manipulation des échantillons d'eau de ballast

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

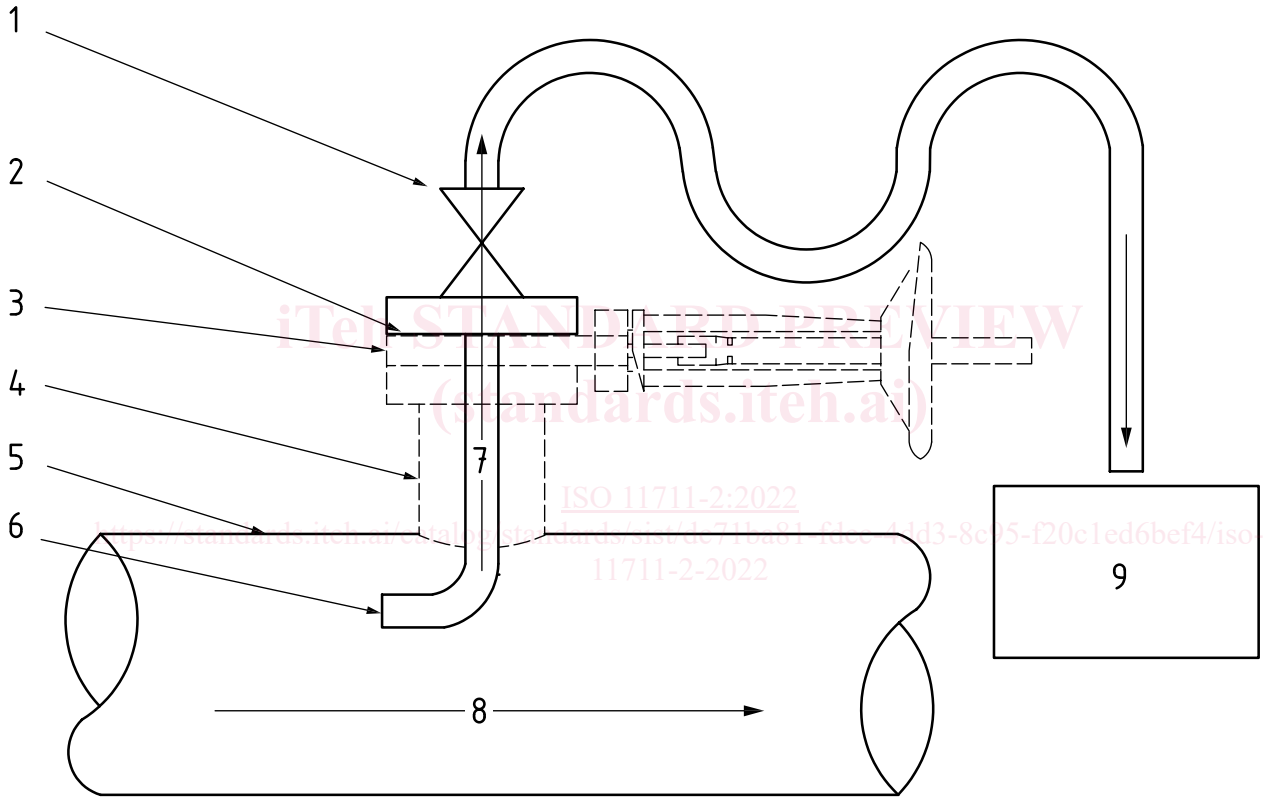
This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*.

A list of all parts in the ISO 11711 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The sampling guidance provided by the ISO 11711 series is intended to standardize the measurement of organism concentrations through sampling of a ship's ballast discharge consistent with the requirements of the International Maritime Organization (IMO) Regulation D-2[1]. The ISO 11711 series currently includes two parts, where ISO 11711-1 provides guidance on the shipboard arrangements for piping and fittings necessary for sampling and return ports, and standardizes the presentation of the sampling port to accommodate various sampling probe configurations. This document addresses the process of collecting and processing ballast water samples for subsequent analysis such as required for type approval, according to IMO Resolution MEPC.300(72) (BWM Code)[2]. It provides guidance to ballast water sampling teams and other concerned parties on the apparatus, installation, and procedures required to obtain representative samples of ballast water discharges from sample ports on a ship. These concepts are illustrated in Figure 1.



Key

1	sample collection device isolation valve	6	sample probe
2	sample port access flange	7	sample water flow
3	sample port valve	8	ballast water flow
4	sample port	9	sample collection device
5	ballast discharge pipe		

– – – – ISO 11711-1 Ballast water sample port - fitting arrangements

——— ISO 11711-2 On-board ballast water sampling and sample processing

NOTE 1 Figure not to scale.

NOTE 2 The figure shows a sample port arranged perpendicular to the main ballast flow.

NOTE 3 See Annex A for examples of configurations of sample collection devices and their connection to ballast piping.

Figure 1 — Illustration of the scopes of ISO 11711-1 and 11711-2

Specifically, this document defines appropriate sample probe and sample flow control to achieve representative sampling and minimize measurement uncertainty consistent with measurement requirements. Appropriate sample volumes and collection times provide statistical confidence for viable organism counts at the discharge limit. Regulation D-2[1] requires the measurement of two organism size classes: ≥10 µm and <50 µm (<10 organisms ml^{-1}) and ≥50 µm (<10 organisms m^{-3}), and three indicator microbes: toxigenic *Vibrio cholera*e (serotypes O1 and O139, <1 cfu 100 ml^{-1} or <1 cfu g^{-1} wet weight zoopl.), *Escherichia coli* (<250 cfu 100 ml^{-1}), and intestinal enterococci (<100 cfu 100 ml^{-1}). Sampling approaches for each are provided, where both indicative and detailed analyses of viable organisms are supported, as defined by BWM.2/Circ.42/Rev.2 [3], as may be amended, and considering the criteria in ISO 17025 for quality management, measurement uncertainty, and standardized procedures. The ISO 11711 series does not intend to add any requirements to the BWM Convention or related documents of IMO but provides supplemental guidance for sampling of ballast water.

Ships and marine technology — Aquatic nuisance species —

Part 2: Ballast water sample collection and handling

1 Scope

This document provides requirements and recommendations to ballast water sampling teams or other concerned parties on the selection and use of sampling apparatus to collect and process ballast water discharge samples aboard a ship from sample ports installed in accordance with ISO 11711-1. It includes an overview of the sampling process, and a discussion on the design and maintenance of sample probes, the necessary sample flow rates, the sample collection devices that incorporate sample flow control to maintain representative sampling conditions, and the handling of samples for subsequent analyses.

This document primarily addresses the collection of ballast water discharge samples. However, it can also be applied to uptake samples with consideration of appropriate sample volumes given anticipated organism concentrations in ambient (as opposed to treated) waters.

NOTE While this document is focused on installations aboard a ship, it can be used for land-based facilities.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

MEPC.173(58), *Guidelines for Ballast Water Sampling* (G2)

ISO 5667-3, *Water quality — Sampling — Part 3: Preservation and handling of water samples*

ISO 11711-1:2019, *Ships and marine technology — Aquatic nuisance species — Part 1: Ballast water discharge sample port*

ISO 17602, *Ships and marine technology — Metal valves for use in flanged pipe — Face-to-face and centre-to-face dimensions*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
absolute pore size
pore size based on empirical measurements of the pores in a *filter* (3.9)

3.2
capture efficiency
measurement of organism retention in a sample collection apparatus, typically expressed as a percentage

3.3
closed loop configuration
sampling arrangement that returns the filtered water to the ballast discharge pipe

3.4
closed system
sample collection device (3.23) that houses a *filter* (3.9) within a sealable container having inlet and outlet connections

Note 1 to entry: The filter used to concentrate organisms is typically made of metal or nylon mesh (see 6.1.3).

Note 2 to entry: A closed system can be operated in either *open loop configuration* (3.19) or *closed loop configuration* (3.3).

3.5
collection container
container used to obtain, hold, and transport water samples

3.6
concentration factor
ratio of *filtrate* (3.11) volume to *filtrand* (3.10) volume

3.7
depth filtration
filtration method where particles are captured within the filter media rather than on the surface of the *filter* (3.9)

3.8
effective surface area
filter (3.9) area available for filtration

3.9
filter
barrier that is introduced to retain organisms and particles of a given size while smaller particles are allowed to pass through

3.10
filtrand
concentrated sample, used in whole or in part for analysis, that is collected during the concentration process

3.11
filtrate
water that passes through a *filter* (3.9)

3.12
filtration velocity
flow velocity (3.13) through *filter* (3.9) pores

Note 1 to entry: In SI units, this parameter is expressed in metres per second.

3.13
flow velocity
distance travelled by a fluid per unit time (independent of any pipe dimensions)

Note 1 to entry: In SI units, this parameter is expressed in metres per second.

3.14
hot-tap sample probe assembly
sample probe assembly that can be installed into and removed from a water-filled, pressurized ballast pipe

3.15
maximum allowable working pressure
MAWP
maximum pressure that the weakest component in a pressurized system is designed to withstand

3.16
measurement requirement
specific requirement needed to support the purpose of the measurement, including sample timing, volume, duration, a specific ballast tank or sampling location, and acceptable measurement uncertainty

Note 1 to entry: See 4.3.2.

3.17
nominal pore size
pore size specified by the *filter* (3.9) manufacturer to identify the size of particles typically retained by the filter

3.18
open loop configuration
sampling arrangement that returns the filtered water to an unpressurized container (e.g. a bilge)

3.19
open system
sample collection device (3.24) that houses a *filter* (3.9) within an open container, e.g. an open tank with a *plankton net* (3.21)

3.20
operation, maintenance, and safety manual
OMSM
reference manual supplied by the manufacturer for a ballast water management systems (BWMS) product that identifies factors that affect the operation of the BWMS, including any warm-up or other requirements that must be completed to achieve operational stability

Note 1 to entry: The OMSM specifies what constitutes stable operating conditions for the BWMS, factors that can affect operating conditions, and any adjustments required to reach or to maintain a stable operating condition.

3.21
plankton net
conical *filter* (3.9) device that collects organisms in a removable cod endNote 1 to entry: the filter material is a fabric net with a specific pore size, and the device can be towed in open waters or used as a filter in an *open system* (3.19) for organism concentration

3.22
representative sampling
sampling methodology that obtains concentrations and compositions of constituent materials and organisms that are in the proportions and physical state of the source volume of interest

Note 1 to entry: In the case of ballast water sampling, representative conditions are considered under fully turbulent flow, where an appropriate sited sample probe obtains a sample at a *flow velocity* (3.13) of 0,25 to 1 times the flow velocity of the water in the ballast discharge pipe, thus sample flow is isokinetic or sub-isokinetic [4], [5].

3.23
sample collection device
device that can concentrate and collect the larger class of organisms [via a *filter* (3.9) or *plankton net* (3.21)], collect a whole water sample, or both

Note 1 to entry: A sample collection device can consist of multiple individual systems, e.g. multiple *closed systems* (3.4), each housing a filter.

[SOURCE: ISO 11711-1:2019, 3.13, modified — Note 1 to entry has been added]

3.24
sample collection team
personnel responsible for setting up the *sample collection device* (3.23), collecting and retrieving the ballast water samples

3.25
sample collection device isolation valve
full port valve used to isolate the *sample collection device* (3.23) from the ballast discharge pipe

3.26
sample flow control valve
valve used to regulate the sample flow rate

3.27
sample hold time
duration between end of sample collection and start of analysis

3.28
sample probe bend radius
radius of the curvature in the sample probe, as measured at the centreline

3.29
sample probe insertion length
distance from the diametric centre of the sample probe entrance to the sample port access flange when installed into the ballast discharge pipe

3.30
sample probe opening
entrance through which the water from the ballast discharge pipe enters the sample probe

3.31
test cycle
testing iteration (including uptake, treatment, holding and discharge, as appropriate) under a given set of requirements used to establish the ability of a ballast water management system (BWMS) to meet the set discharge standards

[SOURCE: IMO MEPC.300(72), BWMS Code, 3.15]

3.32
testing organization
company, corporation, firm, enterprise, authority or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration, that conducts the testing of ballast water

[SOURCE: IEC 62507-1:2010, 3.17]

3.33
volumetric flow rate
volume of fluid passing per unit time, calculated from *flow velocity* (3.13) and cross section area

Note 1 to entry: In ballast water operations, this parameter is typically expressed in cubic metres per hour.

Note 2 to entry: In SI units, this parameter is expressed in cubic metres per second.

4 Sample collection process

4.1 General

The sampling team shall conduct shipboard sampling operations appropriate to the ship, its ballast system, and discharge procedures in accordance with IMO sampling guidance MEPC.173(58), Guidelines for Ballast Water Sampling (G2). Prior to sampling, essential information shall be collected to choose sampling equipment appropriate for the anticipated ballast discharge; ideally, this is done prior to boarding the ship, but this may not always be possible. Consultation and coordination with the ship's crew are necessary to understand ballast water management system (BWMS) operations, determine ballasting parameters, identify sampling locations (typically in a machinery space), install or remove the sampling equipment, and coordinate the start and stop of sampling during the ballast operations. Sampling parameters are dictated by the measurement requirements. For example, the timing for a type approval sampling event may be conducted over an entire discharge of a specific ballast tank, while collection of an indicative compliance sample may occur over a specified number of minutes from a tank of convenience.

In practice, activities of the sampling team shall be coordinated with the actions of the ship and crew. This is necessary both for safety and to schedule the collection and processing of ballast water samples. In preparation for sampling, the sample probe shall be installed in the shipboard sample port and connected to the sample collection apparatus. Similarly, the return port when present, is connected as needed. Selection of the sample probe and other sample collection apparatus appropriate for the ship discharge is determined by the sample collection team according to the guidance in this document, and the timing of sample collection is determined by the measurement requirements, as described in 4.3.2, for the ballast discharge.

Certain information regarding the ship's ballasting and ballast water management system is required by the sampling team in advance of the sampling event in order to determine the appropriate safety procedures, materials, equipment, and sample collection parameters. A sampling requirements worksheet is provided in Annex B to facilitate documenting this information. However, sampling teams requires additional information not identified in this document, so they shall also address logistics for ship access that are outside the scope of this document.

In general, the sampling process includes the following.

a) Installation of an appropriately sized sample probe into the ship's sample port.

b) Connection of the sample collection device, typically an open or closed sample system which can collect large volumes (≥1 m^3) of filtered water to analyse organisms ≥50 µm, and/or smaller volumes of whole water (≥10 l) to analyse smaller organisms.

c) Preparation of rinse water (microfiltered, free of organisms in the size class(es) of interest) from the ship's ballast water.

d) Collection of ballast water samples over a duration appropriate to the measurement requirements and ship operations.

e) Processing of collected samples.

f) Transport of samples for off-ship analyses, if necessary.

g) Disassembling, removing, and cleaning of sampling apparatus from the ship.

A minimum volume of 3 m^3 of filtered water to analyse organisms ≥50 µm is recommended; this volume is consistent with the requirements of BWMS type approval testing[2].

4.2 Fundamental principles

4.2.1 General

At all times, the sampling team shall consider safety of personnel and equipment when conducting shipboard operations. Any actions that require access or interaction with the ship's ballast system shall be performed in consultation with the ship's crew and in accordance with ship policy. Only the ship's crew or their delegate shall operate the ballast system or ship's equipment (e.g. electrical supply, bilges, pneumatic supplies).

The purpose and required statistical confidence of measurements dictate the sample collection timing (e.g. beginning, middle, end of the discharge), duration (i.e. collection time), volume collected, and volume analysed. Thus, these measurement requirements shall be defined by the sampling team for each sampling event; this document defines the necessary parameters but does not specify their values.

Sample collection apparatus and handling procedures shall be designed to collect representative samples under fully turbulent flow conditions and shall minimize effects on organisms and the potential for contamination. Sample probes shall be cleaned according to standard operating procedures (SOPs) and verified free of visual foreign matter prior to installation. The probes may be installed for the duration of the test cycle but should be removed for cleaning after no more than one week. Semi-permanent or permanent sample probes shall not be used for sample collection.

Flow measurement is required for both the ballast discharge flow and the sample collection flow. As internal dimensions of the ballast discharge pipe are not readily observable, measuring the flow velocity near the sample probe is preferred. Measurement using the ship's flow meter, the BWMS flow meter, or other direct measurement in a section of ballast discharge pipe with the same diameter and flow stream (e.g. at the return port) is also acceptable. Electronic logging of flow data are preferred to logging measurements by hand. Flow measurement device(s) shall be calibrated following the manufacturer's requirements and in accordance with the sampling team's protocols.

4.2.2 Sample collection flow, duration, and volume

The requirements for organism density resolution and measurement uncertainty shall dictate the sample volumes to be collected. The sample collection duration shall also be based on the end use requirements of the organism density measurement (e.g. port state control, type approval, general compliance). The uncertainty of a single sample event should be considered, as multiple sample events can reduce measurement uncertainty. Best practices shall be employed to avoid sampling bias in the selection of sampling times and sample handling protocols. Note that flow velocity is independent of the size of the pipe (and thus facilitates comparisons between different pipe sizes), while volumetric flow rate incorporates the cross-sectional area of the pipe; either term may be used.

Ship ballast discharge operations can dictate the time available for sample collection and the ballast discharge flow rates. The ballast discharge flow rate, ballast discharge pipe inner diameter, sample volume, and sample collection duration are parameters necessary to determine the appropriate sample collection flow velocity. To ensure isokinetic to sub-isokinetic conditions, the sample flow velocity shall be between the range of 0,25 to 1 times the ballast discharge flow velocity. The details for expansion from the G2 guidelines of 0,5 to 1 times flow velocity are given in Reference [5]. Sample collection flow velocity shall not exceed 3,0 m s^{-1} and subsequent sample handling shall minimize any effect on organism viability.

The volume of the sample that is analysed may be less than the volume of sample collected; the analysis volume shall be based on the methodology employed and the required statistical confidence of the measurement (see 4.3.2).

4.3 Preparation

4.3.1 General

The sample collection team shall determine the measurement-specific information discussed in this subclause prior to boarding the ship. Information describing the installed BWMS and its treatment process shall also be identified prior to boarding the ship. Any requirements for personal protective equipment shall be in accordance with the ship and the sampling organization. The sample collection worksheet in Annex B can be helpful as a template for documenting the measurement-specific information discussed below.

4.3.2 Measurement requirements and purpose of the sample

Measurement requirements shall specify measurement uncertainty and thus the minimum volume of sample collected for a given analysis method. The duration of the sample collection shall also be specified. In general, detailed measurements require suitable volumes in order to resolve concentrations of sparsely distributed organisms; this depends on the discharge limits for the organism size class. The required volumes, therefore, depend upon the reporting limit and uncertainty and therefore vary with analysis objectives. Special requirements (e.g. sampling of discharges from a specific tank) shall be identified during preparation for the sample collection and analysis activities. The purpose of the sample (i.e. regulatory, compliance, type approval, self-monitoring) generally drives the requirements for measurement uncertainty and identifies the waters to be sampled.

4.3.3 Ship access and sampling facilities in machinery spaces

Access shall be arranged in accordance with the ship's requirements (and local maritime authorities if necessary). The sample collection team shall communicate the requirements for the transport of the equipment to the ship, and request information on the ship's ballast system. As sampling locations are in machinery spaces, for example, the engine room of the ship, sampling apparatus shall be designed to be carried by hand or assembled in place unless other arrangements are made in advance. The information requested from the ship should identify the following.

- Special safety requirements in the space where the sample port is located (e.g. explosion proof).
- Compliance of the sample port with ISO 11711-1 (thus is also compliant with the G2 guidelines of BWM Convention).
- Type of port configuration (in-line, 45°, or 90°).
- Availability of a nearby return port, or arrangements for disposal of sampled water (e.g. volume of 1 m^3-3 m^3).
- Make, model, treatment processes, holding time (as stipulated on the type approval certificate), and treatment rated capacity of ballast water management system(s).
- Locations and types of any chemical injection in the ballast system.
- Availability of a piping diagram (e.g. photograph of the piping diagram from the ship's operation, maintenance, and safety manual).
- Ship power specifications:
  - distance of available outlets from sampling location,
  - plug configuration,
  - voltage, frequency, and current ratings for available outlets.
- Bench/table space availability for sample processing and analysis.

