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Ships and marine technology — Ballast water management systems (BWMS) —

Part 2: Risk assessment and risk reduction of BWMS using electrolytic methods

Navires et technologie maritime — Systèmes de gestion de l'eau de ballast (BWMS) —

Partie 2: Appréciation du risque et réduction du risque des BWMS qui utilisent des procédés électrolytiques

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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).

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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.*

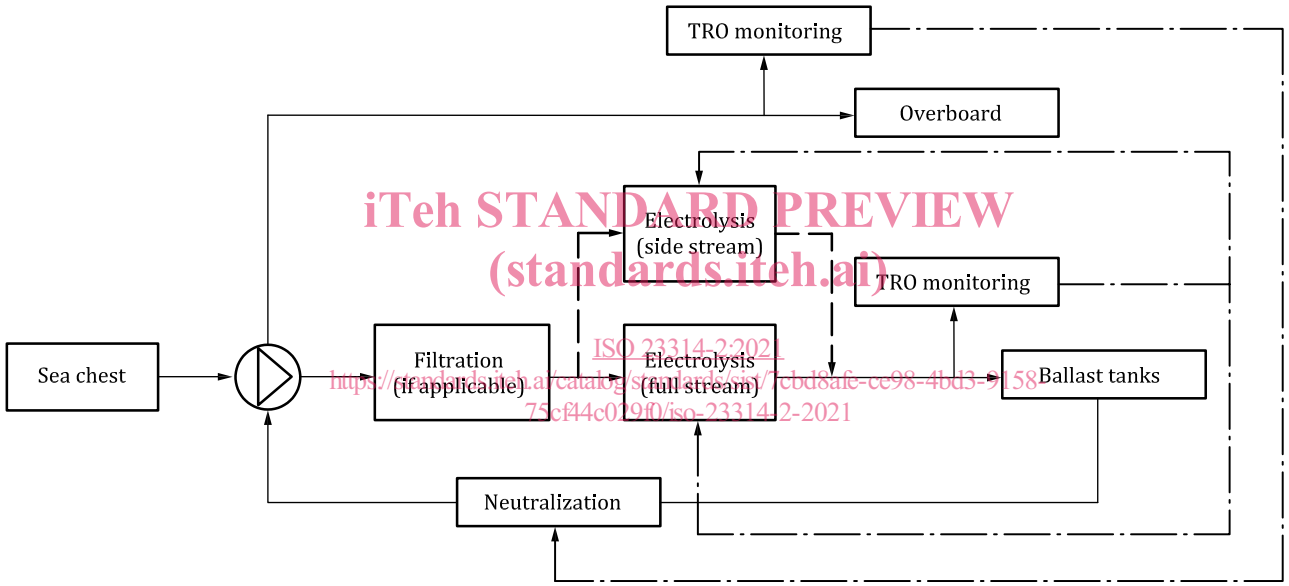
A list of all parts in the ISO 23314 series can be found on the ISO website.

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

A ballast water management system (BWMS) using the electrolytic method applies a combination of filtration (if applicable), electrolysis and a neutralization process to treat ballast water to meet Regulation D-2 of the International Maritime Organization (IMO) BWM Convention[19], or the ballast water discharge standard (BWDS) requirements of port state administrations, e.g. the U.S. Coast Guard (USCG)[31].

At the uptake of ballast water, the BWMS utilizes filtration (if applicable) and injection of active substances (e.g. sodium hypochlorite) generated by an electrolysis process. The active substance can be generated within the full flow of the ballast pipe (full stream) or generated from a smaller side stream (either extracted from the ballast pipe or sourced from a brine tank) and then mixed with the full ballast flow. The active substance in the ballast pipe is measured as total residual oxidants (TRO) and the BWMS regulates the TRO level to ensure ballast water is treated to the threshold level. During discharge, the residual TRO is monitored and neutralized prior to discharge overboard to ensure that the amount of residual active substance entering the receiving environment is acceptable. The treatment process is shown in Figure 1.



Key

_____ or — — — treatment flow

—·— feedback signal

Figure 1 — Overview of BWMS using the electrolytic method

Ships and marine technology — Ballast water management systems (BWMS) —

Part 2: Risk assessment and risk reduction of BWMS using electrolytic methods

1 Scope

This document provides requirements and recommendations for designers of BWMS using electrolytic methods to document the risk assessment and risk reduction process over the lifecycle of the equipment, and to support its approval for use on ships by administrations and classification societies. Specifically, this document provides basic terminology, principles and a methodology to identify and subsequently minimize the risk of hazards in the design of BWMS using electrolytic methods. It specifies the procedures for risk assessment and risk reduction following the guidance in ISO 12100. Risks considered include: human health and safety; marine environment related to conditions on board; and ship installation, operation, maintenance and structural integrity.

This document does not address the methodology for the risk assessment of corrosion effects, toxicity and ecotoxicity of active substances, relevant chemicals and/or other chemicals generated or used by BWMS using electrolytic methods, which is evaluated by the IMO GESAMP-Ballast Water Working Group as prescribed in the document IMO GESAMP, Methodology for the Evaluation of Ballast Water Management Systems using Active Substances[26].

This document does not address risks associated with the end of life disposition of the BWMS.

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.

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100 and the following 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
active substance
substance or organism, including a virus or fungus, that has a general or specific action on or against harmful organisms and pathogens

Note 1 to entry: For *BWMS* (3.3) using *electrolytic methods* (3.8), it means reaction products that are generated by the electrolytic method for the ballast water treatment.

[SOURCE: IMO G9]

3.2
ballast water
water with its suspended matter taken on board a ship to control trim, list, draught, stability or stresses of the ship

3.3
ballast water management system
BWMS
system that processes *ballast water* (3.2) such that it meets or exceeds the ballast water discharge performance standard in Regulation D-2 of the BWM Convention

Note 1 to entry: A BWMS includes ballast water treatment equipment, all associated control equipment, piping arrangements within the BWMS as specified by the manufacturer, control and monitoring equipment, and sampling devices.

Note 2 to entry: A BWMS does not include the ship's ballast water fittings, which can include piping, valves, pumps, etc. that would be required if the BWMS was not fitted.

Note 3 to entry: A ballast water treatment system (BWTS) defined in Environmental Technology Verification (ETV) is considered the same as BWMS.

[SOURCE: IMO BWMS Code]

3.4
dangerous gas
gas that can develop an explosive and/or toxic atmosphere hazardous to the crew and/or the ship

EXAMPLE Hydrogen (H_2), hydrocarbon gas, ozone (O_3), chlorine (Cl_2), chlorine dioxide (ClO_2).

3.5
electrical distribution conductor
conductor intended for distributing the electricity, such as bus bars or conductors of insulated cables

3.6
electrolysis unit
unit that mainly consists of one or several chambers making use of an *electrolytic method* (3.8) to produce *active substances* (3.1) for the treatment of *ballast water* (3.2), including ventilation components for the safe handling of *dangerous gases* (3.4) if applicable, as well as relevant piping, valves, electrical and electronic components

3.7
electrolytic chamber
chamber that contains one or several sets of electrodes and associated power connections, and that makes use of the *electrolytic method* (3.8) for the production of *active substances* (3.1) when water flows through it

3.8
electrolytic method
treatment process in which water flows through a set of special electrodes, producing *active substances* (3.1) when an electric current is applied

3.9
flammable liquid
liquid having a flash point not exceeding 60 °C (closed cup test)

3.10
global integrated shipping information system
GISIS
public integrated information database developed by the IMO, which is composed of several modules that deal with ship particulars, maritime safety, chemicals associated with treated *ballast water* (3.2) and other shipping-related information

3.11
life cycle
entire lifespan from the design, manufacturing, storage, installation, to operation and disposal of a *BWMS* (3.3)

3.12
maximum allowable discharge concentration
MADC
maximum allowable concentration of *active substances* (3.1) during discharge of *ballast water* (3.2) as defined by port state control or local regulation

3.13
neutralization unit
unit that mainly consists of neutralizing agent preparation and dosing equipment for the purpose of neutralizing *active substances* (3.1) by adding neutralizing agent into the de-ballast pipe so as to reduce *TRO* (3.14) concentration to achieve compliance with the *MADC* (3.12)

3.14
total residual oxidant
TRO
sum of the effect of oxidizing chemicals, such as hypochlorous acid (HClO), hypochlorite (ClO), chlorine (Cl_2), hypobromous acid (HBrO), hypobromite (BrO), bromine (Br_2), chloramine compounds, bromine compound

4 Strategy for risk assessment and risk reduction

The process for risk assessment and risk reduction is based on guidance from ISO 12100 and is summarized in Figure 2.

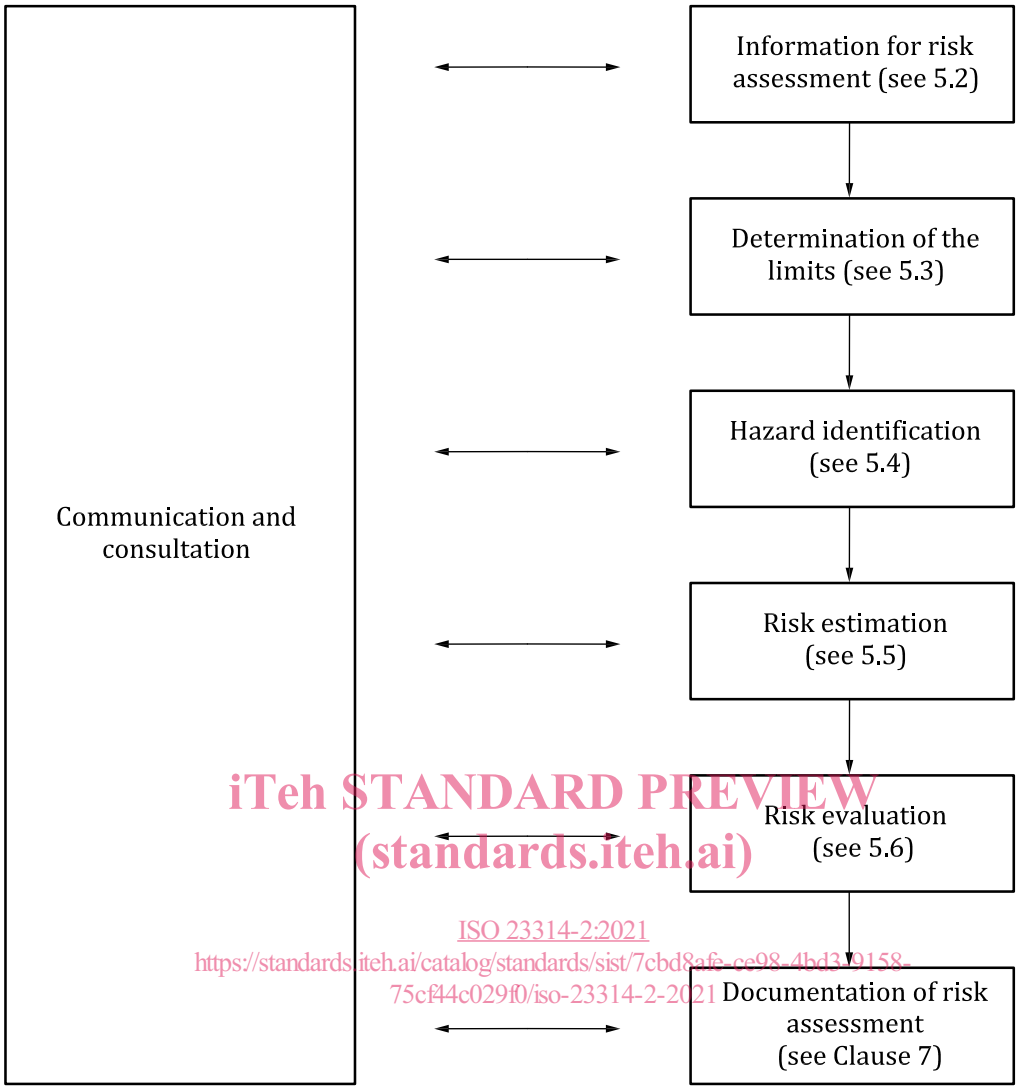


Figure 2 — General procedure of risk assessment and risk reduction for BWMS using the electrolytic method

5 Risk assessment process

5.1 General

The risk assessment for BWMS using the electrolytic method is comprised of risk analysis and risk evaluation.

Risk analysis consists of determining the limits, identifying the hazards, and estimating risk over the whole lifespan of a BWMS, as considered in 5.3 to 5.5. Risk analysis provides the information required for the risk evaluation (see 5.6), which in turn allows judgment to be made about whether or not risk reduction (see Clause 6) is required.

5.2 Information for risk assessment

The information for the risk assessment of a BWMS using the electrolytic method shall consider the documentation described in the following list.

a) System description:

— documents related to installation guidance; the operation, maintenance and safety manual (OMSM); schematic diagrams; process flow diagrams; and applicable test reports.

b) Regulations, standards and other applicable documents:

— ISO and IEC standards (e.g. IEC 60079), IMO regulations or circulars (e.g. BWM Convention[19], BWMS Code[21], Procedure G9[20]), IACS Unified requirements (e.g. IACS UR M74[27]), port state administration rules (e.g. USCG 46 CFR 162.060[31]), and classification society rules;

— safety data sheets (SDSs) of the active substance, neutralizing agent, TRO measurement reagent, and dangerous gas (e.g. hydrogen);

— database of chemicals commonly associated with treated ballast water in the IMO GISIS.

c) Related to experience of use:

— known accidents, incidents or malfunction history of the actual or similar electrochlorination systems (from database of marine incidents, e.g. GISIS):

— the potential for adverse effects from human exposure (e.g. to active substances);

— the experience of users of similar system e.g. electrochlorination system in power plant, waterworks, etc.

The information used in the risk assessment shall be updated throughout the design process or when modifications to the BWMS are required.

5.3 Determination of the limits

5.3.1 General

Risk assessment begins with the determination of the limits of the BWMS, taking into account all the phases over the lifespan of the BWMS. This means considering the characteristics and performances of both subsystems and the overall system as an integrated process. Characteristics of the system, including its relationship with humans, the environment, and other products shall be identified in terms of the limits of the BWMS as given in 5.3.2 to 5.3.5.

The purpose of this step is to identify all key parameters and their associated performance limits. These parameters pertain to installation, operation, maintenance, personnel and the environment.

5.3.2 Use limits

Use limits include the intended use and the reasonably foreseeable misuse of the BWMS. Aspects to account for include the following.

— The anticipated levels of training, experience or ability of the people who carry out installation, commissioning, operation, and maintenance of the BWMS, e.g. unexpected system shutdown can be activated due to misuse by an operator who is improperly trained or unfamiliar with the BWMS.

— Exposure of other persons to the hazards associated with the system that can be reasonably be predicted, e.g. crew for other duties, administration officer or service personnel for other equipment adjacent to the BWMS.

5.3.3 Space limits

Aspects of space limits shall address the requirements for safe installation, operation, and maintenance of the BWMS. Considerations shall include:

— power supply and cabling;

— cooling water or ventilation air;

— operation and maintenance space;

— space for chemical storage (e.g. neutralizing agent, TRO measurement reagent);

— space for dangerous gas exhaust on open deck;

— installation location (e.g. hazardous area).

5.3.4 Time limits

Aspects of time limits shall consider specific operating and maintenance factors, including:

— life limit of parts that can wear due to corrosion, or life of critical components where a decline in efficiency affects performance capabilities (e.g. electrode);

— recommended service and calibration intervals;

— holding time (minimum for efficacy and maximum based on regrowth);

NOTE The holding time can be dependent on water salinity, water temperature and TRO concentration.

— TRO measurement reagent service life/neutralizing agent shelf life in both solid (if applicable) and aqueous forms (stored in ready to use form).

5.3.5 Environmental limits

Environmental limits shall consider the range of uptake water chemistries to be treated, operational limits of process variables within the BWMS, limitations imposed by the shipboard environment on the BWMS, hazardous by-products of the electrolytic process, and any environmental constraints on the storage and use of chemicals associated with the BWMS. At a minimum, the following limits shall be considered:

— recommended minimum salinity and temperature of the ballast water;

— recommended minimum salinity and minimum and maximum temperature of the electrolytic unit feed water;

— recommended minimum inlet pressure of the filtration unit (if applicable);

— treatment rated capacity (TRC);

— maximum allowable discharge concentration (MADC), related to potential toxicity to the receiving environment;

— lower TRO limit for treatment efficacy;

— upper TRO limit for the potential corrosive effects on ballast tanks;

— ambient marine environment related to locations on board;

— potential flammable and explosive atmospheres that can be created on board the vessel;

— potential health risks to personnel due to exposure to dangerous gas, and flammable and explosive environments;

— personnel exposure to active substances or other relevant chemicals;

— TRO measurement waste (if applicable).

NOTE The limits including water salinity, water temperature, holding time, and TRO concentration are also identified as representative system design limitations (SDL) for a BWMS using the electrolytic method as per the BWMS Code[21].