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BWMS Technical Information for ship-owners and surveyors

KOREAN REGISTER Marine & Ocean Equipment Team

Ballast Water Management System (BWMS) technical information for ship-owners and surveyors 2018

Complied by the Marine and Ocean Equipment Team, Korean Register

Preface

I would like to take this opportunity to extend special thanks to our valued customers for their continued support.

There is no denying that the global economy has been experiencing weak growth over the past several years owing largely to rising geopolitical uncertainties such as the US-led trade war. Under these difficult circumstances, we will also see poor market condition prevailing in the maritime industry for some time to come.

However, we must not forget that behind every crisis there is an opportunity. If we work together closely, I am confident that we will eventually see the light at the end of the tunnel.

Korean Register (KR), as one of the leading technical advisors to the maritime industry, has been endeavoring to develop technological solutions that will assist our valued customers in overcoming challenges that they face in their everyday business. As a part of this effort, KR has pooled its resources to develop "BWMS Technical Information for Shipowners and Surveyors".

In this publication, you will find helpful tips on what the crew members on board need to know about the Ballast Water Management System (BWMS) as well as useful information on the focus area of surveyors and the Port State Control on BWMS, all designed to help you make sound and effective decisions on the installation and operation of BWMS.

In closing, KR will do its utmost to continuously provide the technical services to meet the needs of our valued customers. We wish you continued success and look forward to your keen support as always.

Thank you.

Korean Register of Shipping
Executive Vice President of Survey Division
Choi Jong-eun

Notice

This document is intended to assist ship-owners and surveyors for understanding and inspection of Ballast Water Management System (BWMS) with reference to experiences of inspecting BWMS installed on KR classed ships, experiences working as an independent laboratory (IL) of United States Coast Guard (USCG) and a Recognized Organization (RO) for Readiness evaluation on behalf of the Korean Government, IACS UR M74 Rev.1, and Pt. 5, 6 and 9 of Rules and Guidance for the classification of steel ships. Thus, Korea Register of Shipping (KR) distributes this document to relevant organizations and affiliated companies free of charge.

KR is not responsible for any legal disadvantages that may arise from the commercial sale of this document or any act that does not conform to the purpose of establishment, and this document does not have any effect in the event of any dispute arising from this document while performing work regarding the BWMS.

In addition, please note that the pictures in this document are intended to help you understand the contents and are not directly related to the contents.

If you find any mistranslations or typographical errors in this document, please contact KR (Marine & Ocean Equipment Team) and the contents regarding the mistraslations or typographical errors will be corrected when the document is revised.

Thank you all for your interest in this document.

2018.10.25.

Korean Register of Shipping

Marine & Ocean Equipment Team

Summary

1. The Ballast Water Management Convention entered into force on 8 September 2017 and vessels covered by the Convention regulation D-2 standard are installing ballast water management systems on board. However, there is currently no guidance relating to this method of compliance and ship type, voyage and other matters. As a result, Korean Register has published this guidance focusing on the characteristics of each BWMS type, considerations for retrofit, operation and maintenance, with check points for surveys that should be recognized by shipowners including crews and surveyors.

2. The guidance is divided into four chapters, Introduction (Ch. 1), General information on BWMS (Ch. 2), BWMS Considerations for shipowners (Ch. 3) and BWMS Considerations for surveyors (Ch. 4). We believe that it will be helpful for shipowners to refer to Chapters 2 & 3 and surveyors should refer to Chapter 2 & 4.

3. Chapter 2, provides the key information that crew and surveyors should refer to when operating or conducting a survey. It covers the requirements of the Convention and a technical analysis of each type of BWMS. In addition, the considerations for each ship type are summarized with reference to IACS UR M74 and Part 9 of the Rules of this Society, the operational limitations of each BWMS are summarized based on the experience of type approval of the USCG and Korean Government.

4. Chapter 3 covers important information regarding BWMS operation and maintenance, with reference to ships classified by this Society which have been surveyed with the results summarized. The chapter included the BWMS PSC (port state control) Guide-lines to help ships prepare for PSC inspection. However, this guidance does examine issues relating to existing installation or one-off problems.

5. Chapter 4, addresses notifications, certification, and includes a guide and checklist for survey, and examples of performance testing which is one of the core surveys.

6. Lastly, it should be noted that the issues identified in this guidance and some of the problems identified by shipowners may be linked to a given type of BWMS, not a specific production method or particular BWMS manufacturers.

Abbreviation

APT ····· After Peak Tank

BWMS ····· Ballast Water Management System

BWMC ····· Ballast Water Management Convention

BWRB ····· Ballast Water Record Book

BWMP ····· Ballast Water Management Plan

B/P ····· Ballast Pump Room

C/P ····· Cargo Pump Room

CFR ····· Code of Federal Regulation

DPD ····· N,N'-diethyl-p-phenylenediamine

E/R ····· Engine Room

FPT ····· Forward Peak Tank

G/S Pump ····· General Service Pump

G8 ····· 8th Guideline of BWMC

IMO ····· International Maritime Organization

IL ····· Independent Laboratory

IBWMC ····· International Ballast Water Management Certificate

LEL ····· Lower Explosion Limit

MEPC ····· Marine Environmental Protection Panel

MSDS ····· Material Safety Data Sheet

ORP ····· Oxidation-Reduction Potential

OB ····· Over Board

PSCO ····· Port State Control Officer

R.O. ····· Recognized Organization

SC ····· Sea Chest

TRO ····· Total Residual Oxidant

UE ····· Unpaired Electron

USCG ····· United States Coast Guard

UV ····· Ultra Violet

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Chapter 1. Introduction

Section 1. Background of Technical information

The International convention for the control and management of ships ballast water and sediments was adopted in 2004 and it entered into force on 8 September 2017 once the requirements for entry into force had been met on 8 September 2016.

Under the Convention, regulation D-2 specifies the concentration of allowable viable aquatic organisms in ballast water discharged from ships to prevent the introduction of harmful aquatic organisms and pathogens. In accordance with regulation B-3, existing vessels on international voyages and new vessels must install a ballast water management system (BWMS) to comply with regulation D-2, by the first or second IOPP (International Oil Pollution Prevention) renewal survey after 8 September 2017.

Existing vessels retrofitting BWMS will need to consider where to fit the BWMS in the limited space available, while meeting the requirements of existing piping and electric and electronic equipment. Ship-owners and crews will also need to take some time to become familiar with operations and maintenance of the new BWMS equipment.

This guidance, therefore, focuses on the items to be checked during installation, operation and inspection after the initial survey. In addition to the technical information gathered by KR from its type approval testing on behalf of various Administrations, this guidance incorporates analysis from KR's database of existing ships and BWMS operational issues during voyages. As a result, this guidance should be able to offer solutions for most problems relating to the operation of BWMS.

Chapter 2. General of BWMS

Section 1. BWMS Code(IMO) & CFR(USCG)

1. Ballast Water Management Convention and BWMS Code

A ship must install a BWMS on board to meet the requirements of regulation D-2, and the type approval for BWMS is given on a legal basis, in accordance with regulation D-3. Regulation D-3.1, states that an Administration will approve the installation of a BWMS system that meets the 'Guidelines for approval of ballast water management systems (G8)'.

The Guidelines for the approval of BWMS (G8) were developed at the 53rd session of MEPC (Maritime Environment and Protection Committee) in 2005 (Res. MEPC. 125(53)) and it was revised at the 58th session of MEPC in 2008 (Res. MEPC. 174(58)). Now (September 2018), most of the BWMSs have been type approved taking into account the G8 as revised in 2008. As requested by the shipping industry, IMO (International Maritime Organization) decided to revise the G8 at the 67th session of MEPC in 2014 with a view to consolidating the requirements for type approval of BWMS. The discussion was concluded at the 70th session of MEPC in 2016 after intensive debate lasting two years, then finally the '2016 Guidelines for approval of Ballast Water Management Systems (G8, Res. MEPC. 279(70))' were released into the world.

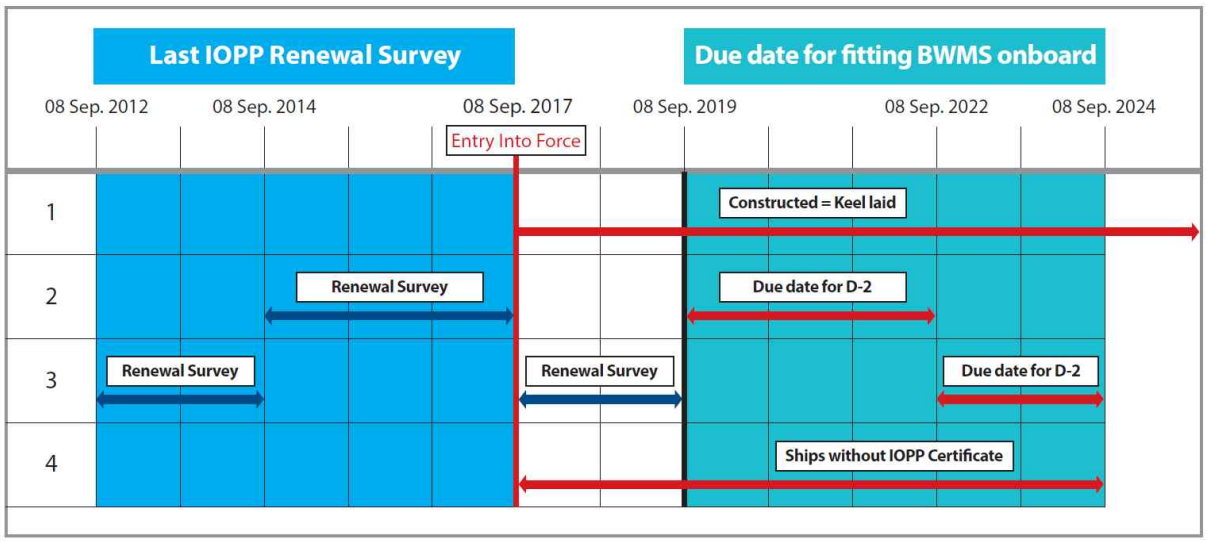
The IMO then amended the '2016 G8' to the 'Code for approval of Ballast Water Management System (Res. MEPC. 300(72), hereafter 'BWMS Code')' making it mandatory, with the Guidelines 8 applicable to all parties and Member States.

2. Application of G8 and BWMS Code

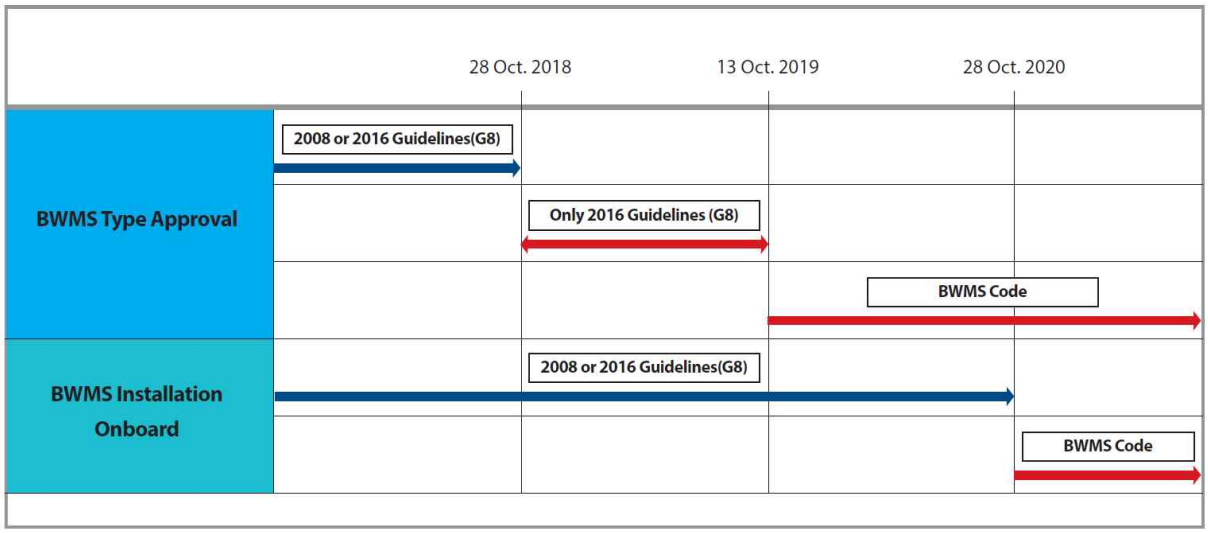
To confirm that a BWMS was properly installed or is being installed on board, we should know application date of the G8, 2016 G8 and the BWMS Code.

In accordance with the '2016 Guidelines for approval for Ballast Water Management (Res. MEPC. 279(70), hereafter '2016 G8'), a BWMS to be installed

on or after 28th October 2020 must be approved by 2016 G8 or the BWMS Code. While a BWMS approved by G8, 2016 G8 or the BWMS Code can be installed before 28 October 2020. The installation date should be the contractual date of delivery of the BWMS to the ship, in the absence of such a date, it should be the actual date of delivery of the BWMS to the ship.



[Fig. 1] BWMS installation schedule in accordance with revised B-3 regulation



[Fig. 2] Application date of BWMS Code in accordance with installation date

According to paragraph 1.13 in the BWMS Code, a BWMS approved under the 2016 G8, will be deemed to be approved in accordance with the BWMS Code. However, there is no need for renewal or reissuing of the type approval certificate issued under the 2016 G8.

3. Ballast Water Management in USA

The USA has not ratified the BWM Convention, and ship's ballast water discharge is covered by the relevant USA jurisdiction code (Code of Federal Regulations, CFR). The USA published final rule for Ballast Water Management in 2012. Ballast water management, 33 CFR 151 subpart C (in the Great Lakes and Hudson River) and D (in water of the United States) covers the ballast water management control of non-indigenous species.

In accordance with 33 CFR 151.2025, USA allows only four ballast water management measures, 1) no discharge of ballast water, 2) ballast water treated by BWMS approved by USCG (United State Coast Guard) on board, 3) discharge to facility on shore or another vessel in order to treat the ballast water and 4) allowing use of the public water system in USA. As a result, it is expected that most vessels will manage their ballast water using BWMS's approved by USCG.

According to 33 CFR 151.2030, the ballast water discharge standard is on the same level as regulation D-2 of IMO. If vessels use a BWMS on board to comply with the ballast water discharge standard under 33 CFR 151.2025, a vessel which was constructed on or after 1st December 2013 should install USCG type approved BWMS on board upon delivery. Existing vessels with ballast water capacity of 1,500 m^3 to 5000 m^3 should install USCG type approved BWMS at the first scheduled dry docking after 1st January 2014 and existing vessels with different ballast water capacities should install USCG type approved BWMS at the first scheduled dry docking after 1st January 2016.

The USA specified standard, procedures and requirements of type approval for BWMS are listed in 46 CFR 162.060. USCG has certified various Independent Laboratory (IL) Systems to provide type approval of BWMS. The USCG only approves BWMS tested by an IL recognized by the USCG and Korean Register is the only USCG approved IL in Asia.

At the time of publishing the final rule for ballast water management in USA, has no BWMS type approved by the USCG. Therefore, the USA has made provision for Alternative Management System (AMS) in 33 CFR 151.2026 and the USCG has approved the application of AMS, being BWMS approved by foreign

Administrations pursuant to BWM Convention, as temporary measure to cover ballast water management until USCG type approved BWMSs are ready.

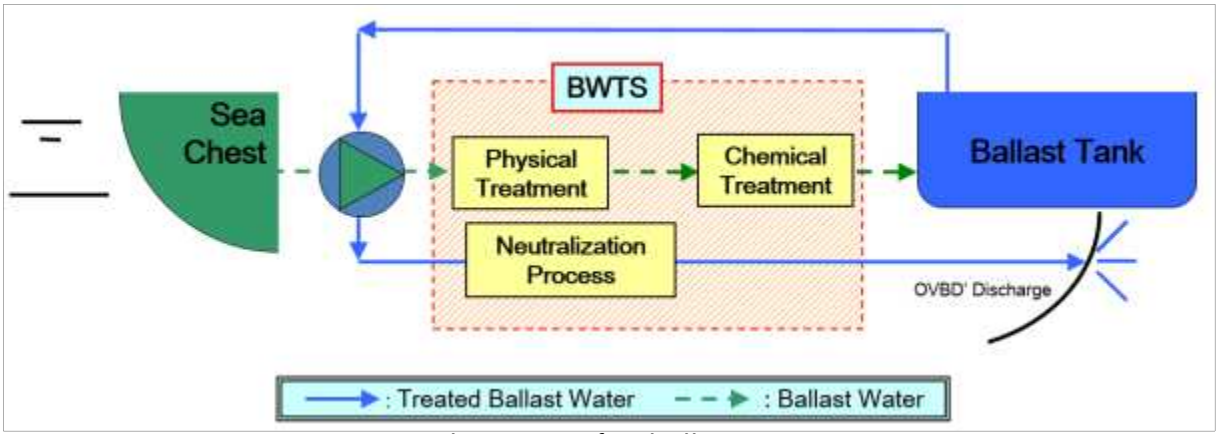
A vessel using an installed AMS prior to date is required to comply with the ballast water discharge standard (BWDS) in accordance with 33 CFR 151.2035, the vessel can use AMS for 5 years from the date that the vessel is required to comply with the BWDS in accordance with 33 CFR 151.2035. Five years after this date, the AMS on board must be type approved by USCG or the vessel should replace the AMS with BWMS type approved by USCG.

Since the manufacturer had upgraded their BWMS significantly, there are many cases of changes for BWMS component or structure among the BWMS have been approved as AMS, when comparing early models of AMS with the BWMS have been type approved by USCG.

To approve an individual AMS model as USCG type approved BWMS, USCG will conduct a technical review, making a decision whether to approve AMS as equivalent to USCG type approved BWMS or identifying matters to be addressed in order to secure AMS approval.

Section 2. Technical specification of each type of BWMS

1.1 General treatment technology of BWMS



[Fig. 3] General process for ballast water treatment

1.1.1 The general process for[1] BWMS is shown in Figure 3. The physical treatment passes the ballast water through a filtration system which generally removes aquatic organisms and solids larger than 50 micrometers. Next, the aquatic organisms smaller than 50 micrometers in the ballast water are treated by chemical treatment, e.g. using chlorine and then the treated ballast water is injected into the ballast tank.

1.1.2 If the treated ballast water should be needed for re-treatment or neutralization as post-treatment, it can be discharged overboard after post-treatment to discharge treated ballast water.

1.1.3 The physical and chemical treatment processes are mainly performed for the sterilization of micro-organisms or bacteria. There are several available methods, such as irradiation of Ultra Violet (UV), elimination of dissolved oxygen in water and the injection of chemicals such as ozone as a biocide.

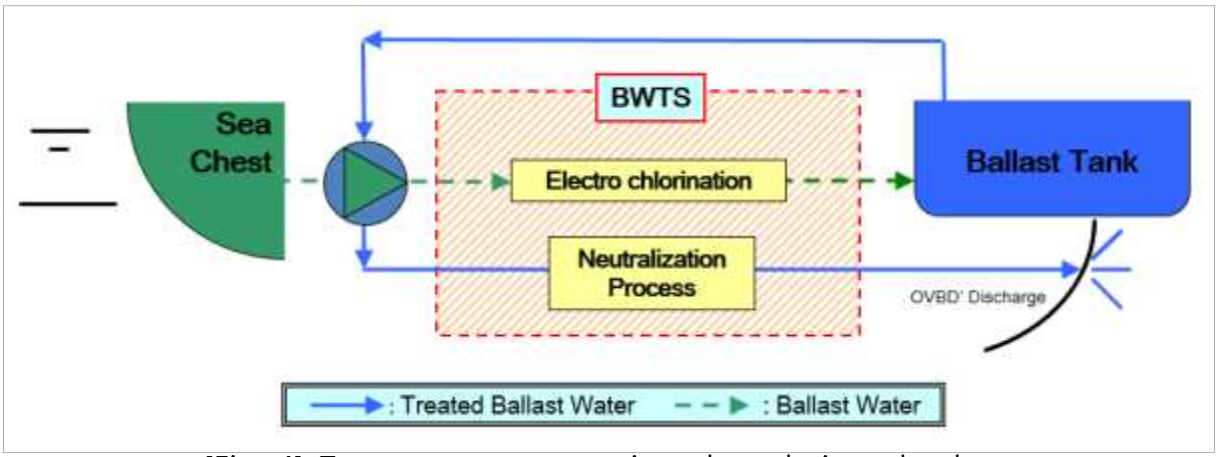
1.1.4 Major treatment technologies of BWMS were shown in below Table.

1) In case of UV method, it is not neutralized, Generally, it is treated one more with UV in drainage

No.	Treatment technologies		
	Ballasting	De-Ballasting	Remarks
1	(Filtration +) Full flow electrolysis	Neutralization	Generation of Active substances[2)]
2	Filtration + Side stream electrolysis	Neutralization	Generation of Active substances
3	Injection of chemicals	Neutralization	Generation of Active substances
4	Filtration + Ozonation	Neutralization	Generation of Active substances
5	Filtration + UV	UV	

[Table 1] Major treatment technologies for Ballast Water Management System

1.2 Electrolysis treatment technology



[Fig. 4] Treatment process using electrolysis technology

1.2.1 BWMS using electrolysis technology

1.2.1.1 Full flow electrolysis technology

Where full flow electrolysis technology is combined with a BWMS filtration system, the filter removes aquatic organisms and sediment larger than 50 ㎛ size and the other sizes of aquatic organisms are removed by hypochlorite generated from the electrolysis unit.

When full flow electrolysis technology is compared with side stream electrolysis technology, the main difference is that the electrolysis unit used to generate hypochlorite is directly connected with main line after

2) Active substances: a substance or organism, including a virus or a fungus that has a general or specific action on or against harmful aquatic organisms and pathogens

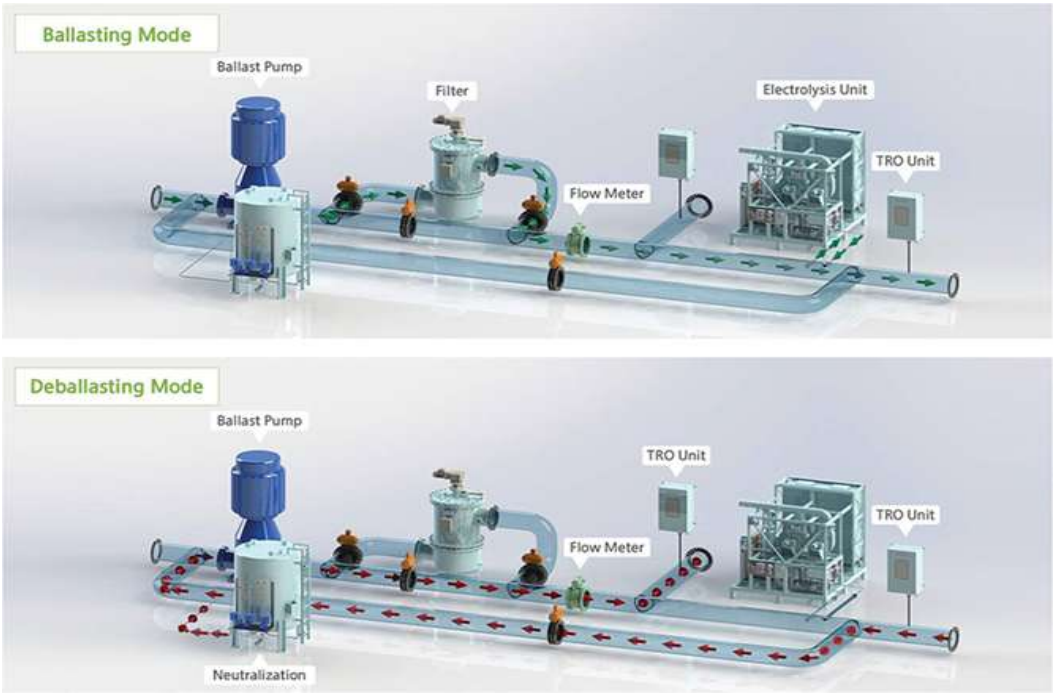
ballast P/P and is consist of one piping line. The general arrangement of BWMS using full flow electrolysis technology is shown in the Figure below.

[Fig. 5] General arrangement of ballast water management system using full flow electrolysis technology.

1.2.1.2 Side stream electrolysis technology

Side stream electrolysis technology removes organisms and sediment larger than 50 ㎛ through the filter system process, in addition a small portion of filtered ballast water from the main ballast water pipe is injected into the electrolysis unit to produce a high concentration of hypochlorite. The classes of aquatic organisms are removed by an injection of generated high concentration of hypochlorite to the main ballast water pipe. When side stream electrolysis technology is compared with full flow electrolysis technology, the high concentration of hypochlorite is produced by passing high current through a relatively small volume of salt water. Compared with full flow electrolysis technology, it offers the advantage that a BWMS using side stream electrolysis technology is able to be installed relatively easily in narrow space because it is smaller than the full

flow electrolysis technology system.



[Fig. 6] General arrangement of ballast water manangement system using side stream electrolysis technology.

1.2.2 As described above, it is known that sodium hypochlorite produced by an electrolysis technology destroys the nuclei and cell membranes of aquatic organisms, killing the organisms. The chemical composition of active substances produced by each manufacturer may be different from each other.

1.2.3 During ballasting, the electrolysis technology kills aquatic organisms in the main ballast water pipe using hypochlorite generated from the electrolysis unit which then sends treated ballast water to the ballast tanks. Some level of hypochlorite is retained to prevent the regrowth of undamaged organisms in the ballast tank. Therefore, ballast water treated by electrolysis technology should be discharged after neutralizing with the remaining hypochlorite mixing neutralizer (e.g. Sodium thiosulfate) if the level of hypochlorite in the ballast water is higher than the maximum allowable discharge concentration.

1.2.4 Issue of TRO Sensor

A BWMS using electrolysis technology is an example of a BWMS that makes use of Active Substances (AS). This BWMS is important to maintain the

concentration of the active material in the ballast water, and a TRO (Total Residual Oxidant) sensor is used to confirm the concentration of the active substance. The principle of a TRO sensor is that very small portion of seawater is injected to cuvette, mixed with a DPD solution and buffer solution, it changes the color of the injected seawater and a sensor estimates the concentration of residual oxidants in the seawater by reading level of changed color of seawater. It should be noted that there's an expiration date for the DPD solution and buffer solution, used for measuring TRO. Furthermore, preventive maintenance and inspection is required to prevent the interruption of normal operations through scale (accumulation of salt crystal and organic matters) build up in the cuvette.

Recently, an amperometric type TRO sensor has been developed to solve the issues regarding maintenance of existing DPD type TRO sensors and many manufacturers are also trying to develop TRO sensors for BWMS using Active Substances.

1.2.5 Hydrogen gas

Seawater passes through the electrode of an electrolyzer in BWMS using electrolysis technology and the reaction below occurs between anode and cathode.

- Chemical reaction at the anode: $2Cl^- \rightarrow Cl_2 + 2e^-$
- $Cl_2 + H_2O \leftrightarrow HOCl + H^+ + Cl^-$
- $HOCl \leftrightarrow OCl^- + H^+$
- Chemical reaction at the cathode: $2H_2O + 2e^- \rightarrow H_2\uparrow + 2OH^-$
- Chemical reaction in the seawater: $Cl_2 + 2OH^- + 2Na^+ \rightarrow NaOCl + H_2O + NaCl$

(Reference : Chapter of 3.1.2MEPC 62/2/6)

During the electrolysis of seawater, hydrogen gas is generated as part of the above reaction equation and it is recognized that explosive gas can be generated. To address, it is necessary to shut-down the BWMS if there's an overload of an air blower/fan as described on Table 3.35.1 of Sec 35, Ch 3 in the Guidance for Approval of Manufacturing process and Type approval, etc. (but, if the blowers have doubled and can be automatically started, the BWMS shut-down is not required).

The alarm will be activated at LEL[3] (lower explosion limit) 30% and shut-down at LEL 50%. In accordance with the 3505 provision of the Guidance, the concentration of explosive gases must not exceed 50% of the LEL, even after stopping the operation of electrolysis unit, there is a possibility of explosive gas persisting in the ventilation pipe, and so gas ventilation of the unit should be sustained for a certain time period according to the manufacturer's recommendations, but not for less than three minutes. Detector(s) should be installed in the ventilation pipe for explosive gases. The detector(s) should be activated above the designated concentration level. At which point the BWMS should be stopped and a visual and audible alarm activated.

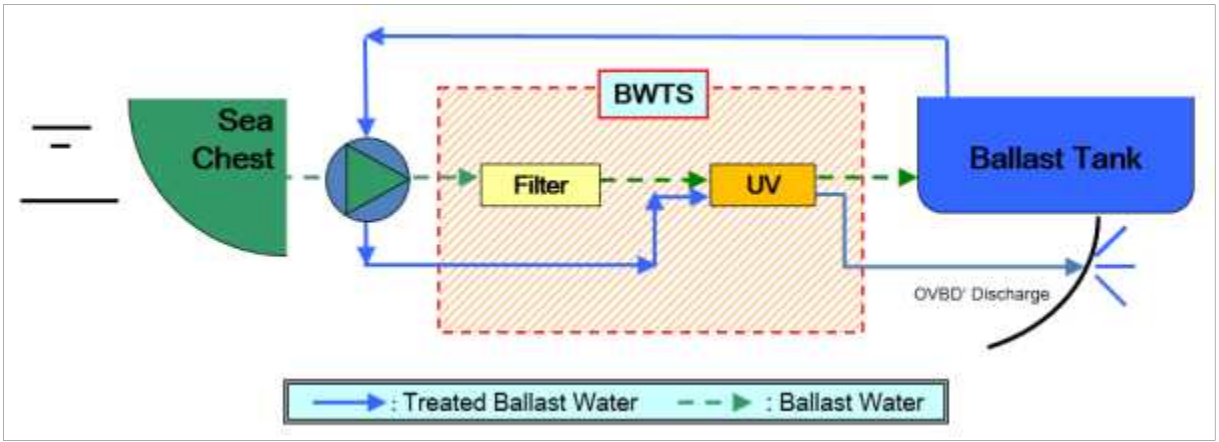
1.2.6 Limiting Operation depending on salinity

As paragraph 1.2.5 mentioned, the electrolysis unit requires salt to generate hypochlorite. Therefore, if the BWMS using electrolysis technology is installed on a vessel sailing in brackish and fresh water, this should be considered an operational limitation for the BWMS depending on the salinity of water. This limitation is specified on the type approval certificate alongside the normal operational salinity range and must be considered in the BWMS operational plan and the ship's voyage schedule.

Increasingly, BWMS manufacturers using electrolysis technology are preparing a solution where seawater is stored in Aft Peak Tank (A.P.TK) during the ship's voyage in seawater, and when a ship operates in low salinity area, the seawater stored in A.P.TK is properly mixed with low salinity water to meet the salinity range requirements on the type approval certificate for operation in a low salinity area. A similar measure uses a brine tank with a high level of salinity which is installed to solve the salinity operation limitations for the electrolysis unit.

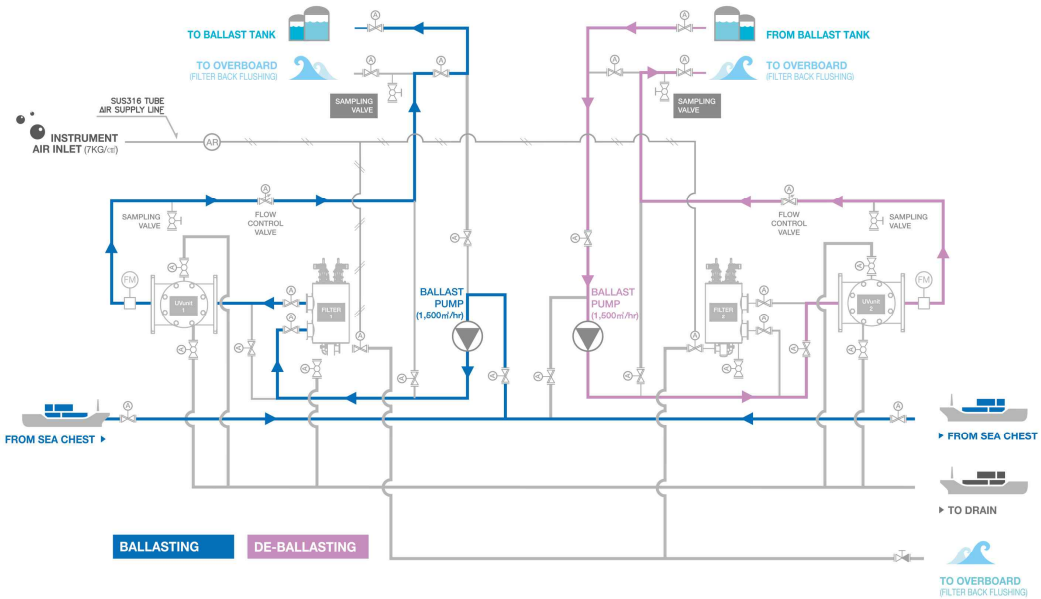
3) LEL : Lower Explosion Limit, If a gas leak occurs and the concentration of the gas increases, gas explosion occurs at the above concentration.

1.3 Filter + UV treatment technology



[Fig. 7] The treatment process using filter + UV technology

1.3.1 In the case of a filter + UV technology, the filter removes aquatic organisms and sediments larger than 50 ㎛ size class, then the other size classes of aquatic organisms are sterilized using irradiation from ultra violet light. The arrangement of a BWMS using filter + UV treatment technology is shown in below Figure 8.



[Fig. 8] General arrangement of ballast water management system using filter and UV technology.

1.3.2 Depending on the type of BWMS using UV treatment technologies, it is divided into a UV chamber for ballasting only or for both ballasting and

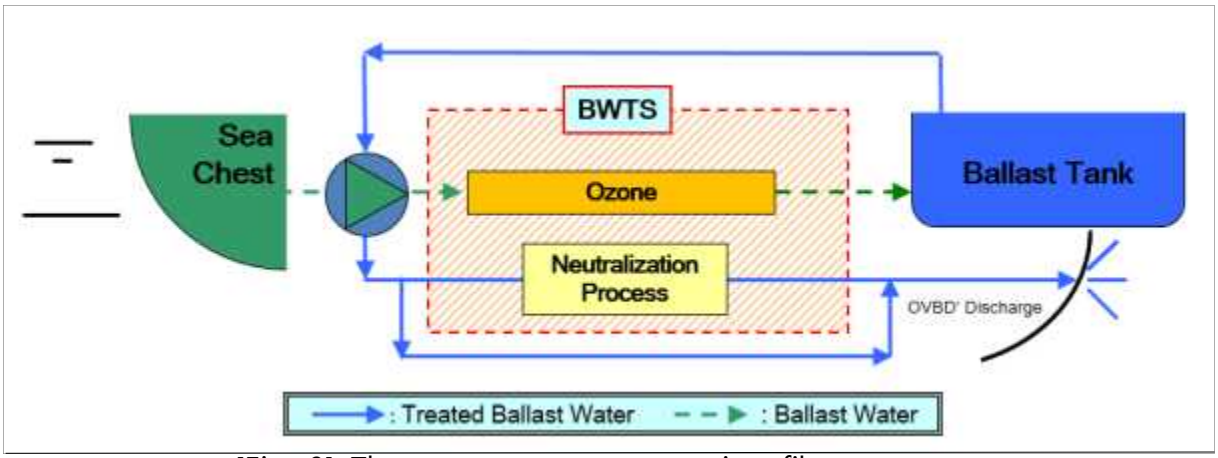
de-ballasting. This can be checked by referring to the type of BWMS approved and its Operation, Maintenance and Safety Manual (OMSM). It should be noted that biological efficacy of BWMS using UV technology is only certain when the BWMS is operated in accordance with operation methods recommended by its manufacturer.

1.3.3 The UV Lamp for BWMS using UV treatment technology is usually M.P. (Medium Pressure). The UV lamp for BWMS is significantly different to the UV lamps used for UV type water purifiers in our daily lives, and it should be noted that exposing any crew member to the light from the UV Lamp of a BWMS would be a significant HSE risk.

1.3.4 Compared to other types of BWMS, the amount of electricity consumed by UV treatment technology is relatively high. However, recently this has been reduced to a similar level of other BWMS by applying additional electric/electronic modules, and now a BWMS with a lower electricity consumption than other general BWMS has been launched.

1.3.5 In the case of ships entering the jurisdiction of the USA, some of BWMSs using UV treatment technology have two modes, the so-called IMO Mode and USCG Mode. Ships entering ports in the USA, will need to operate the BWMS taking into account the amount of electricity consumption and operational requirements of the BWMS under the approved conditions.

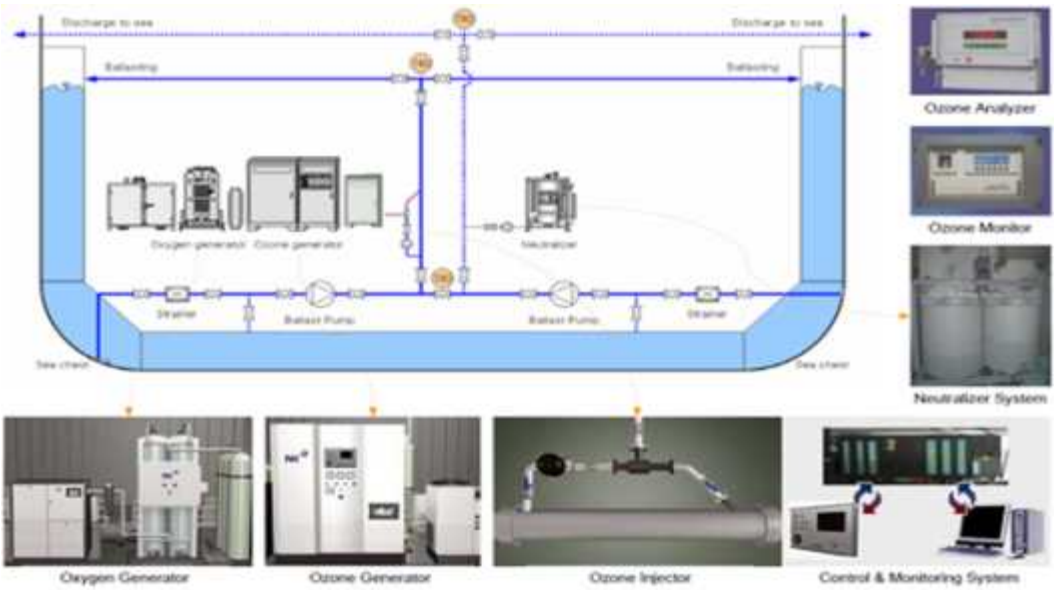
1.4 Ozone treatment technology



[Fig. 9] The treatment process using filter + ozone

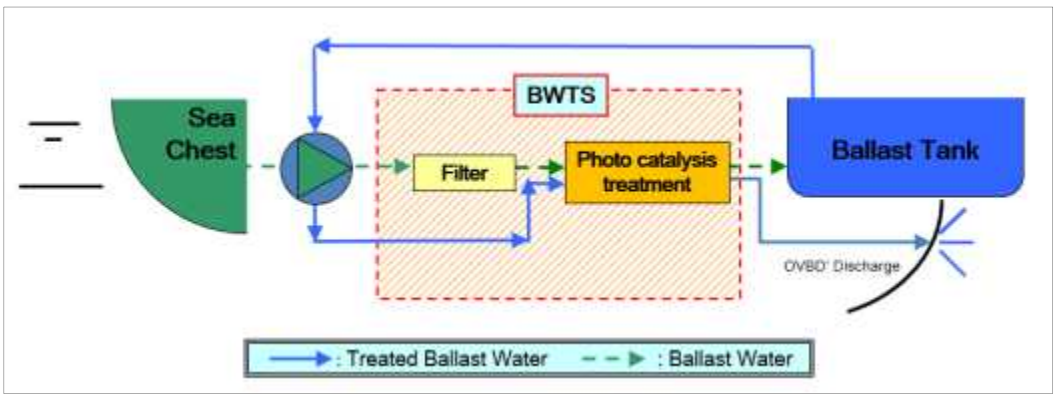
1.4.1 There is an advantage that a BWMS using ozone treatment technology

does not have a filtration system, but to generate ozone, it need ozone a generator/destructor as well as auxiliary equipment, such as air compressor, air dryer, air receiver and tank, oxygen generator and tank, water chiller. Therefore, careful maintenance activities are required, following the recommendations of the manufacturer. The arrangement of a BWMS using ozone treatment technology is shown below.



[Fig. 10] General arrangement of ballast water management system using Ozone treatment technology.

1.5 Filter + photocatalysis treatment technology



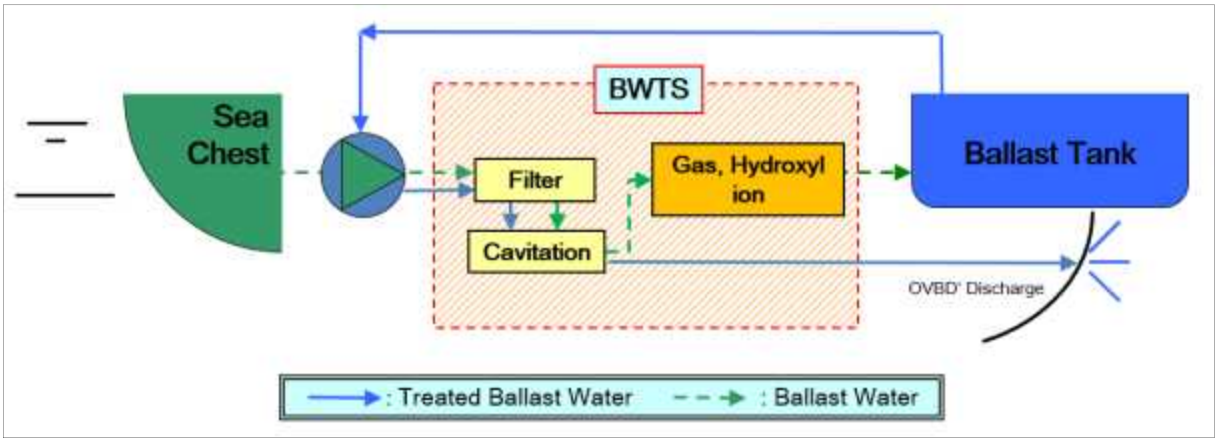
[Fig. 11] The treatment process using filter + Photocatalysis treatment technology

1.5.1 This technology has the advantage that it does not use chemicals. First, a

filter removes the aquatic organisms and sediments larger than 50 ㎛ size, and then the other class sizes of aquatic organisms are sterilized using radicals generated from the irradiation of light to Titanium Dioxide.

1.5.2 A radical is an atom that has an unpaired valence electron, molecule or ion. Titanium Dioxide is used for the raw materials of white pigment, food additives or toothpaste. Titanium Dioxide Photocatalysis produces oxygen or hydroxyl radical (OH radical) when a specific wave of light is irradiated on titanium dioxide, this chemical has a higher power of oxidation than chlorine, hypochlorite, hydrogen peroxide, ozone, which are generally used for sterilization or disinfection. During the de-ballasting, the ballast water should be discharged after re-treatment by BWMS.

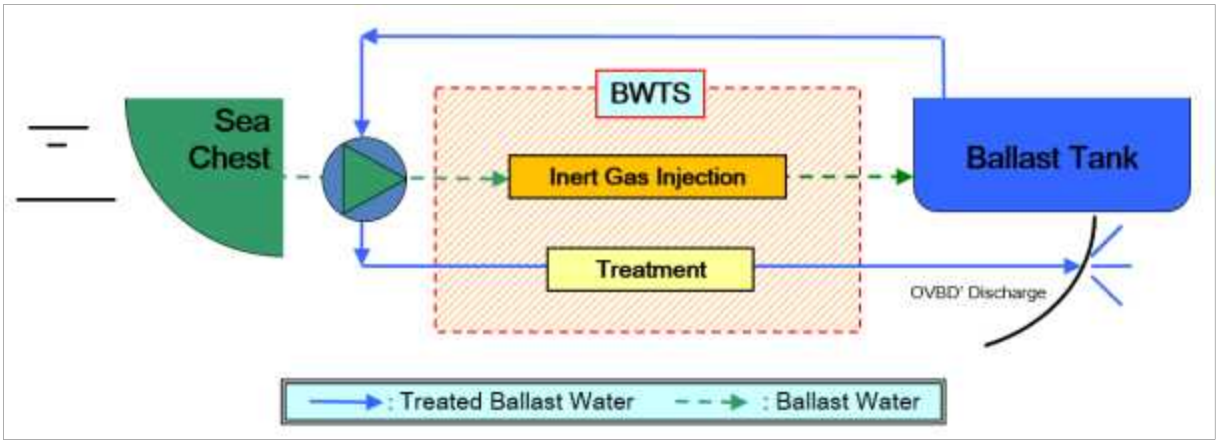
1.6 Filter + Cavitation + Nitrogen treatment technology



[Fig. 12] The treatment process using filter + Cavitation + Nitrogen treatment technology

1.6.1 Up-take ballast water passes through a filter to aquatic organisms and sediment remove larger than 50 ㎛ size class and the other size classes of aquatic organisms in ballast water are physically damaged by the cavitation equipment and sterilized by the addition of nitrogen gas purified on board and hydroxyl ion generated from electrolysis.

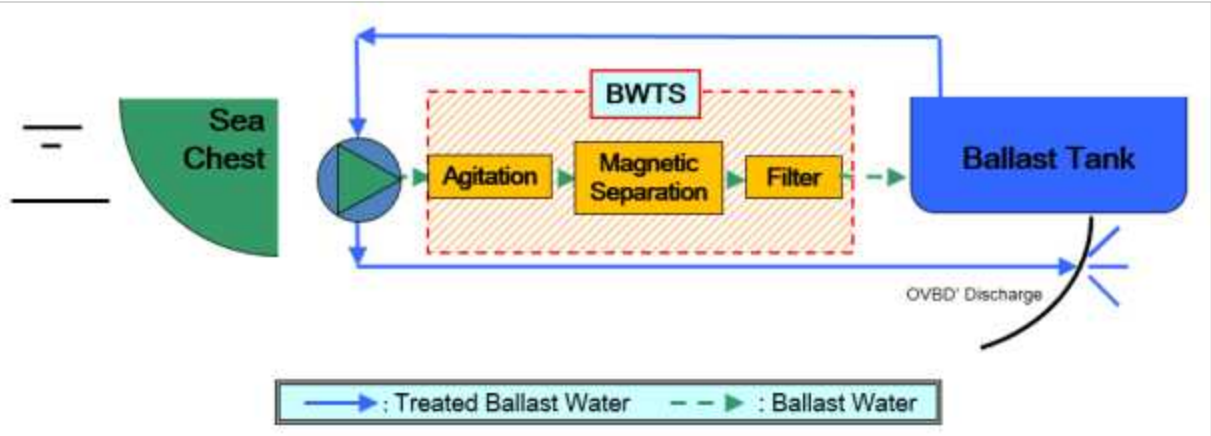
1.7 Inert gas treatment technology



[Fig. 13] The treatment process using inert gas treatment technology

1.7.1 During up-taking ballast water, for sterilization, inert gas is injected through the venturi pipe to reduce the concentration of dissolved oxygen in the ballast water. To prevent the growth of aquatic organisms in the ballast water, entrance of oxygen to ballast tanks should be prevented and oxygen in the ballast tanks should be eliminated during the voyage. To discharge ballast water, therefore, it should be discharged with an injection of air from ambient through the venturi due because air has no way in or out of the ballast tank.

1.8 Filter + Magnetic separation treatment technology



[Fig. 14] The treatment process using filter + magnetic separation treatment technology

1.8.1 This system has a process where magnetic powder is added to up-taking ballast water and ballast water is stirred so that the aquatic organisms absorb the magnetic powder and then the magnetic powder and aquatic organisms are

separated from ballast water using a magnet. This system does not need neutralization or re-treatment because it does not use chemicals for sterilization and does change the water quality.

Section 3. Considerations of BWMS for vessel type

1 Oil Tanker

1.1 Reference Rules for BWMS Installation

1.1.1 Rules for Ballast piping system (Rule Pt 7 Ch 1)

1) The requirements are also applied to ballast tanks used as cofferdams at the fore and back of cargo oil tanks.

2) Ballast pipes in ballast tanks adjacent to cargo oil tanks are to be separated from other pipes and are not to be led to the engine room.

3) Therefore, a pump for ballasting or deballasting is generally installed in the pump room outside the engine room.

.4) Ballast tanks defined as being safe are to be ballasted and deballasted by pumps which are located in the gas safe zone. However, it may be deballasted by pumps which are located in dangerous zone, provided that a check valve is fitted on the line for deballasting only.

5) In cases where balllast tanks are adjacent to cargo oil tanks that are intended to be deballasted by cargo oil pumps in an emergency, a spool piece (or blank flange) and screw-down non return valve are to be provided on each ballast pipe at the joints with cargo oil pipes. Further, a warning notice is to be posted to remove the spool pieces, except in emergencies. By-pass mode is permitted as an Emergency Ballasting Mode referred to by MEPC 70. However, it must be recorded in the Ballast Water Record Book.

1.2 Protection for Dangerous Zone and Electrical Equipment

1.2.1 Hazardous zone in oil tankers carrying oil with a flash point below 60℃

1) Oil tankers carrying cargo oil with a flash point of 60℃ or less, are classified as Zone 0, Zone 1 and Zone 2 according to the probability and risk of

flammable vapor present in IEC 60092-502 Reg.4.2. The type of electrical equipment that can be installed differs.

2) Ballast tanks related to the BWMS and a cargo pump room where the BWMS is likely to be installed are classified as Zone 1. And spaces up to 2.4m above upper deck are classified as Zone 2.

3) Therefore, when installing electrical equipment in the above-mentioned dangerous zone, explosion-proof requirements should be planned for.

1.2.2 Hazardous zone of FA Oil Tanker carrying cargo oil with flash point exceeding 60℃

1) For oil tankers carrying cargo oil with a flash point exceeding 60°C, cargo oil tanks, cargo tank ventilation pipes, and cargo oil pipe interiors are classified as hazardous area Zone 2 in accordance with IEC 60092-502 Reg.4.3.

1.3 Installation of oil tanker BWMS to transport cargo oil with flash point below 60 ℃

1.3.1 These are examples showing a dangerous zone in an oil tanker carrying cargo oil with flash point below 60℃

1.3.2 According to the BWM Convention G8 Part 4.9, all electrical equipment that is part of BWMS should be installed outside the hazardous zone. If installed in the hazardous zone, it shall be the type-approved ex-proof type. Any moving parts should be arranged to avoid the formation of static electricity.

1.3.3 Considerations for Installation of BWMS using Direct Treatment Type

1) Direct treatment BWMS include full flow electrolysis and ultraviolet treatment equipment.

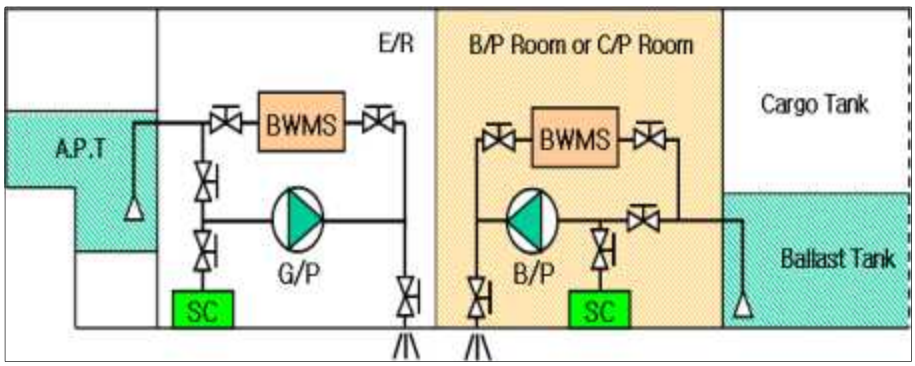
2) Oil tankers with a flash points below 60°C, should be installed outside the hazardous zone, except for explosion-proof type approved electrical equipment.

3) However, since the ballast tank itself is designated as a hazardous zone, all the associated ballast water pipes are designated as hazardous Zone 1. Therefore, any electrical devices such as sensors and BWMS installed directly in the ballast water pipes must be approved explosion-proof types.

4) Installation inside the Pump Room.

- In the case of an oil tanker with a cargo pump room or a ballast pump room, a ballast water treatment system can be installed here. [Figure 15] is a schematic diagram of the installation in a cargo pump room.

- the BWMS-related electrical equipment installed in a pump room considered to be a hazardous zone, must be explosion-proof of the approved type.

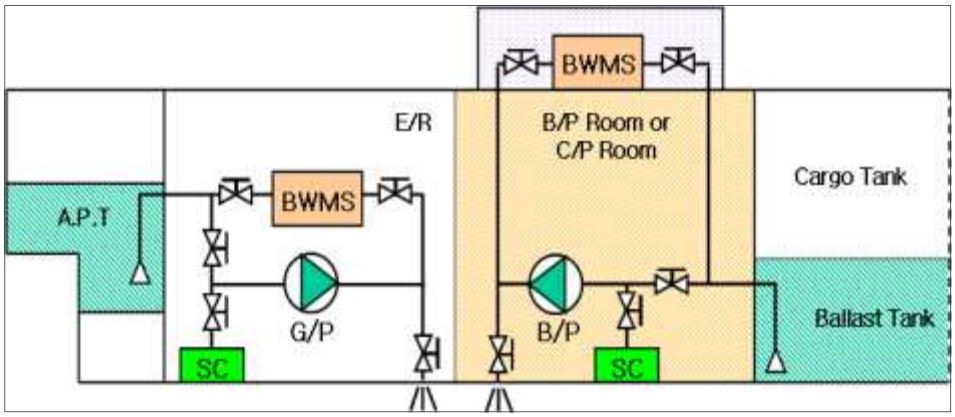


[Fig. 15] Installation of BWMS in Pump Room

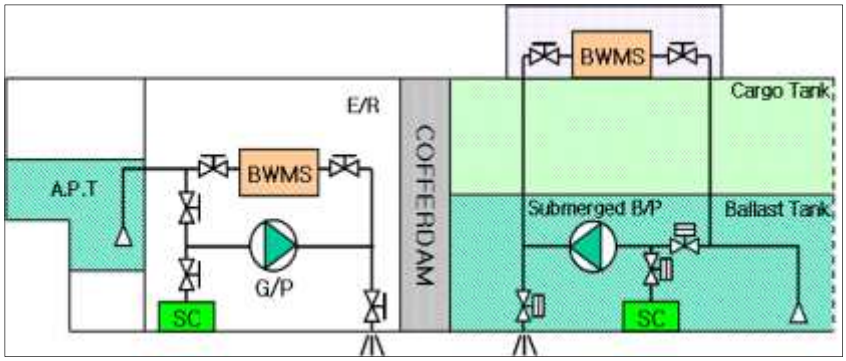
5) Installation in Areas other than Engine Room or Pump Room

- It is difficult to find a suitable installation zone in oil tankers not having a cargo pump room or ballast pump room since installation of the BWMS in the engine room or accommodation zone is prohibited.

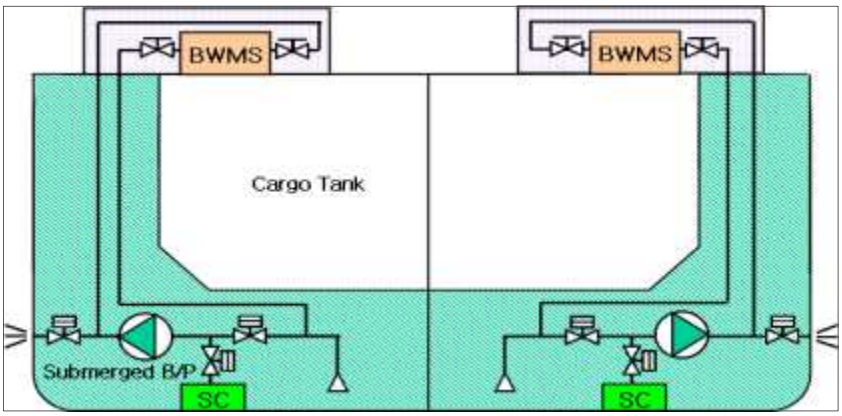
- In this case, the BWMS may be installed on the upper deck. [Figure 16] is a schematic view of an example where BWMS is installed on the deck. The following should be considered when installing the BWMS on upper deck.



[Fig. 16] Installation of BWMS outside Pump Room



[Fig. 17] BWMS installation of ship without pump room-1



[Fig. 18] BWMS installation of ship without pump room-2

- In the case of installing ballast water system on the upper part of the deck and treating the ballast water by directing it to the upper part of the deck, consideration should be given to reducing the ballast water pump head. Also, when ballast water moves from a high place to a low place, a vacuum may be generated and appropriate measures should be taken such as installing a vacuum valve to prevent this.

- If a non-explosion proof BWTS is installed in a zone where the cofferdams are installed above the cargo deck and the openings and entrance are located at a height of more than 2.4m and are regarded as safe zones, the ballast water pipe itself is a dangerous zone 1. In such cases there are leak factors such as flanges, valves in this location, so the BWMS Room can be in the hazardous zone 2 but it must be suitably explosion-proof.

- However, if appropriate safety measures are taken according to IEC60092-502, the BWMS room may be designated as a safe zone by Korea Register. This is described in IEC 60092-502 VI-1.4.
- Consideration must be given to the installation of a ballast pump with a high head to send the ballast water to the place where the BWMS on deck is installed.

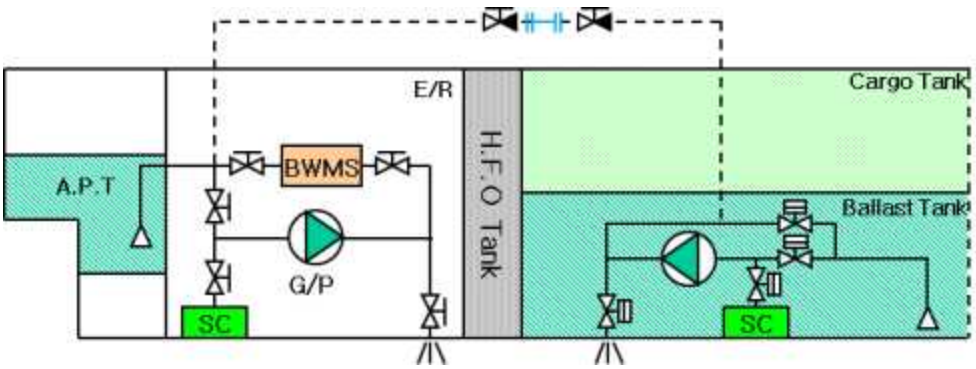
- In the case of the BWMS type which is generating seawater, the dangerous gas discharge pipe should be led to a safe zone outside the enclosed area because if there was a dangerous gas leakage, it could accumulates in the enclosed area.

- The BWMS Room must be equipped with a mechanical ventilation system capable of ventilation six times per hour, in case of any leakage of hazardous gases.

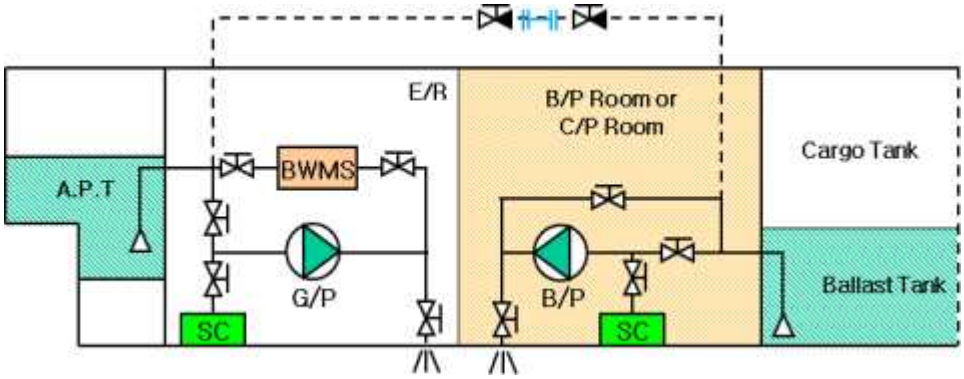
- If BWMS is installed on exposed decks without a separate enclosed space in the BWMS Room, it should be checked whether it is more than IP 54[4)] for each equipment.

6) Installation only in the engine room

4) For the application of the degree of protection, see Rule (Guidance), Pt 6, Ch 1, Table 6.1.6.



[Fig. 19] Oil Tanker without Pump Room Installation only in engine



[Fig. 20] Oil Tanker without Pump Room Installation only in engine

- This arrangement is a structure that can only be sent from the ballast water pump or G/S fire and bilge pump in engine room through the BWMS to the ballast water system of the pump room in dangerous zone or the ballast water system of the submersible pump.

- The BWMS that can be deployed in this way will be a full flow electrolysis. This is because when the ballast water is drained, it is only discharged through the neutralization process, without going through the processing module again. That is, it cannot be applied to the ultraviolet ray method in which the ultraviolet ray is discharged through the processing module again.

- When designing such an arrangement, the capacity of BWMS should be selected first. Because it is connected to the main ballast water system, the capacity of the BWMS should not be less than the total capacity of the ballast pumps or submersible ballast pumps located at least in the pump room.

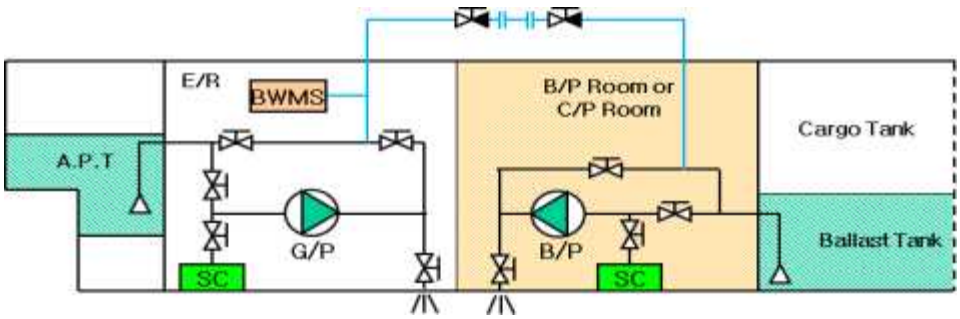
- Ballast pumps are to be installed separately for the ballasting and deballasting. For ballasting, the use of a separate ballast pump or G/S Fire Bilge Pump

installed in the engine room should be considered. In addition, a submersible pump or a ballast pump installed in the pump room should only be used for the deballasting.

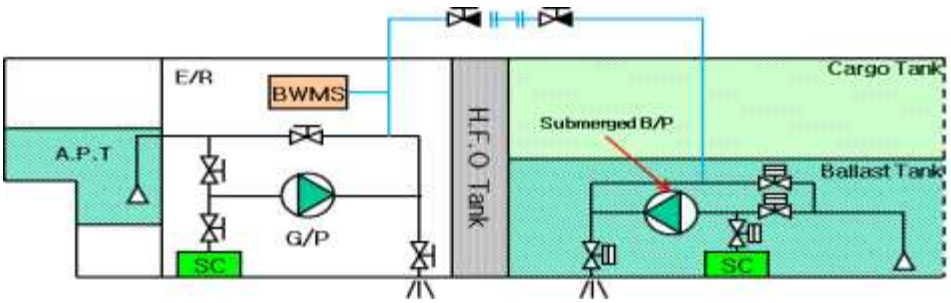
1.3.4 Considerations for installing injection-type BWMS

1) Injection-type treatment BWMS include side stream electrolysis, chemical injection and ozone injection treatment

2) Oil tankers with a flash point below 60°C must be installed outside the hazardous zone, except for explosion-proof type electrical equipment.



[Fig. 21] Oil Tanker with Pump Room only installed in engine room-1



[Fig. 22] Oil Tanker with Pump Room only installed in engine room-2

3) In the zone where an ozone generator is installed to treat ballast water, an ozone gas leak detector should be installed to activate an alarm if the ozone gas leaks. In addition, pipes supplying O_3 should be installed in the zone except for weather deck using double pipes or welded joint SUS pipes.

4) If the BWMS is installed on the weather deck, it should be confirmed whether or not grade is more than IP 56 which is appropriate for each equipment.

5) If the BWMS is a type generating hazardous gas such as hydrogen gas after treatment, the discharge pipe of the hazardous gas must be led to a safety zone on the weather deck outside the engine room.

6) The discharge pipe must be a fully welded joint without flange joints, however the number of the flange joints should be minimized and a hydrogen gas detector installed nearby the flange joints in case of leaks.

7) If the chemicals used as active substance contains ingredients that may harm the safety of the crew, it cannot be installed in the engine room and should be installed in a separate zone.

8) If a BWMS using chemicals to treat ballast water is installed, MSDS data should always be kept in the vessel, and emergency medicine for the safety of the crew should be stored and managed by the officer. In addition, safety protective equipment to handle the chemicals should be kept onboard at all times.

9) Although cargo operations are generally conducted while the vessel is docked and engine room ventilation system is operated at minimum, it is necessary to operate a ventilation fan during the operation of the BWMS using hazardous gases and the materials as active substances.

10) If the equipment for the BWMS is installed in the engine room, to inject the substances for treatment into the main piping of the ballast pump installed in the pump room, the following requirements must be satisfied.

- The equipment shall be used only when injecting the substances.

- The substances shall be injected on deck, not in the piping penetrating the bulkhead between the engine and pump room.

- To prevent backflow in the injection pipe, the appropriate shut-off means (e.g. two pairs of check valves, spool piece, water seal and double block bleed valve) shall be installed in cargo area.

1.4 Electrical equipment in the form of ballast water sampling

1.4.1 If the ballast water is sampled directly from a piping of ballast water which is considered to be a hazardous zone such as the piping installing TRO (Total Residual Oxidant) sensor or gas detector, an approved explosion-proof BWMS must be installed even if the equipment (e.g. TRO sensor, gas detector, etc.) is installed outside of the hazardous zone.

1.4.2 If the BWMS is installed in the safety zone, the type and status of the installation must be appropriate to the safety zone.

1.5 General Requirements for Electrical Equipment in Oil Tanker's Hazardous zone.

1.5.1 Explosion Protecting Classes[5)]

1) The explosion protecting classes of electrical equipment such as sensors and automatic control valves which are installed on a pipe of ballast water to automatically control a treatment system, should be more than or equal to IIB T4.

1.5.2 Hull Return System of Distribution

1) Electrical equipment installed in oil tankers is not able to be grounded or use hull return system, unless exceptionally recognized in KR's Rules for the Classification of Steel Ships Part 7, Chapter 1.

1.5.3 Disconnection Switch

1) Each distribution circuit for electrical equipment installed in the hazardous zone should be provided with a multi-pole linked the disconnection switches installed in a safe zone.

2) In addition, the disconnection switches must be clearly labelled to identify the electrical equipment each is connected with, and a further effective means must be provided to prevent risks from incorrect operation.

5) For details of the explosion-proof rating, see Rule 6: 1/9

1.5.4 Monitoring of Insulation Level

1) When feeders and distribution circuits connect to electrical equipment and pass through the hazardous zone, excluding intrinsically safe circuits, the insulation level must be monitored, and the alarm activated where the insulation resistance is less than set value.

2. Chemical Tanker

2.1 Related Regulations for the installation BWMS

2.1.1 Rules for the ballast piping system (Rule Pt.7 Ch.6 and IBC Code)

1) Pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks must be independent of similar equipment serving the cargo tanks and of the cargo tanks themselves.

2) Discharge arrangements for permanent ballast tanks sited immediately adjacent to cargo tanks must be outside the machinery zone and accommodation zone.

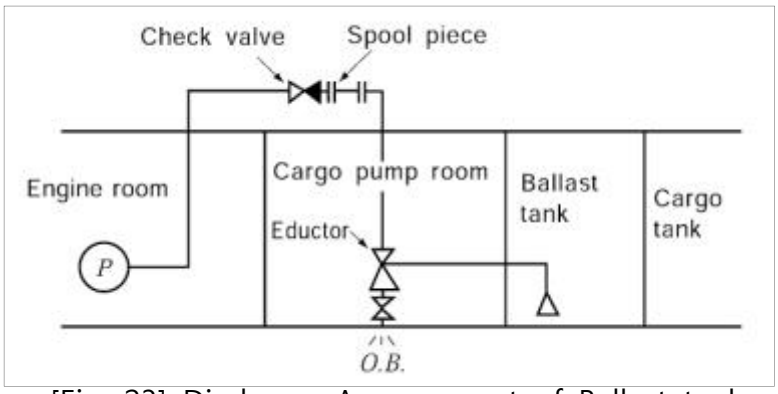
3) The injection system can be a pump installed in the machinery zone, by injecting from the tank deck and installing a check valve.
2.1.2 Injection of ballast in cargo tanks can be carried out in the deck position using a dedicated ballast pump. However, the injection pipe should not be connected to the cargo tank or cargo pipe in a fixed manner, and a check valve must be provided.
The loading of ballast water in cargo tanks can be done without any treatment in emergency ballasting mode, but in the case of general ballast loading, the whole process must be done through the BWMS.

2.1.3 Discharge water from dedicated ballast tanks adjacent to cargo tanks can be discharged overboard through the eductor in the cargo pump room, using a ballast pump in the engine room as shown in [Fig. 21]. IACS has developed UR M74[6], and it has more stringent requirement for the seawater, active substance

6) IACS UR M74 : Requirement for Installation of BWMS will require Rev.1 as of September 2018, but Rev.2 will be expected in due course.

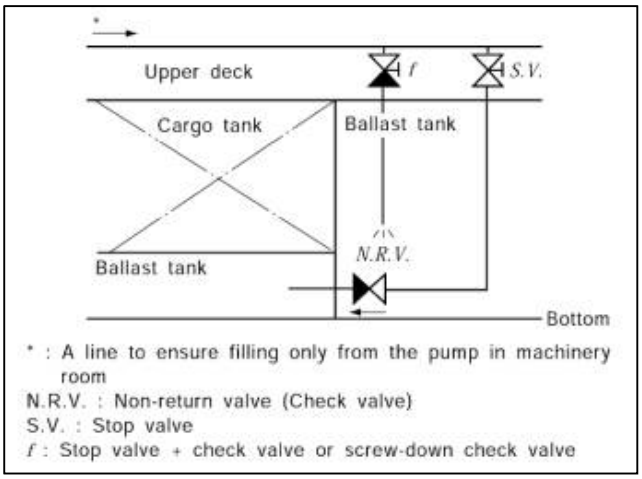
and other substances transported from the engine room to the pump room. Therefore, even when operating water is transported, it should be arranged as shown in [Fig. 23].

2.1.4 The separation requirements (two pairs screw tightening check valves, spool piece or water seal or double block bleed valve) should be applied between the ballast pump and the eductor.



[Fig. 23] Discharge Arrangement of Ballast tank

2.1.5 In Rule Pt 7, Ch 6, Sec 3, 305. 1, it is stated that "Filling arrangements may be in the machinery spaces provided that such arrangements ensure filling from tank deck level and non-return valves are fitted" which refers to instances where pipes are exclusively used for filling but cannot be used for discharging, and are fitted with stop valves and check valves that are operable from the weather deck or via stop valves on weather deck. Also, the stability requirements must be sustained in the event of progressive flooding due to damage to the piping system and due consideration should be given to the arrangement of pipes so as to prevent spillage of dangerous ballast or cargo into other components.



[Fig. 24] Ballasting in Ballast tank

2.1.6 The ballast system of the engine room and the ballast piping system on the exposed deck shall be subject to the separation requirements referred to in 2.1.4.

2.1.7 The pipelines of ballast tanks adjacent to cargo tanks and not adjacent to cargo tanks are to be segregated in principle.

2.2 Protection for dangerous spaces and electrical equipment

2.2.1 Dangerous spaces in chemical tankers carrying chemical cargoes with a flash point below 60℃

1) For chemical takers carrying chemical cargoes with a flash point of 60℃ or below, dangerous space is classified under Zone 0, Zone 1, and Zone 2 according to the probability of the existence of flammable oil mist and its dangerousness, where each level demands different requirements for electrical Installation.

2) Ballast tanks related to the BWMS, and a cargo pump room where the BWMS is likely to be installed are classified as Zone 1. And a space up to 2.4m above the cargo deck is classified as Zone 2.

3) Therefore, when installing electrical equipment in the said dangerous spaces, special consideration of the explosion-protection requirements should be taken into account.

2.2.2 In chemical tankers carrying chemical cargoes with a flash point above 60℃, cargo tanks, cargo tank ventilation pipes and the inside of cargo pipes are, according to IEC 60092-502 Reg.4.3, classified as Zone 2.

2.3 Installation of BWMS in Chemical Tankers Carrying Chemical Cargoes with a Flash Point below 60 ℃

2.3.1 According to the BWM Convention/Guidelines/G8 Part 4.9, any electrical equipment that is part of the BWMS should be installed in a non-hazardous area or should be certified as safe for use in a hazardous area. Any moving parts, which are fitted in hazardous areas, should be arranged to avoid the formation of static electricity.

2.3.2 Considerations of installation of direct treatment BWMS

1) Direct treatment BWMS includes direct electrolysis treatment equipment and ultraviolet treatment equipment.

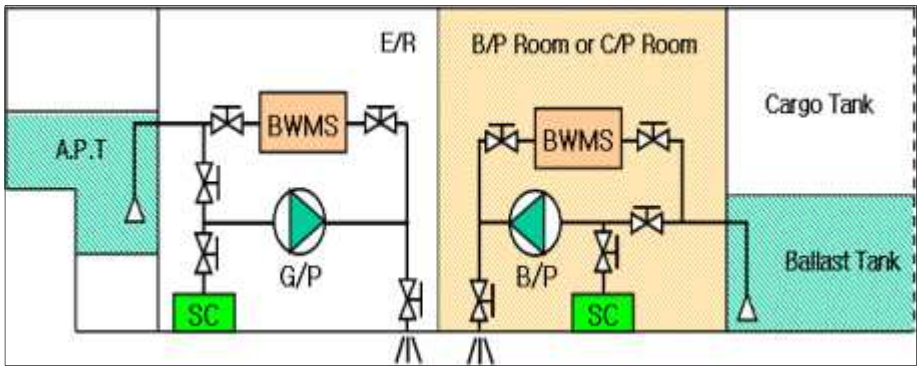
2) Chemical tankers with a flash points below 60°C should be installed outside the hazardous area, except for explosion-proof type approved electrical equipment.

3) However, since ballast tanks are classified as hazardous areas, all related pipes are also classified as space 1. For this reason, electric components of the BWMS such as treatment units or sensors that are directly connected to the ballast pipe should be certified explosion-proof.

4) Installation of BWMS in cargo pump room or ballast pump room.

- On chemical tankers where there is a cargo pump room or a ballast pump room, a ballast water treatment system can be installed here. Fig. 23 is an outline diagram showing the installation of the BWMS in the cargo pump room.

- BWMS-related electrical equipment in the pump room is considered to be a hazardous zone should be approved explosion-proof.

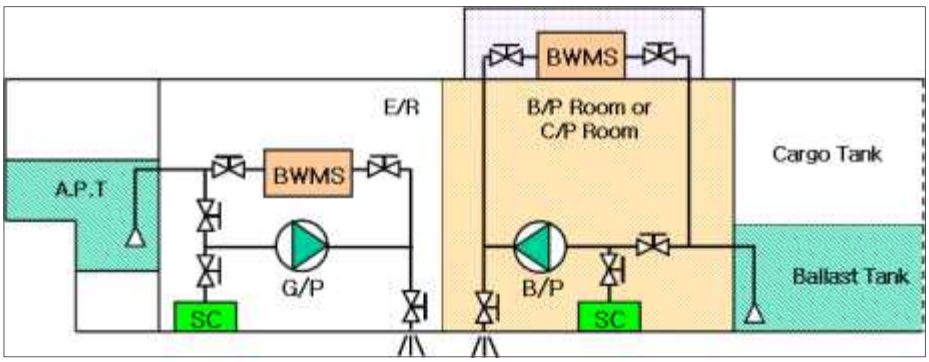


[Fig. 25] Installation of BWMS in Pump Room

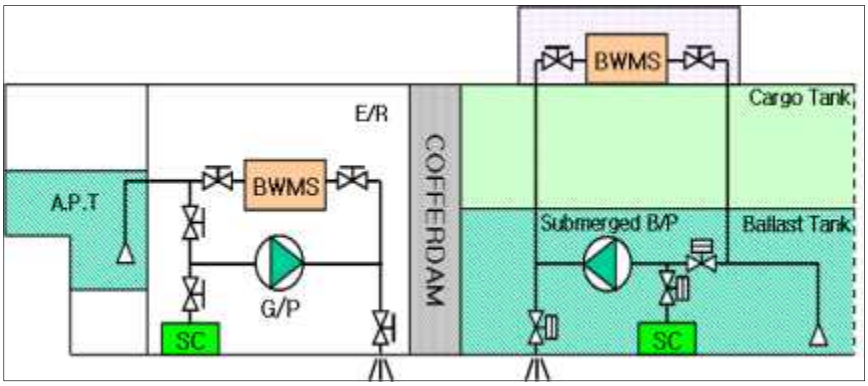
5) Installation in Areas Other than Engine Room or Pump Room

- Since the BWMS may not be installed in engine room or accommodation, in case of a chemical tanker where there is no sufficient space of installation or there is no pump room, it is difficult to find the proper place for installation of the BWMS.

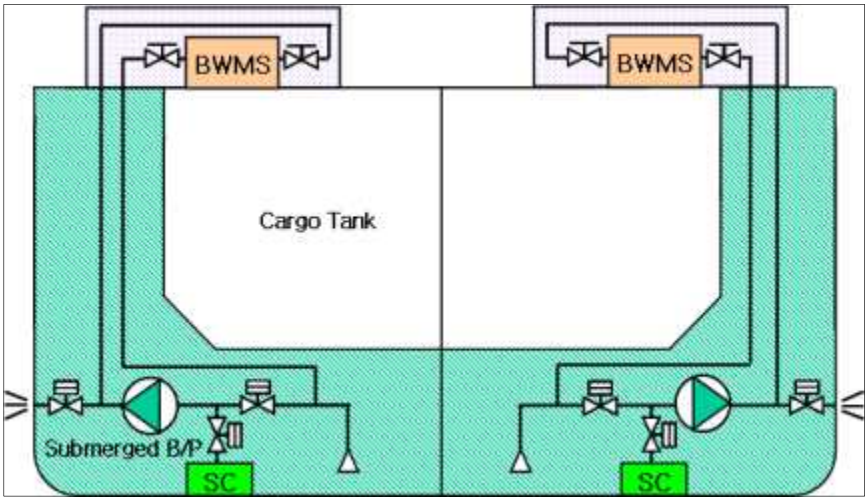
- In this case, the BWMS may be installed on the upper deck. [Fig. 26], [Fig.27] and [Fig.28] is a schematic view of an example where BWMS is installed on the deck of cargo zone. The following should be considered when installing the BWMS on upper deck.



[Fig. 26] Installation of BWMS Outside the Pump Room



[Fig. 27] Installation of BWMS Outside the Pump Room-1



[Fig. 28] Installation of BWMS in an Chemical Tanker Without a Pump Room-2

- If the BWMS is installed on ship's upper deck requiring ballast water to be pumped up to the BWMS, the head loss of the ballast pump should be considered. Also, an excessive vacuum may be found in the ballast pipes when shifting the ballast water downstream from an elevated place, hence countermeasures such as the installation of vacuum valves should be considered.

- If the BWMS is installed above the upper deck but elevated by means of a cofferdam so that the piping connections and openings are located 2.4 meters above the upper deck, the installation area can be regarded as a safe area. Thus installation of a BWMS of non-explosion-proof type may be allowed. However, because ballast pipes are still considered as space 1, if there is a source of leakage such as a flange or valve in the installation area, the area is then considered as space 2. For this reason, any electrical equipment installed inside should be explosion-proof suitable for Zone 2.

- However, if suitable safety measures are taken according to IEC60092-502, the installation zone may be considered as a safe zone if approved by this Society (refer to IEC 60092-502 VI-1.4).

- Consideration should be given to the installation of a ballast pump with a high head to send ballast water to the zone where the BWMS on the deck is installed.

- In the case of BWMS types where dangerous gases such as hydrogen gas are generated in the process of processing seawater, the dangerous gas discharge pipe must be led to a safe zone outside the enclosed zone because there is a possibility of accumulating dangerous gas if there's a leakage.

- The BWMS Room should be equipped with a mechanical ventilation system capable of ventilation six times per hour in case of hazardous gas leakage.

- If the BWMS is installed on the exposed deck without installing a separate enclosed space in the BWMS Room, it should be confirmed that the BWMS is above the appropriate IP 56 grade for each item of equipment.

6) Installation in engine room

- For chemical tankers subject to the "IBC Code[7)]" and "Hazardous Chemical Carrier Regulations", ballasting is only possible in ballast tanks (all tanks in the hazardous area) through the ballast pump in the engine room.

- Where such ballast water is to be injected, it is possible for it to be led directly from the ballast water pipe above the exposed deck to the ballast tank. Refer to Section.

3.2.4 for arrangements of related piping systems.

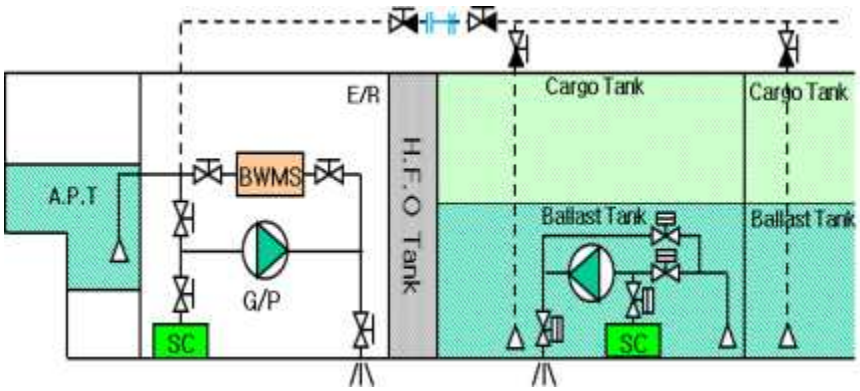
- This arrangement is not only different from the way in which the oil tanker's

7) IBC Code: Hazardous Chemical Substance Transportation Code for the structure and equipment of the ship (International Bulk Chemical Code), International standards for ensuring the safety of transportation of hazardous chemical substances

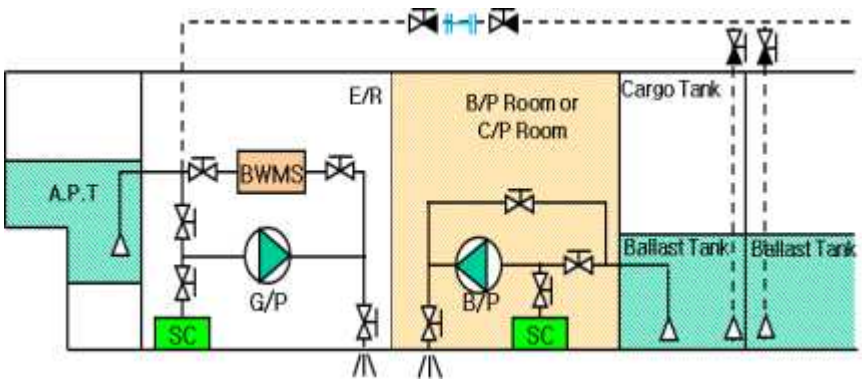
direct treatment is installed in the engine room. It is a characteristic of the chemical tanker line not to install the ballast water pipe on the upper part of the exposed deck. However, when only the direct treatment method (electrolysis method) is installed in the engine room, as shown in [Fig. 29] and [Fig. 30] tubes leading from the upper deck directly to the ballast tanks must be provided for each tank.

- When designing such an arrangement, the capacity of BWMS should be selected first. Because it is connected to the main ballast water system, the capacity of the BWMS should not be less than the total capacity of the ballast pumps or submersible ballast pumps located in the pump room.

- Ballast pumps are to be installed separately for the ballasting and deballasting. For ballasting, consider the use of a separate ballast pump or G / S Fire Bilge Pump installed in the engine room. In addition, a submersible pump or a ballast pump installed in the pump room shall be only used for the deballasting.



[Fig. 29] Example of guiding from top of exposed deck directly to ballast tank-1



[Fig. 30] Example of guiding from top of exposed deck directly to ballast tank-2

2.3.4 Considerations for installation of injection type treatment system BWMS

1) Injection-type treatment system BWMS include side stream electrolysis chemical injection and ozone injection treatment.

2) Oil tankers with a flash point below 60°C should be installed outside the hazardous area, except for explosion-proof type electrical equipment.

3) If the BWMS is equipped with an ozone (O3) generator, an ozone detecting device that activates an alarm in case of leakage must be installed where the ozone generator is installed. Also, due consideration should be given to the O3 pipes to prevent leakage; for example, using double pipes or welded joint SUS pipes.

4) When BWMS is installed on the exposed deck, it should be confirmed whether each item of equipment is grade IP 56 or more.

5) If the BWMS is such a type that it generates hazardous gas such as hydrogen gas after treatment, discharge pipes for the hazardous gas should lead to a safe area outside the enclosed space.

6) The discharge pipe should be a fully welded joint without flange joints, but if flanges are used, the number shall be minimized and a hydrogen gas detector must be installed near the flange joints.

7) If the chemical used as the active substance contains ingredients that can be used for the safety of the crew, it cannot be installed inside the engine room and should be installed in a separate place.

8) When BWMS using chemical substances is installed, the MSDS data must be kept on the ship at all times, and emergency medicine in case of any crew accidents must be kept and managed by the responsible officer. Safety protective gear for the handling of the material must always be provided.

9) Cargo operations are carried out while the vessel is at anchor, and the ventilation system of the engine room is operated at minimum, but it is necessary to operate the ventilation fan of the engine room normally while

operating the BWMS using hazardous gases and materials as active substance.

10) In cases where the BWMS related equipment is installed in the engine room and injects the treatment material into the main piping of the ballast pump installed in the pump room, the related requirements shall be followed.

- Must be used only when injecting.

- The ballast water between the engine room and the pump room should be injected through the deck without penetrating the bulkhead.

- Install appropriate shut-off means (two pairs of check valves and spool piece or water seal or double block bleed valve) in the cargo area for counterflow to the injection pipe.

2.4 Electrical Installation of Ballast Sampling Type BWMS

2.4.1 Sampling directly from ballast pipes with a TRO (Total Residual Oxidant) Sensor Unit or a Gas Sensor Unit should be approved explosion-proof types even when installed outside the dangerous areas.

2.4.2 If installed in a safe space, the electrical equipment should be of appropriate type for the areas.

3. Bulk Carrier / Container Ship

3.1 Reference rules for installing BWMS

3.1.1 Rules for ballast pumps (Pt.5, Ch 3, Sec 4)

1) All ballast tanks are to be connected at least two power driven ballast pumps. One of them can be driven by the main engine.
These pumps can also be considered as independent power ballast pumps if the independently powered bilge, hygienic water, and general service pumps are properly connected.

2) However, when draining by gravity from the topside tank, a screw-on type stop valve with a closure timing that can be operated from an easily accessible location on the freeboard deck can be used. In addition, in cases where a cargo oil pump is installed, capable of sucking ballast water for emergency use such as an oil tanker, the cargo oil pump may be regarded as one independent power ballast water pump.

3.1.2 Rules for ballast water tank and drain valve (Rule pt5, ch6, sec.4)

1) Appropriate countermeasures such as a check valve with indicator or stop valve should be used to prevent the flow between ballast tank to ballast tank and overflow from outboard. Where a butterfly valve (except remote control valve) is used, a holding device or equivalent should be added to prohibit the movement of the valve disk by vibration or fluid flow.

2) Where a remote control valve is installed, if the control power is lost then the valve is to be closed and keep in position. Alternatively, where it is easy to manually close the valve if there's a power loss, the position of the remote control valve should be retained.

3) Installation of sea chest allows for ballasting or deballasting by gravity in exclusive ballast tank. But, the related valve should be controlled from the freeboard and double stop valves. It will be decided by the type of BWMS after entry into force of the convention but the most BWMS are in-line type. Thus, this installation may not be allowed.

3.2 Dangerous Zone

3.2.1 Arrangement in accordance with dangerous cargo loading in general cargo carrier, bulk carrier and container.

1) In cases where loading flammable cargo in accordance with IMSBC Code[8] or IMDG code[9], the cargo hold and its ventilation duct into which the dangerous goods are loaded will be indicated as a dangerous zone.

8) IMSBC Code : International Maritime Solid Bulk Cargoes Code

9) IMDG Code : International Maritime Dangerous Goods Code

2) In the case of Class 2.1, 3 (flash point ≤ 23 ° C), 6.1 (flash point ≤ 23 ° C), cargo of class 8, or cargo of class 4.3 in bulk form, when installing a ballast water treatment system in such a dangerous zone within 3m from ventilation openings, explosion-proof electrical equipment shall be installed.

3) The limited usage related to the loading of dangerous cargo is not considered in case of installation on engine room.

3.2.2 In case of installation inside ro/ro carrier and car carrier

1) The closed ro/ro space or closed car space is classified as a dangerous zone.

2) Nevertheless, if the enclosed zone is mechanically ventilated 10 times per hour and the warning device for ventilation failure is installed in the bridge, only the area below 450 mm above the deck is designated as a hazardous area from each platform. In the case of installation above 450mm, it is allowed if the electrical installation is sealed and protected (IP55 or above) and the surface temperature does not exceed 200°C to prevent the scattering of sparks.

3) All spaces under the bulkhead deck, if applicable to special category spaces, are classified as hazardous regardless of the number of ventilation.

3.3 Installation of BWMS

3.3.1 Installation of electrolysis BWMS (full flow type)

1) Installation inside engine room

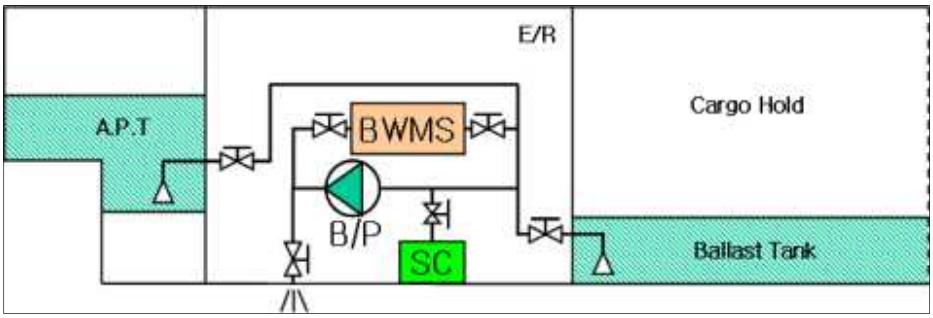
- Below [Fig 31] is the schematic for BWMS installed inside engine room.

- Applicable treatment type is UV and electrolysis (direct).

- Ballast tanks in most cargo carriers except oil tankers are classified as a safe area, thus there is no particular issue installing the BWMS inside the engine room. However, in case of the system generating hydrogen gas, the discharge pipe for the hydrogen gas must lead to a safe area of open deck outside the engine room

- The discharge pipe should be a fully welded joint without flange joints, but if flanges are used, the number should be minimized and a hydrogen gas detector installed near the flange joints.

- During anchoring and cargo operations, the ventilation system at the engine room is operating at minimum but the engine room ventilation system is to be operated normally during BWMS operations where dangerous gas and goods are used as active substances.



[Fig. 31] Installed BWMS inside Engine Room

2) Installation outside engine room

- [Fig 32] is the schematic for an installed BWMS outside the engine room.

- Applicable type of treatment are the UV type and electrolysis types (direct).

- The above arrangement can be applied where BWMS is installed outside the engine room, because the engine is so small or there's difficulty in installing the piping.

- In case that the BWMS is installed on the ship's upper deck requiring ballast water to be pumped up to the BWMS, and the resulting head loss of ballast pumps should be considered. Also, an excessive vacuum may be found in the ballast pipes when shifting the ballast water downstream from an elevated place, hence countermeasures such as installation of vacuum valves should be considered.

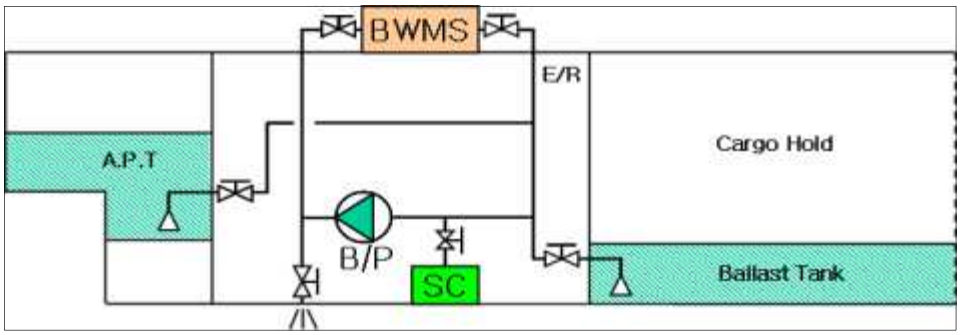
- BWMS is to be installed outside the dangerous zone as applicable. But, special consideration such as explosion-proofing should be applied in case of installation in car space, ro/ro space or cargo space as regarded as dangerous zone.

Moreover, additional protection measure must be considered in spaces which could be easily mechanically damaged due to unloading work.

- If the BWMS is such that it generates hazardous gases such as hydrogen gas after treatment, the discharge pipe of the hazardous gas should be led to a safe area outside the enclosed space since the hazardous gas may accumulate in the enclosed space.

- Where the BWMS is generating hydrogen gas and is installed in a closed space, a mechanical ventilation device (6 times/h) is to be installed.

- Where BWMS is installed on open deck, appropriate IP grade is to be considered and installed in a protected place to prohibit mechanical damage by cargo.



[Fig. 32] Installed outside Engine Room

3.3.2 Installation of injection type BWMS

1) Where a BWMS is installed with an ozone (O3) generator, an ozone detecting device is to be arranged with alarm in case of leakage.

2) Special consideration should be given to the piping transferring the generating ozone gas or chemicals - such as double walled pipes or full penetrated welded SUS pipes.

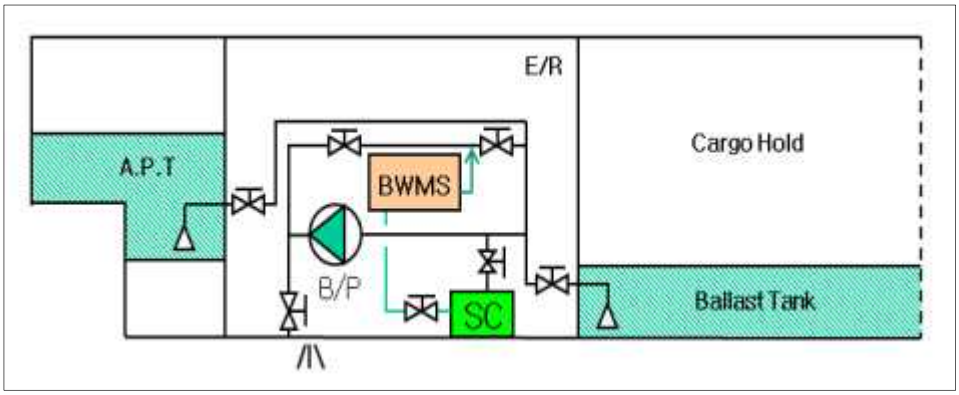
3) In case the BWMS generates hazardous gases such as hydrogen gas after treatment, the hazardous gas must not be leaked into the engine room and the discharge pipe led to a safe area outside the engine room.

4) The discharge pipe should be a fully welded joint without flange joints, but if flanges are used, the number should be minimized and a hydrogen gas detector installed near the flange joints.

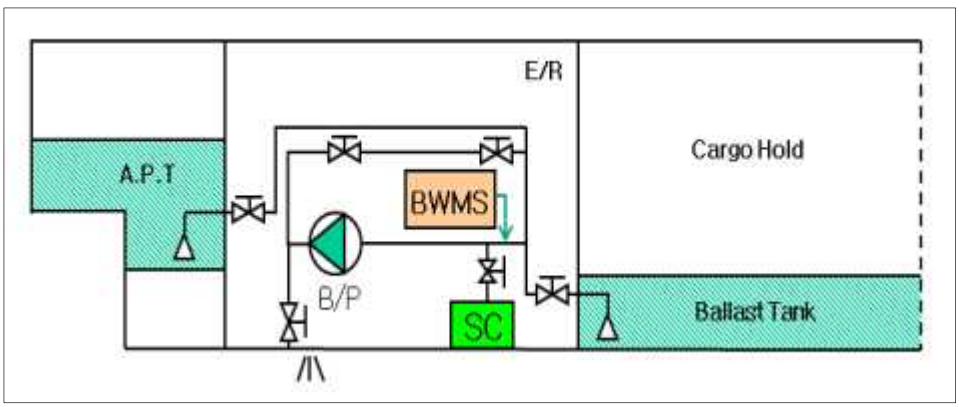
5) If the chemical used as the active substance contains ingredients that could threaten the safety of the crew, it cannot be installed inside the engine room and shall be installed in a separate place.

6) When a BWMS using chemical substances is installed, the MSDS data shall be kept on the ship at all times, and emergency medicine for crew should be kept and managed by the responsible officer. Safety protective gear for the handling of the materials must always be provided.

7) The cargo operations are carried out while the vessel is at anchor, and the ventilation system of the engine room is operated at minimum, but it is necessary to operate the ventilation fan of the engine room normally while operating a BWMS using hazardous gases and materials as active substances.



[Fig. 33] Installation of inside injection type BWMS(indirect electrolysis type)



[Fig. 34] Installation of BWMS outside(Ozone gas or chemical injection)

3.4 Special consideration

3.4.1 Bypass alarm and record of BWMS

1) Alarm is to be activated and recorded in case of bypass mode.

2) Bypass means that untreated water without BWMS treatment is flowing into the ballast tank, an audible and visual alarm is to be activated and recorded if this situation arises.

3) All valves related to the bypass mode must be remotely controlled and the automatic detection alarm should be in place.

3.4.2 Initial operation of BWMS

1) Where BWMS requiring the bypass or recirculation during ballasting and/or deballasting, interlock system for valve related to ballasting or deballasting is reflected and untreated water is not used for ballasting and deballasting.

2) Most of these arrangements are specified in the type approval conditions or in the drawings for type approval.

3.4.3 Stripping Eductors for BWT

1) Where bulk carrier are fitted with a large ballast water tank, eductors are only installed for stripping purposes.

2) If a vessel with such a layout adopts a BWTS in which ballast water is to be additionally treated at de-ballasting, all ballast water discharged through the stripping tube should be designed to be treated by the BWTS.

3) But, if the challenging water for stripping eductors is sea water (or fresh water on water) then sampling from the ballast tank is useless. Therefore, the installation of the sampling port should refer to MEPC67.

4) When ballasting or the de-ballasting is carried out without BWMS or a bypass mode is operating, the alarm is to be activated and recorded.

Section 4. BWMS Type Approval Limitation

1. General

When discussing the amendments to the Guidelines for Type Approval of the BWMS (G8, Res. MEPC.174 (58)), shipowners are required to ensure that the BWMS installed on their vessels meets the Regulation D-2. However, as a test requirement for type approval, it is practically impossible to reproduce all the world's most challenging conditions. This is the System Design Limitation (SDL) of the BWMS proposed, which compromises the shipowner's requirements. This specifies the range of water quality and operating conditions to meet D-2 requirements in the certificate, and when shipowner selects the BMWS for installation, it is possible to check the contents of the certificate and to install the most appropriate BWMS considering the ship's route and patterns.

2. BWMS Type Approval Limitation

2.1 Type Approval Limitation in accordance with BWMS Code

In the BWMS Code, the BWMS type approval limitation is divided into System Design Limitation (SDL) and Operation Limitation (OL). The concept of both limitations is very similar. That is, it refers to a specific parameters of the water quality conditions or the operating conditions for the BWMS to meet the D-2 Regulation. The BWMS Code requires that all type approval certificates specify the range of salinity and water temperature at which the BWMS can operate, as an Operation Limitation (See Figure 33. Type Approval Certificate Form).

According to Annex 6.2 of the BWMS Code, a type approval certificate could be issued without specifying SDL. However, the BWMS with unclear SDL will be difficult to select from users. The SDL is required to fill out the type approval certificate with the words 'This equipment is designed to operate under the following conditions', and BWMS would be expected to meet D-2 Regulation if the BWMS is operated within the range of SDL identified in the type approval certificate. Table 3 summarizes the parameters that can be identified as Operation Limitations by the treatment technology of BWMS.

Technology	Potential SDL		Control and monitoring parameters seen in BWMS	Design elements / related information
	Environmental / water quality parameters	Technical / operational parameters		
Filteration	• Particle size, quantity, and quality • Salinity and temperature	• Maximum flow rate • Minimum backflushing pressure	• Flow rate • inlet and/or outlet pressure or differential pressure(dP) • Minimum backflushing pressure	• Mesh size or retention threshold (nominal or absolute) • Filteration capacity (flow rate) • Creaning capacity (backflush) • Number or frequency of backwashes or cleaning cycles
Hydrocyclone	• Particle specific gravity, quantity, and quality • Salinity and temperature	• Pressure • Minimum and Maximum flow rate	• Flow rate • inlet and/or outlet pressure	• Capacity • Separation percentage
Ultraviolet (UV) irradiation	• UV Transmittance • Particle size and quantity • Salinity and temperature	• UV dose or intensity • Minimum and Maximum flow rate • Minimum holding time	• UV intensity and/or UV Transmittance • Current and voltage • Minimum and Maximum flow rate	• UV dose • Minimum flow rate to prevent overheating of reactor • CFD analysis of reactor design
Eloectro-chlorination	• Salinity and temperature • Conductivity or salinity and temperature of supplied water • Active substance demand	• Active substance dose (quantity or concentration) • Maximum flow rate • Minimum holding time	• Current and voltage • Active substance dose or concentration • Water temperature • Conductivity or salinity and temperature of feedwater • Flow rate • Holding time	• Active substance production rate
	• Salinity and temperature	• Neutralizing agent dose • Maximum flow rate	• Neutralizing agent flow rate or quantity • Flow rate • Concentration of active substance during discharge	• Neutralization storage quantity and dosing rate
Chemical injection (e.g. ozone, sodium hypochlorite, CLO_2, etc.)	• Salinity and temperature • Active substance demand	• Active substance dose (quantity or concentration) • Maximum flow rate • Minimum holding time	• Current and voltage • Temperature of ozone reactor • Active substance dose or concentration • Salinity and/or conductivity • Temperature • Flow rate • Holding time	• Active substance production rate or storage quantity and/or Active substance dosing rate
	• Salinity and temperature	• Neutralizing agent dose • Maximum flow rate	• Neutralizing agent flow rate or quantity • Flow rate • Concentration of active	• Neutralization storage quantity and dosing rate

Technology	Potential SDL		Control and monitoring parameters seen in BWMS	Design elements / related information
	Environmental / water quality parameters	Technical / operational parameters		
			substance during discharge	
Heat	• Salinity and temperature	• Minimum temperature and holding time • Maximum flow rate	• Temperature and holding time • Flow rate	• Heating capacity
Cavitation	• Salinity and temperature	• Minimum differential pressure • inlet and/or outlet pressure • Maximum flow rate	• Differential pressure • Flow rate	• Available differential pressure
Ultrasound	• Salinity and temperature	• Maximum Ultrasound power • Maximum flow rate • Maximum exposure time	• Current and voltage • Flow rate	• Frequency and amplitude of ultrasound delivery and Exposure time control
Deoxygenation	• Salinity and temperature	• Minimum inert gas purity (%) • Minimum injection rate • Minimum holding time	• Dissolved oxygen content • Inert gas purity(%) • Injection rate • Holding time	• Mixing equipment arrangement • Mixing flow rate/volume • Holding time
In tank treatment system - chemicals	• If the chemical used are appropriate	• Minimum uniformity of tank mixing • holding time	• Active substance dose or concentration in tank • Holding time	• Mixing equipment arrangement • Mixing flow rate/volume • Holding time
	• Salinity and temperature	• Neutralizing agent dose	• Neutralizing agent flow rate or quantity • Active substance concentration in tank	• Neutralization storage quantity and dosing rate
In tank treatment system – non-chemicals (e.g. inert gas, heat etc.)	• According to the proper parameter for the treatment mechanisms being used	• A portion of the tank • Water to be circulated • Minimum uniformity of mechnisms being used • minimum holding time	• Measurement of mechanism to ballast tank, or in ballast tank • Holding time	• Mixing equipment arrangement • Mixing flow rate/volume • Holding time

[Table 2] List of potential System Design Limitations and related self-monitoring parameters (BWM.2/Circ.00[10])

10) Circular number is not fixed yet. The SDL(System Design Limitation) will be demonstrated at MEPC 73th.

BADGE OR CIPHER (Limiting Operating Conditions apply)*

주관청명

NAME OF ADMINISTRATION

선박평형수관리설비의 형식승인증서

TYPE APPROVAL CERTIFICATE OF BALLAST WATER MANAGEMENT SYSTEM

이 증서는 선박평형수관리설비의 승인을 위한 Code (resolution MEPC. 300(72))에 포함된 상세요건에 따라서 아래의 선박평형수관리설비가 검사/시험되었음을 증명합니다. 다만, 이 증서는 아래에 기재된 선박평형수관리설비에 한하여 유효합니다.

This is to certify that the ballast water management system listed below has been examined and tested in accordance with the requirements of the specifications contained in the Code for Approval of Ballast Water Management Systems (resolution MEPC.300(72)). This certificate is valid only for the ballast water management system referred to below.

선박평형수관리설비명(Name of ballast water management system) .....

선박평형관리설비 제조사(Ballast water management system manufactured by): .....

형식 및 모델명(Under type and model designation(s) and incorporating) .....

장비 및 조립도면 번호 (To equipment/assembly drawing No.): ..... date: .....

기타 장비의 제조사 (Other equipment manufactured by): .....

장비 및 조립도면 번호 (To equipment/assembly drawing No.): ..... date: .....

정격처리용량 (Treatment Rated Capacity (m^3/h)): .....

이 형식승인증서의 사본은 선박검사 시 제시하기 위해 선박평형수관리설비를 설치한 선박에 항상 비치하여야 합니다. 만일, 형식승인증서가 타 주관청의 승인에 기초해서 발행되었다면 그 형식승인증서도 첨부되어야 합니다.

A copy of this Type Approval Certificate shall be carried on board a ship fitted with this ballast water management system, for inspection on board the ship. If the Type Approval Certificate is issued based on approval by another Administration, reference to that Type Approval Certificate shall be made.

운전제한조건은 이 증서에 기술되어 있습니다(Limiting Operating Conditions imposed are described in this document.).

(온도(Temperature) / 염분(Salinity))

기타 제한사항은 다음과 같습니다(Other restrictions imposed include the following): .....
이 장비는 다음의 조건에서 운전하도록 설계되었습니다 (This equipment has been designed for operation in the following conditions): .....

Official stamp Signed .....
Administration of .....
Issued this ..... day of ..... 20 .....
Valid until this ..... day of .....20 .....

[Fig. 35] Form of Type Approval Certificate described in BWMS Code

3. Type Approval Limitation described in Type Approval Certificate issued by Administrations

3.1 USCG

In the BWMS Code, the BWMS type approval limitation is divided into System Design Limitation (SDL) and Operation Limitation (OL). The concept of both limitations is very similar. That is, it refers to a specific parameters of the water quality conditions or the operating conditions for the BWMS to meet the D-2 Regulation. The BWMS Code requires that all type approval certificates specify the range of salinity and water temperature at which the BWMS can operate, as an Operation Limitation (See Figure 33. Type Approval Certificate Form).

According to Annex 6.2 of the BWMS Code, a type approval certificate could be issued without specifying SDL. However, the BWMS with unclear SDL will be difficult to select from users. The SDL is required to fill out the type approval certificate with the words 'This equipment is designed to operate under the following conditions', and BWMS would be expected to meet D-2 Regulation if the BWMS is operated within the range of SDL identified in the type approval certificate. Table 3 summarizes the parameters that can be identified as Operation Limitations by the treatment technology of BWMS.

3.2 Korean Administration

In the case of Type approval certificate by R.O.K, the limiting conditions imposed are described in the appendix, but no operating limitations were noted except the description that tests for protection against heavy seas for the BWMS have not been carried out and the certificate does not cover that the BWMS is approved for use in the explosive hazardous areas. However, as the BWMS Code will be applied to the amendment of the Law of Ballast Water Management, the operating limitations including the range of temperature and salinity during the test will be specified.

3.3 Greek Administration

In the case of Type approval certificate by R.O.K, the limiting conditions imposed are described in the appendix, but no operating limitations were noted except the description that tests for protection against heavy seas for the BWMS have not been carried out and the certificate does not cover that the BWMS is

approved for use in the explosive hazardous areas. However, as the BWMS Code will be applied to the amendment of the Law of Ballast Water Management, the operating limitations including the range of temperature and salinity during the test will be specified.

3.4 Singapore Administration

In case of Type approval certificate by Singapore administration, operating limitations imposed by RO are described in the annex, and Pressure rating, Water temperature, Ambient temperature, Minimum flow rate, Maximum TRC, UVT, UVI etc. are limitation conditions for Filteration+UV.

3.5 German Administration

In case of Type approval certificate by German administration, as operating limitation, Maximum dosage of the Active Substance of TRO, a discharge concentration of TRO, neutralizing agent dose and Salinity are limitation conditions for Filteration+Electrolysis, and Ballast Water Temperature Range, Minimum UV-Transmittance(or Minimum radiation dosage) and maximum/minimum flow rate are limitation conditions for Filteration+UV. Depending on the manufacturer's option, Minimum Holding Time (Minimum retention time) may be set as the limitation condition.

4. Type Approval Limitation described in Class Approval Certificate

Class approval certificates mainly deal with the installation limitations according to the rules and the conditions that a manufacturer or ship owner should carry out after obtaining the type approval certificate in addition to the IMO requirements. See [Fig 36] for an example.

B. Approval Condition

1. Application & Limitation

1) This approval is granted on the basis of the test reports and the documentation type-approved by Korean Administration (Date: 4th Dec. 2009 and 24th May 2017)
2) The manufacturer should inform this Society of all kinds of revisions of the equipment including software. If the changes are recognized to affect functionality of the approved equipment, type test to confirm the reliability of the revised equipment may be performed in the presence of our surveyor.
3) Unless specially directed by an Administration, this approval is not to be construed as a substitute for the Administration's approval.
4) This certificate will be automatically revoked when the type approval certificate issued by the Korean Administration is not valid.
5) Any latest conventions or requirements setteled by International Maritime Organization or Administrations should be retroactively applied at the earliest possibility.
6) In case where this system is installed on board, the system drawings for individual vessel are to be approved and/or reviewed by this society.
   - Piping diagram of ballast system including ballast water management system
   - Installation & outline drawings of ballast water management system
   - Drawings of main instruments of ballast water management sytem
   - Instrument lists of ballast water management system
   - Power and communication diagram
   - Operation and maintenance manual
   - Other documents requested by this Society
7) Treatment Rated Capacity (TRC) for the above models may be considered by installation of multiple units in parallel, provided that the ultimate functioning and effectiveness of the system on board a ship of the type and size for which the equipment will be certified will not be adversely affected as set out BWM.2/Circ.8.
8) Minimum radiation dosage (250mJ/㎠) must be maintained at any time.
9) Components composed of ballast water management system shall not be installed on exposed weather deck.
10) Explosion-proof certification by a notified/recognized certification body is not covered by this certificate. Ratings and special condition for safe use in hazardous areas are to be obtained from the relevant valid Ex-certificate.

2. Individual Product Cert. and Drawing Approval Requirement

1) Individual product certification is required.

3. Marking

1) The product or packing is to be marked with the manufacturer's name and type designation on a suitable position.

4. Others

1) Test condition

Test	Condition	Remark
EMC	All locations excluding the bridge and deck zone	-
Temperature	5 ~ 55℃	-
Vibration	Acceleration ±0.7g	-
Degree of protection	IP44(PCP, PBP and PRP)	-
Salt mist	Not Applied	-

* Remark
  Degree of protection for each component is to be verified by system drawing approval.

< The End >

[Fig. 36] An example of approval limitations described in Class type approval certificate

Chapter 3. BWMS Considerations for Ship-owners

Section 1. Operational considerations by type of BWMS

1. UV System

It is easy to install and modify and there is almost no safety problem from the viewpoint of the classification society. It works independently regardless of salinity and temperature. Because it does not use chemicals, it is eco-friendly and can handle a large capacity. However, since the UV system is water-permeable (UV-T) dependent, it does not work well in turbid water. The US Coast Guard's interpretation that all micro-organisms released on the US coast must be killed before de-ballasting, rather than rendered simply infertile, means that the type-approved filter + UV system is more sensitive to water turbidity and may require longer holding times. Accordingly, it is desirable to control the flow rate of the UV type BWMS so that it can be treated for a longer time when treating seawater in a high turbidity region. If the UV lamp and filter are faulty, the entire system cannot be operated, so periodic inspection and replacement is necessary. In addition, special attention should be given to clogging by using the flushing mode of the filter provided by the manufacturer to prevent clogging of the filter.

[Fig. 37] General system configuration of UV type BWMS

Examples of maintenance items recommended by the manufacturer for each component are shown in [Table 3]

Component	Action	Time Interval	Notes
General	Test run the system: Run a ballast and/or deballast process. Follow up with a CIP process	Once a month	If the system, for some reasons, is not operated by normal ballast operations, it needs to be run to verify that it is in good condition
General	Inspect for corrosion and erosion damage	Once a year	
General	Calibration of sensors	Once a year (Flow meter: Every second year)	
UV reactor	Outer inspection of seals for leakage	Once a year	
	Check UV lamps for leakage	Once a year	
	Replace of UV lamps	Recommended to change all lamps after 3000 hours of operation.	UV lamp sets
	Replace UV sensor	IMO requirement: Every second year EPA requirement: Every year	
Filter	Inspection and cleaning of filter element	Once a year	Replace filter element, if damaged
	Outer inspection of seals for leakage	Once a year	If necessary, change faulty seals

[Table 3-1] Typical maintenance items of UV type BWMS

Component	Action	Time Interval	Notes
CIP[11] liquid	pH value check	Once every 3months.	
	CIP liquid level check	Once every 3months. Depending on number of UV reactor and ballasting frequency, the liquid check might have to be performed more regularly	If the CIP liquid level is low but the pH value is below 3, CIP liquid and water can be added to fill up the liquid level in the tank.
	Replacement of CIP liquid	When the pH value is higher than pH 3 or once a year. or When the CIP module has been inactive for over one year	
	Control of stored CIP liquid	Visual inspection after three year	
Valve block on CIP module	Control that the cables are firmly attached to the terminal strip.	Once a year	
Valves and actuators	Control that the component, cables and hoses are firmly attached	Once a year	
Power cables	Check power cables connections	Once a year	
Control system	Replace battery[12] in PLC module	When alarm PLC battery low is indicated in the control system or after 5 years.	Automatic check when the control cabinet is turned on and every 24 hours.

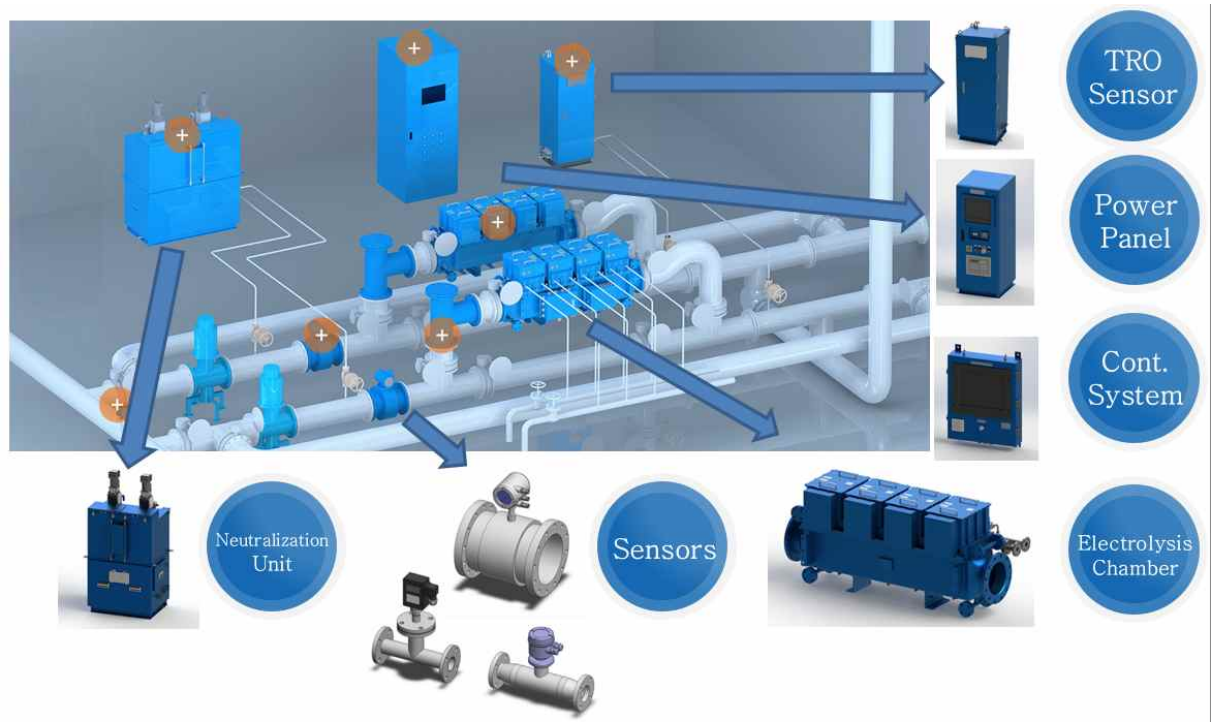
[Table 3-2] Typical maintenance items of UV type BWMS

11) CIP : Cleaning in plac, It is a solution for the cleaning of UV Lamp, and it is called by various names by manufacturer.

12) Refer to PLC module battery is not available in some cases.(In most cases it is supplied from the Panel and not connected to the Battery)

2. Electro chlorination (Full Flow) System

In addition to being able to handle large volumes, electrolysis-based systems are very efficient, and the treatment of water is done only during ballasting and neutralizes the TRO during discharge. The power consumption is low and the pressure loss in the piping is also low. One of the disadvantages is that a small amount of hydrogen gas is generated during the electrolysis and installation of the gas detector is necessary, which is a safety factor. In addition, the electrolysis system is sensitive to salinity and low temperature, so salt or heating systems should also be installed. Finally, the installation, control and maintenance are more complicated than UV + filter systems. As described above, there is a difference in performance depending on the water temperature and salinity of each main port. In particular, in the case of BWMS where the BWMS performance is restricted in the freshwater area, it is desirable to install a separate salt tank on the ship to increase the salinity of freshwater which may lead to an increase in power consumption.



[Fig. 38] General system configuration of electrolysis (Full flow) system

Examples of maintenance items recommended by the manufacturer for each component are shown in [Table 4]

Component	Action	Time Interval	Notes
Electro-Chamber Unit	Total Ballast Operation Time on HMI	Every 200 hours[13]	Clean Electro-Chamber Module with washing unit
Power Rectifier Unit	Clean cooling water inlet hose	Once a year	Clean with compressed air brushing
TRO Sensor Unit	Overhaul air pump	Once a year	
	Clean 2-Way Solenoid Valve	Once every 6 months	
	Clean inline T-strainer of CLX Online Residual Chlorine Monitor	Once a month	Clean with compressed air brushing
Auto Neutralization Unit	Clean Fresh Water Tank	Once a year	Clean F.W tank with fresh water
	Overhaul metering pump	Once a year	
	Clean strainer of ANU tank	Once every 6 months	
Flow Meter Unit	Check operation status of TMS[14] Program	Once a month	Conduct self function test
Conductivity Sensor Unit	Clean sensor	Once every 6 months	Clean with compressed air brushing
Gas Detection Sensor	Check appearance status of GDS & input cable	Once every 3 months	Clean with compressed air brushing
T-Strainer[15]	Clean T-strainer	In case the differential pressure increases to 0.5 bar	

[Table 4] Typical maintenance items of electrolysis (Full flow) system

13) Since the residence time of the electrolytic chamber varies with each manufacturer, refer to OMSM for each BWMS.

14) For checking the status of the sensors connected to the BWMS called Total Measuring System, refer to the different names that are described by each manufacturer.

15) The T-strainer serves as a filter, but the size of the filter is larger than 50 μm (60 to 300 μm). Note that most full flow BWMS with a filter other than the T-strainer are used.
Refer to the different names that are used by each manufacturer.

3. Electro chlorination (Side Stream) System

The basic principle is the same as the electrolysis (Full flow) type BWMS. The advantage is that it is relatively easy to arrange it on ballast water main piping because it requires a relatively small space when installing the BWMS. The disadvantage is the need for additional seawater tanks, piping and feed pumps for electrolysis.

[Fig. 39] General system configuration of electrolysis (Side stream) system

Examples of maintenance items recommended by the manufacturer for each component are shown in [Table 5]

Component	Action	Time Interval	Notes
Back-flushing filter[16]	Remove the element from the filter and clean it by freshwater gun	Once a year. Or When the filter is clogged	
Electrolysis Unit	Clean the strainer and replace it if necessary	Once a year	
	Check the power consumption and wash it by the acid liquid it if necessary	Once every 2 years. Or When power consumption is increased by 20 %	Refer to the de-scaling method of manual
	Calibrate the H2 sensor at recommended intervals.[17]	Once every 6 months	
	Calibrate and clean the conductivity sensor at recommended intervals.	Once every 2 years	
Neutralization / Salinity Unit	Clean the strainer and replace it if necessary	Once a year	
TRO Sensor	Check the T-strainer and clean it if necessary	Once a month	
	Check the check valve and pump tubing inside TRO sensor and flush or replace it if necessary	Every 3 months	
	Replace consumable parts - Indicator & buffer of reagent kit	At each intervals - Every 3 months & a year	
Back-flushing & Booster Pump	Check the seal leaks and replace it if necessary	Once a year	
Ballast piping line	Clean ballast piping line during sailing	After every de-ballasting operation	Purpose: To remove mud in the main pipe caused by de-ballasting

[Table 5] Typical maintenance items of electrolysis (Side stream) system

16) If the pressure difference between the forth and back of the filter occurs and the differential pressure sensor continues to operate, it will automatically backflush. Note that if the backflushing operation is continued without the filter element being securely held, an alarm will occur frequently and the filter element will need to be well maintained, since the device will retire quickly.

17) For safety, the calibration of the H_2 gas sensor must be performed. Some manufacturers offer leaf gas sensors as well, and physically refer to the fact that H_2 gas sensors provide alarms first because the reaction of leaf gas is slower than H_2 gas.

4. Chemical Injection System

Generally, the power demand for this system is low because energy is consumed by dispersing chemicals in ballast water. Because the dosing[18] pump is used as a basic component, the system is easier to install than other technologies and requires a relatively small space. However, the chemicals used are trademarks such as Peraclean™ or Purate™, and the supply may be limited at certain ports. In addition, the chemicals must be kept in closed containers and can be dangerous. Using chemicals requires strict safety practices and crew training. Regular storage of chemicals means additional operating costs compared to the UV or electrolysis.

[Fig 40] General system configuration of chemical injection system

Examples of maintenance items recommended by the manufacturer for each component are shown in [Table 6].

18) Chemicals are in liquid form and powder form. In case of powder types, care should be taken not to generate dust when injecting. Some manufacturers have devices that automatically feed powdered medicines. Whether liquid type or powder type, the safety of the crew should be a priority.

Component	Action	Time Interval	Notes
Metering Feeder Unit	Check terminal	Once a year	
	Check working air pressure	Daily	
	Check cooling water tightness periodically	Once a year	
Dissolving Unit	Check terminal	Once a year	
	Check relief valve	Once a year	
	Check cooling water tightness periodically	Once a year	
Neutralizer Unit	Check terminal	Once a year	
	Check safety valve	Once a year	
	Check cooling water tightness periodically	Once a year	
Sensors & Instruments	Calibrate instruments	Once a month	
General	Check leakage of water or air	Daily	

[Table 6] Typical maintenance items of chemical injection system

5. Ozone System

Ozone is produced from oxygen in the atmosphere through an Ozonation unit, which is then injected into a ballast water tank to sterilize the microorganisms in the ballast water. It is eco-friendly in that it has excellent sterilization performance regardless of salinity or turbidity of seawater, and it is not necessary to input chemical substances. Maintenance costs including power consumption are reduced as a ship's size increases. The disadvantage is that it is necessary to manage the safety of the ozone gas because ozone gas itself is harmful to the human body and the environment, and the basic power consumption is higher than that of the electrolysis and UV type due to air compression, etc.

[Fig. 41] General system configuration of Ozone system

Examples of maintenance items recommended by the manufacturer for each component are shown in [Table 7]

Component	Action	Time Interval	Notes
Air compressor and air dryer	Check oil level	Daily	Replenish if insufficient
	Check compressor temperature	Daily	
	Check oil separator element (differential pressure)	Daily	
	Check safety valve	Once every 3 months	Change if abnormal
	Check oil return line & after cooler	Once every 3 months	Clean, if necessary
	Check oil separator element (differential pressure)	Daily	
	Change oil & oil filter element	Once every 6 months	Change after initial 500 hours (1 month)
	Change air filter & separator element	Once every 6 months	Change after 3000 hours
	Check suction valve & min. pressure valve	Once a year	Change if abnormal
O_2 generator	Check filter element	Every 4000 hours	
	Check consumables (repair kit of valves)	Once every 2 years	Replace if necessary
O_3 generator	Check cooling water tightness periodically	Once a year	
	Check condensation drain	Once a year	Open periodically the 1/4" plug at the outlet of the pressure relief
Water chiller	Check lubricating oil	Once every 2 months	
	Check safety, protection equipment	Once a year. Or every 6000 hours	Contact the manufacturer
	Overhaul compressor	Once every 6 years. Or every 28000 hours	Contact the manufacturer
General	Warming up operation	Once a month	To maintain the system in a good condition

[Table 7] Typical maintenance items of Ozone system

Section 2. Operational problems after installation of BWMS

It has been reported that many BWMS have operated abnormally as a result of operational problems, which has been a serious additional cost to the shipowner. Therefore, this section discusses ways to prevent operational problems after the installation of the BWMS.

1.1 Training

Compared to other marine and ocean equipment, the BWMS is obviously unfamiliar to crew members. Therefore, training on the system is an important way to solve the most serious operational problems. It is important that the training is performed in a consistent way, and careful attention is required where a BWMS has been specifically designed for a ship. In case of the Republic of Korea, Article 9 (3) of the Ballast Water Management Act and Article 18 of the Enforcement Regulation of the same Act, the crew are obliged to undertake training. According to the relevant provisions, the shipowner must ensure that the crew members in charge of ballast water management are trained in the following matters, by a designated training organization more than once every five years.

① Ballast Water Management Convention
② Procedure of management for Ballast Water and Sediments
③ Operation of Ballast Water Management Plan
④ Writing of Ballast Water Management Records

The Government of Republic of Korea requires that the designated training organization should construct a curriculum to develop the insight to prevent and resolve problems through active discussions on the issues regarding the implementation of the BWM Convention and the problems arising in practice.

- **Training methods**

Visual material, field training and computer-based lectures are training methods used currently, and simulation tools developed by the manufacturer are also provided. These methods are effective and the shipowner requires comprehensive training materials including operational guidelines that are updated periodically, to be organized systematically and specific to the vessel. Shipowners with fleets equipped with various types of BWMS have skilled crews for specific types of BWMS, but the crews may lack knowledge on other types of BWMS. Therefore, enabling crews to work on various ships would be a way of gaining experience and knowledge of the various operational procedures of the BWMS.

The training may be thought of as only necessary for the crew, but the shipowner should regard managers and port engineers as trainees too. The manufacturers sometimes conduct training sessions at manufacturing plants, but their availability is limited. Therefore, for the technical managers, shipowners should ask their vendors to perform the training at the shipyard or port. Then, the technical managers can provide technical training to the crew. If technical managers are trained on their knowledge of BWMS, shipowners will benefit.

1.2 Qualification

Regardless of training method and period, normal maintenance of BWMS may not be guaranteed without minimum criteria for the qualification. As computer-based tests may provide records and certifications for crew management, it is recommended that records and certifications should be used. It is desirable that the training is conducted focusing on the operation of the BWMS because the training is not always enough to fully acquire and apply the technology of BWMS in practice.

- **Sampling**

As the D-2 regulation of the BWM Convention is applied, detailed guidance on performing the appropriate sampling procedure is required, field training and training on recording procedures. In addition, alternative sampling methods and procedures required by third-party should be studied.

As described in Chapter 2, Section 4, if the survey proceeds up to Phase 4 according to the PSC Guideline, the crew will be well-acquainted with the sampling method to demonstrate the integrity of the ship. If the crew is not well-acquainted with the sampling method, they must learn because it is a non-conformity reason in phase 2 of the PSC Guidelines.

1.3 Operation

Operational issues arising from BWMP may be resolved and prevented. Therefore, it is very important to be well-acquainted with the approved BWMP, and necessary to understand the functions of the installed BWMS.

- Sequence

During the design phase, issues that may arise in the sequence of startup and shutdown should be considered due to the fact that many shipowners are concerned about inadequate shutdown resulting in stopping the BWMS and inappropriate lamp cooling. As it is not easy to re-program the sequence during the operation of BWMS after installation, it is important that the program is tested and modified during the commissioning period.

- Equipment of filtration

As backflushing occurs in the filter during ballasting, the backflushing line shall be directed to the outboard side. The amount of backflushing shall be monitored

carefully and adjusted if necessary. This may be resolved using appropriate SEA CHEST, changing the pressure setting value, switching between filter candles and so on. The backflushing performance of piping may help relieve accumulation of sediments. However, careless backflushing may cause damage to the BWMS components such as a UV lamp.

- Storage of Data

All BWMS must be able to automatically store data for at least 24 months in accordance with the BWM Convention. Accordingly, many approved BWMS store log data automatically. However, log data is sometimes lost. Therefore, the shipowner should regularly verify the log data and each system should store data for at least a month. It may be requested for review by PSC and USCG. The data can be used by the shipowner to review any recent problem and to check the performance of BWMS. For reference, the data may be stored on supplementary means (e.g. removable storage device), but the data (records) should always be available or printable on request for a required formal inspection. If the control unit is to replaced, the means to make the data available for 24 months, should be provided onboard. Therefore, if unavoidable replacement or repair is required, the data should be verified by the manufacturer of the BWMS for 24 months from the time of repair.

- Consumables

Chemicals are important for operating several BWMS. It is very important to confirm the method and plan for storing consumables and the expiration date of the consumables. The crews may be in danger when exposed to these chemicals. Therefore, they must be thoroughly trained, and know the correct way of using them. Careful attention must be paid to expiration dates; several consumables (e.g. DPD and Buffer solution of TRO sensor) may become invalid (outside of the

expiration date), this is most frequently highlighted during any document review as Phase 1 of PSC Guidelines.

4. Maintenance

The preparing and carrying out of maintenance plans, preliminary planning for sediment disposal and planning for consumable usage is a very important issue. Therefore, the risks arising from the BWMS must be identified and BWMS operations in the enclosed space in the hazardous area must be precisely reviewed.

- Maintenance plan

Shipowners and manufacturers must consider the annual survey plan of the BWMS when preparing any safety plan for maintenance. As part of the survey, a number of service engineers are to confirm the components of the BWMS, software updates, and the ways of accessing hazardous areas, and the crew must confirm potential troubleshooting actions and updated recommendations from the BWMS manufacturer. The survey must identify any source of failure and seek to understand the differences and commonalities between the subject ship and other ships.

A number of BWMS determine the dosage of disinfectant and detect the degree of neutralization by measuring the TRO (Total Residual Oxidant). Reagents used for the TRO measurements are vulnerable to improper storage and use, and any abnormal operation of the TRO sensor may cause a series of problems. In addition, a calibration of the TRO sensor will be required periodically. Prior to the entry into force of the BWM convention, many vessels equipped with BWMS did not operate their BWMS. However, when the entry into force of the BWM

Convention was imminent, problems occurred, as a result of using solution which was used for commissioning. Although the reagents were replaced, crystallized salt grains and other materials may have adversely affected the sensor due to cleaning operation having been performed inadequately. For that reason, in many cases the TRO sensor needed to be replaced and repaired.

For UV systems, the costs of replacing UV lamps are quite high and the volume of ballast water may be reduced during ballasting and de-ballasting as a result of filter clogging, where the filter is applied. Therefore, it is very important to conduct thorough training on the systems and procedures used onboard.

For most filters, the pressure sensor is installed at both ends of the filter as a differential pressure sensor. If a differential pressure occurs, backflushing is performed to wash the filter with high pressure seawater or fresh water. If excessive backflushing occurs in the process of the filtration, treated water may flow less than TRC (Treatment Rated Capacity) into the ballast tank. This phenomenon is caused by poor water quality in the area where the ship is located. Therefore, the ship should prepare for BWMS operations taking these matters into consideration.

- Management of sediments

Problems regarding the treatment of sediments occurs when the ballast water is not ballasted by the BWMS. An appropriate rate of filtration effectively removes microorganisms and improves the performance of filters. However, it is not able to prevent the generation of fine soil in the tank. Therefore, several shipowners use ultra-fine filters to prevent excessive accumulation of sediments.

- Consumables

The matters regarding the consumables are important for maintenance. Chemicals and the UV lamps BULB must be replaced frequently and replacement cycle is crucial in a case where the lamps causes system failures. The expected lifetime of most UV lamp BULB is not predictable due to cooling water problems and the damage caused by frequent start-up and shutdown. Therefore, reviewing the performance of the consumables is required before and/or after replacement of the consumables.

Several shipowners have experienced operational problems before and/or after installation, as a result of their experience with vendors. However, if the vendor goes bankrupt, it's necessary to find a way to solve any serious problem in the future. Therefore, it is necessary to assess whether or not the vendor's technical support will be available in the long term. Shipowners must plan ways to supply the consumables smoothly in the event of problems securing long terms technical support from the vendors.

2. BWMS Management Guideline by BWMS type

2.1 UV TREATMENT

[Fig. 42] Example for typical field installation of BWMS using UV technology

A. Crew training

Shipboard and marine training	
Training period	2 hours ~ 24 hours
Training method	Onshore crewing office seminar / Training using software / commissioning
Purpose of training	Solving matters of BWMS occurring in shipyard
Trainer	Staff of manufacturer or service engineer
Trainee	Crews and technician of ship yard
Materials of training	Specification of manufacturer and CD/DVD (e.g. movies for replacement of filter and UV lamps)
Challenges	1. Problems regarding adaptability of crews (No previous experience) 2. Continuous changes of the crew (Continuous training is required.) 3. Difference of BWMS type and manufacturer by ships 4. Training of sampling 5. Training of monitoring and records to meet requirements regarding PSC and requirements as stated in VGP. 6. Sufficient training period required by manufacturer for providing brief and detail training with qualified trainers and trainee

B. Failure and Issues occurring possibly when operating or installing BWMS on board

Hardware failure	Ignition of UV lamp
	Requiring frequent cleaning of UV lamp, Frequent failure of UV lamp, Abnormal circulation of UV
	Failure of UV intensity sensor
	Failure of backflushing filter pressure switch
	Error of hard disk in control panel
	Cartridge of flow meter (malfunction of LCD)
	Flooding of reactor due to seal defect
	Defects of minor components such as plastic switches.
Software Failure	Failure of GPS communication
	Cartridge of flow meter (malfunction of LCD)
	Requiring frequent update of software, malfunction of control panel due to lack of compatibility with software version.
Health and safety issues	Damage of lamp due to waterfall
	Misuse of manually operated valve
Reduction in ballast rate	Reduced by 3 to 4 % according to vessel trim and list
	Reduction of pumping capacity (ballast pump)
	Influence of soiled UV lamp

C. Events, issues and challenges for BWMS maintenance

Events, Issues and challenges	1. Backflushing cycle is performed to maintain a good status of differential pressure sensor. If the chamber is full of water and has not worked recently, manual cleaning needs to be performed periodically. 2. All pneumatically actuated valves of UV filter are operated to maintain a robust condition and prevent adherence. 3. Conducting operational test of BWMS over 6 hours (3 hours : Ballasting / 3 hours : de-ballasting) 4. Due to the limited availability of service engineers who provide administrative support when ships are in remote locations, sales networks rarely meet basic standards. 5. Errors of control panel occurred about 1.5 years after installation. The software shall be updated by the maker. 6. Cleaning filter / replacement of UV lamp

D. Issues and challenges for consumables

Issues and challenges	1. Frequent failure of UV lamp, Frequent replacement of UV lamp 2. Spare components are expensive. (UV lamps are the most expensive.) 3. The weakest components are UV sensors, purge units and lamp wipers.

2.2 Electrolysis (Full-flow type)

[Fig. 43] Example for typical field installation of BWMS using Electrolysis technology (Full-flow type)

A. Crew training

Land-based and Shipboard training	
Training period	3 hours ~ 8 hours
Training method	Onshore crewing office seminar
Purpose of training	Solving BWMS matters occurring in shipyard
Trainer	Staff of manufacturer and service engineer
Trainee	Crews and technician of ship yard
Training materials	Specification of the manufacturer, CD/DVD
Challenges	1. The system and quality of training materials are different according to the fleet, and skills and basic training are required. In addition, the operating interface of crews differs throughout the system. 2. It is necessary to confirm whether or not BWMS installed onboard meets relevant requirements of U.S. code federal regulation and BWM convention simultaneously. In addition, if necessary, confirm whether or not additional BWMS construction is needed to meet the requirements of U.S. Code Federal Regulation and BWM convention simultaneously. 3. Repeated training due to replacement of crew and loss

	of information 4. It is important to be well-acquainted with information about new components and systems because of increasing exposure to the new components and systems. 5. Practical training is required to increase understanding of practical operational methods. - Practical training : Training course on operation and repair for ballasting and de-ballasting

B. Failure and Issues occurring possibly when operating or installing BWMS on board

Hardware failure	TRO sensor
	Filters clogging in certain ports/rivers
	Increase of pressure beyond the permissible values of filter inlet/outlet
	Failure of backflushing solenoid valve
	Abnormal operation due to non-performance of valve calibration
	Electrode scaling
	High flow rate of flow meter according to vessel head and other factors
	Unspecified sensor failure
	BWMS stop due to increasing temperature of rectifier
	Failure of TRO sensor
Software Failure	Valve order out of sync
	Rectifier communication
	Software update
	Valve position sensors - Active monitoring is required for suspicious valve position before start-up.
	Software communication regarding valve position sensors - BWMS is stop (Error of software timing) prior to opening and closing valve due to the fact that the control system of BWMS reacts quickly to the feedback signal from the position sensor of the valve of ballast system controlled by the BWMS. The BWMS control system reacts too quickly to the feedback signal from the position sensor of the ballast system valve controlled by the BWMS.
Human error	The system is very complicated and the human error may occur due to the fact that each system is installed in a separate location in the vessel.
Health and safety issues	Risks of chemicals injury occuring during the operation.
Reduction in ballast rate	Actural flow rate is reduced by 10 to 20 % of TRC due to backflushing of filters.

Other issues and challenges	Error is not notified by system when operating out of valid parameters.
	Frequent replacement of TRO reagent is required due to short lifetime of the reagent.
	In order to operate system, continuous participation of crews and carefully monitoring is required. In addition, the BWMS is shutdown periodically in the actual operating mode of the BWMS. Therefore, crews must pay more attention to operation of ballasting / de-ballasting than actual cargo operation.
	There is no officer who knows the BWMS well in the fleet. Therefore, it takes time to become familiar with the BWMS. In addition, lots of man hours are required because the system is complicated.
	Several sensitive sensors, transmitters, indicators are installed in system and, if maintenance is poor, possibility of occurring malfunction of system is high and the system may consume additional chemicals.
	Continuous calibration for components of the system is required.
	Space of maintenance is narrowed due to securing space of the system in engine room and cargo pump room.

C. Events, issues and challenges for BWMS maintenance

Events	1. In the event of system failure due to requirements of installation and service using complicated spare components, the system was not able to be used and it was difficult to supply spare components smootly. 2. There were 6 to 7 claims per ship, and the problems occurring during the operation after 2 years were minimized. Regular monitoring is required.
Issues and challenges	1. If maintenance is poor, failure of several sensitive sensors, transmitters, indicators and etc. may occurs. 2. Modification of TRO sensor 3. Consuming additional chemicals during BWMS operation 4. Activity of maintenance is not monitored. 5. Continuous calibration for components of the system is required. 6. Periodic maintenance is required according to the manufacturer's instructions.

D. Issues and challenges for consumables

Issues and challenges	1. Reliable supply of chemicals as consumables is required. 2. It is difficult to transport chemicals needed in some ports. 3. No other consumables are required apart from neutralization.

	4. Neutralized chemicals is solidified due to humidity. 5. It is necessary to replace the components of TRO sensor every 6 months. 6. It is necessary to paying attention to managing chemicals.

2.3 Electrolysis (Side-stream)

[Fig. 44] Example for typical field installation of BWMS using Electrolysis technology (Side-stream type)

A. Crew training

Shipboard and marine training	
Training period	2 days ~ 4 days
Training method	Onshore crewing office seminar / Training using software
Purpose of training	Solving matters of BWMS occurring in shipyard and/or by crews
Trainer	Staff of manufacturer or Service engineer
Trainee	Crews and technician of shipyard
Training materials	Specification of manufacturer and CD/DVD
Challenges	1. The system is different according to the fleet. 2. Problems regarding adaptability of crews (No previous experience, and new methods of approach and work) 3. Detailed specification is needed (lack of understanding). 4. Management of explosive gas

B. Failure and Issues occurring possibly when operating or installing BWMS on board

Hardware failure	Upper plate of filter is deformed because suppling valve of the ballast pump placed after filter is throttled (automatically controlled by BWMS) to maintain the flow rate according to rated capacity of BWMS.
	The main reason for fluctuating flow meter and TRO sensor trips is that the mixing chlorine and seawater by piping arrangement is not performed well. The flow rate of a liquid with electrical conductivity may be accurately measured by using an electromagnetic flow meter. However, defective mixtures of two different liquids (seawater, NaOCl) may affect the accuracy of the flowmeter. Therefore, new piping injection should be installed and time of reaction corrected. In addition, the piping is replaced to the piping with hole to improve the mixing ratio of NaOCl and sea water.
	A fluctuation of electromagnetic flow meter (flowmeter of the electrolysis unit, not the flowmeter of ballast system) may occur during operation. The fluctuation is caused by contamination of de-mister which is a component of the cyclone system. The top of the hydrocyclone which separates H2 gas and chlorine water is disassembled to release residual H2 gas. As a result of cleaning and reassembling inside of the de-mister, the flowmeter of electrolysis unit operates normally
	The accuracy of the conductivity sensor (seawater) is low. In general, salinity is measured as about 3 % in marine water. However, for ambient marine water, salinities measured at port rail and starboard rail were 2.6 % and 2.0 %, respectively.
	It is necessary for applying grease and installation of drain in TRO cabinet to prevent occurring moisture due to the fact that TRO sensor, sampling valve and electromagnetic control valve are very sensitive to corrosion.
	Defects of flowmeter : an abnormal alarm may be caused.
	Failure of rectifier
	Blockage of filter drain line
	Failure of valve actuator
	Abnormal operation of gas sensor
	Failure of various pump
	Faliure of hydrogen blower and filter during backflushing
	Defects of blower breaker may release H2 gas during electrolysis.
	Filter is clogged at certain ports / rivers.
Software Failure	There was a problem regarding operation of sensor during initial test of system. The significant portion of a neutralizing agent was consumed by the system controlling neutralizing process as per sea area. Therefore, the neutralizing agent shall be filled frequently in neutralization tank.

	The setting value (default) of the time delay is not sufficient to recognize the treated ballast water as acceptable values. The shutdown of the system is caused by the matters as aforementioned.
	The software update is required to deal with new methods of TRO and rectifier.
	Blower low pressure alarm is activated when the blower is stopped.
	Communication of BWMS and IAS should be designated two different channels of communication in order to minimize time spent searching for lost channel of communication.
	Periodic reboot is required on main computer.
	Malfunction of LOP monitor, Failure of TRO sensor due to communication fail and Malfunctioning alarm that occurs frequently during the operation.
	Error of server
Health and safety issues	Production of chlorine and hydrogen gas
	Handling toxic and corrosive chemicals
Reduction in ballast rate	Due to the high head of water occurring during de-ballasting (full ballast tanks), a higher capacity of pump than the rated capacity, is required during the de-ballasting. Therefore, the performance of the pump must be proved under conditions of de-ballasting operations.
	The pump injecting neutralizing agents in line shall be able to increase a capacity of the pump, however, the relevant regulations are not appropriate. Therefore, the matters regarding the capacity of neutralizing pump shall be reported to the Administration, and the regulations shall be amended to enable higher output.
	Flow valves result in vibration, deformation and abrasion which adversely affect the stability of piping equipment.
	The difference of capacity between rails may occur after installation of BWMS.
	The regulatory body or charterer shall consider the losses incurred in process of loading / unloading due to the fact that restarting BWMS takes time.
	Actual flow rate is reduced by 10 to 20 % of TRC due to back-flushing of filters.

C. Events, issues and challenges for BWMS maintenance

Events, Issues and challenges	1. The concentration of chlorine (ppm) is increased slowly by condition of BWMS shutdown (5.5 ppm). 2. In regard to crucial cargo operation, frequent alarms confusing for the crew. Frequent stopping of the ballast pump overheats motor starter. 3. The manual recording is required due to the fact that some

	parameters are not monitored and there are too many alarms to record.

D. Issues and challenges for consumables

Issues and challenges	1. The TRO sensor kit should be replaced every three months and enough spare is required. 2. A lot of time is spent due to supplying agent of TRO sensor. 3. The development of supplier for spares and consumables is required. 4. Limited shelf life of reagent / limited supply network

2.4 Ozonation

[Fig. 45] Example of typical field installation of Ozone system

A. Crew training

Shipboard training (100 %)	
Training period	3 hrs ~ 4 days
Training method	Onshore crewing office seminar
Purpose of training	Solving BWMS matters occurring in shipyard
Trainer	Staff of manufacturer or service engineer
Trainee	Crews
Materials of training	Specification of manufacturer, theoretical and practical materials of Service Engineers, and CD/DVD
Challenges	1. The system and quality of training materials are different according to the fleet, and skills and basic training are required. In addition, the operating interface of crews differs throughout the system. 2. Limited time and resources due to imminent supply 3. Training for sampling and monitoring 4. Continuous changes of the crew 5. Lack of continuing training and care of engineers 6. Training of maintenance prior to supply

B. Failure and Issues occurring possibly when operating or installing BWMS on board

Hardware failure	Oxygen sensor/analyzer
	Ozone sensor
	Water chiller
	TRO analyzer & sensor
	Ozone generator
	Ozone injection
	High/low dew point sensor
	Sampling system
	High temperature sensor
	Side stream valve actuator
	Pressure transmitter
	Breaker trips
	Mixing thermostatic valve
	Air dryer
	Low O2 pressure
Software Failure	Low O3 output
	Inability to store system data
	Incorrect output of log file
	There is no signal on the injection pump
	Malfunction of PLC, Failure of O3 production in automatical operation mode
	Error of de-ballasting mode during operation of pump
	During ballasting, the ballast water is de-ballasted and TRO is triggered.

	Auto sequence is not operated in de-ballasting mode.
	Serious water hammering occurs during operation of BWMS due to lack of time between starting recirculation pump start and recirculation outlet valve open
	During ballasting, automatic mode of BWMS is not able to perform initial leakage test, and leakage test is not operated automatically.
Coating of piping	Hole of O3 injection line
	Piping of neutralizing solution in P/R VOID is replaced due to pin hole.

C. Events, issues and challenges for BWMS maintenance

Events, Issues and challenges	1. TRO system results in continuous errors and requires constant management of data. 2. Frequent software updates

D. Issues and challenges for consumables

Issues and challenges	1. Limited shelf life of oxidant 2. The chemicals of TRO analyzer are constantly needed. 3. Neutralizing and stabilizing reagents shall be readily available in appropriate quantities. 4. The correct operation of the TRO analyzer is important for accurate measurement of residual oxidants and accurate consumption of neutralizing and stabilizing reagents.

Section 3. BWMS PSC Guide-line

1. International Maritime Organization adopted the Guidelines for the Port State Control (PSC) of the BWM Convention in 2014 (Res.MEPC.252 (67)) and follows the four steps of the PSC inspection procedure as shown in Table 8.

Port State Control – Inspection Guidance		
IMO/USCG	**IMO Guidance Res. MEPC.252(67)**	**USCG NVIC 07-04, Change 1 MI Notice 05-12**
Phase 1 / Documents	TA Certificate – Documentation BWMP- Training	TA Certificate – BWMP – BWRB Documents – IOPP Certificate
Phase 2/ Crew Knowledge	BWMS Inspection BWMP Review Operation Parameters	Crew knowledge
Phase 3 / Equipment Condition and Operation	Indicative Sampling & Microbial Analysis to D2 Standard	Vessel Examination Operational Inspection Equip. compare BWMS log to documents
Phase 4 / Sample Discharge	Sampling of discharge if warranted, Lab Analysis	Sampling of discharge if warranted, Lab Analysis

[Table 8] PSC Guide-line of IMO and USCG

1.1 The first phase, the initial inspection, will include a document review, such as a valid IBWM certificate, an approved BWMP from the Administration, and an overall visual inspection of the BWMS installed on board. In the second phase, a more detailed inspection will be carried out if it is confirmed that an IBWM certificate is not valid, expired or lost, or there's no BWRB, or BWRB, which does not meet the requirements of the Convention, or the condition of the ship or equipment does not correspond to the IBWM Certificate and BWMP, or no officer is designated in accordance with B-1.5 of the Convention.

1.2 During the second phase of the detailed inspection, the PSCO confirms compliance with the BWM Convention. If a ship needs to use BWMS, they can inquire whether the BWMS and related equipment are in good working order,

whether the crew is following safety procedures, whether the process is working perfectly, and whether BWMS is operating in accordance with the OMSM. The PSCO can inspect all of the components to verify that the BWMS is working properly. This detailed inspection can lead to a sampling step.

1.3 In the third phase, an indicative analysis to measure the dissolved oxygen concentration and residual chlorine concentration may be conducted as an indirect measuring means, and ballast water sampling will be performed to determine whether or not it is meeting the ballast water discharge performance standard (Regulation D-2). If the results of the indicative analysis exceed the criteria set out in the indicative analysis method to BWM.2 / Circ.42 referring to sampling analysis methods (to be determined in the future), a more detailed analysis may be performed.

1.4 The fourth step, which is the detailed analysis step to verify the satisfaction of D-2 standard, is performed according to the detailed analysis method of BWM.2 / Circ.42. The PSCO should not delay the movement, operation, and departure of a ship while waiting for the results of such detailed analysis which is expected to take several days or more. These guidelines also provide the list of detainable deficiencies which are so serious nature that a PSCO may warrant the detention of a ship, these include the absence of an IBWM Certificate, absence of a BWMP, absence of a BWRB, no designated officer has been nominated or result of non-compliance by sampling.

2. The USCG also will assess compliance as part of regular vessel inspection. This compliance approach will follow the similar regime in place for all other equipment inspection such as oily water separator, marine sanitation device etc.

For the first phase, a Coast Guard inspector will review documents including the type approval certificate and AMS acceptance letter. For the second phase, the inspector will verify the crew's knowledge regarding the use of the equipment and will verify the equipment's condition. If the inspector is not satisfied by these results, he or she can take samples of the ballast water discharge.

Chapter 4. Considerations of BWMS survey for surveyor

Section 1. Survey

1.1 Application (Rev.47 2018.7.1)

1.1.1 The BWM must apply to a ship which is designed or constructed to carry ballast water. Ships of 400 gross tonnage and above to which this Convention applies, excluding floating platforms, FSUs and FPSOs, will be subject to surveys and the ship shall be issued a Certificate after the successful completion of a survey.

1.1.2 This Convention will not apply to ships not designed or constructed to carry ballast water and permanent ballast water in sealed tanks on ships, that is not subject to discharge.

1.1.3 This Convention shall enter into force twelve months after the date on which not less than thirty States, the combined merchant fleets of which constitute not less than thirty-five percent of the gross tonnage of the world's merchant shipping. These conditions were met on 8 September 2016, the Convention entered into force as of 8 September 2017 accordingly.

2.1 General of survey (Reg. E-1) (Rev.46 2018.1.1)

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

.1 An initial survey before the ship is put in service or before the Certificate is issued for the first time. This survey shall verify that the Ballast Water Management plan required by regulation B-1 and any associated structure, equipment, systems, fitting, arrangements and material or processes comply fully with the requirements of this Convention.

.2 A renewal survey at intervals specified by the Administration, but not exceeding five years, is applicable. This survey shall verify that the Ballast Water Management plan required by regulation B-1 and any associated structure, equipment, systems, fitting, arrangements and material or processes comply fully with the applicable requirements of this Convention.

.3 An intermediate survey within three months before or after the second Anniversary date or within three months before or after the third Anniversary date of the Certificate, which shall take the place of one of the annual surveys.

.4 An annual survey within three months before or after each Anniversary date. Such annual surveys shall be endorsed on the issued Certificate.

.5 An additional survey either general or partial, according to the circumstances, shall be made after a change, replacement, or significant repair of the structure, equipment, systems, fittings, arrangements and material necessary to achieve full compliance with this Convention. The survey shall be such as to ensure that any such change, replacement, or significant repair has been effectively made, so that the ship complies with the requirements of this Convention.

2.1.2 Ballast Water Management System (BWMS) shall be type-approved by the Administration as well as this Society.

* How to check the Type Approval:

- Using e-MESIS: Class > Approval of M&E > Cert Management > Approval List
- Using Homepage (Internet): service > e-MESIS > approval index > Quick Search

2.1.3 The survey is to ensure that BWRB (Ballast Water Record Book) recording is kept appropriately and the officers and crew are familiar with their duties in the implementation of Ballast Water Management particular to the ship on which they serve and, appropriate to their duties, are familiar with the ship's BWMP (Ballast Water Management Plan).

2.1.4 For the regulation D-2, the survey shall confirm that type approve BWM system is installed on board and the system is in a satisfactory working condition. Performance test consists of "alarm and system shut-down test" and "operational and function test". Operational margin is to be adjusted by agreement between the manufacturer and the Society considering the condition of the vessel. (Please refer to the details on Guidance for approval of Manufacturing process and type approval, etc. Ch.3 Sec.35.)

No.	Item	Alarm & alarm equipment	Shutdown	Remark
1	Maximum treatment capacity	O (exceeding maximum capacity for 3 min.)	O (exceeding maximum capacity for 5 min.)	Depending on the manufacturer's specification. Alarm condition is to be subject to the BWMS specification and test result.
2	Minimum treatment capacity	O	O	Depending on the manufacturer's specification. Alarm condition is to be subject to the BWMS specification and test result.
3	TRO Sensor failure	-	O	
4	Abnormal Operation of bypass valve	-	O	
5	Abnormal operation of automatic valve	O	O	Shutdown in case of valve having main function taking into account of system operation.
6	Differential pressure of filter	O	O	Depending on the manufacturer's specification
7	Salinity	O	O	Depending on the manufacturer's specification
8	Minimum/maximum temperature of treated water	O	O	Depending on the manufacturer's specification
9	Emergency stop	-	O	
10	Overload of blower/fan	O	O	Depending on the manufacturer's specification
11	Blower/fan shutdown	-	O	If redundancy is arranged, shutdown is not required.
12	The concentration of explosive and toxic gases	O (LEL 30%)	O (LEL 50%)	Depending on the manufacturer's specification
13	Failure of control & monitoring equipment	-	O	
14	Low levels of neutralizing tank	O	O	Depending on the manufacturer's specification
15	High/Low TRO value (DPD type)	O*	O*	Depending on the manufacturer's specification and/or Type Approval Condition by Administration
16	High/Low TRO value (Other than DPD type)	O*	O*	Depending on the manufacturer's specification and/or Type Approval Condition by Administration
17	Ballast pump stop	-	O	BWMS shutdown (However, the exception of gravity ballasting)
18	High/Low UV Intensity	O	O	Depending on the manufacturer's specification and/or Type Approval Condition by Administration

19	UV intensity Sensor failure		O	
20	UV lamp Failure (One or more lamps)		O	
21	UV lamp high temperature	O	O	Depending on the manufacturer's specification
22	Power supply failure for rectifier, UV stabilizer and etc.	O	O	Depending on the manufacturer's specification
23	In excess of the allowable performance ranges of other systems	O	O	Depending on the manufacturer's specification and/or Type Approval Condition by Administration
24	Other equipment abnormal	O	O	Depending on the manufacturer's specification
25	Leakage of ozone	O	O	Depending on the manufacturer's specification
26	Ozone dosing	O	O	Depending on the manufacturer's specification

* Note

(1) Unless specifically required by the Administration, the minimum TRO value shall be verified through an additional biological efficacy test.

(2) In case of DPD type, when the reference value exceeds 3 consecutive times, an alarm is to be initiated. When the reference value exceeds 5 consecutive times, the BWMS is to be shutdown automatically. The measurement interval of DPD sensor shall not exceed 90 seconds. However, the first measured value after the start of the BWMS may be excluded as determining condition for alarm and shutdown, and the first measurement of DPD sensor shall not exceed 120 seconds from the start of the system.

(3) In case of other than DPD type, alarm and shutdown shall be activated when the TRO value exceeds consecutively for 4 minutes and 7 minutes respectively.

(4) There are to be means to activate stop valves, as applicable, if the BWMS fails (only for USCG).

(5) There are to be means that compensate for a momentary loss of power during operation of the BWMS so that unintentional discharges do not occur (Only for USCG).

[Table 9] Requirements for alarm and system shutdown

Item	Remarks
Operation records such as normal and abnormal operation.	
Operation records with regard to TRO, UV, ozone, ultrasonic, intensity or dosing of the plasma, etc.	
Operation record of factors that affects the performance of BWMS such as flow rate, temperature, pressure, salinity, and gas density, voltage, current and etc.	
Record of ballast pump operating conditions, the main valve open/close operating condition.	
Record of alarm, shutdown and recovery	
Record of data back-up of an external storage equipment	
Record of the GPS position in case of equipment linked with GPS	Recommendation
* Note (1) The control and monitoring equipment are to be able to store data listed items in Table 3.35.2 for at least 24 months. Furthermore, each data is to be stored in the interval of at least a minute. (2) Where the control and monitoring equipment is replaced, means is to be provided to ensure the data recorded prior to replacement remains available on board for 24 months. (3) Each operation data, alarm and shut down data is to be stored separately. (4) The control and monitoring equipment is to be designed not to be changed or eliminated by the crew.	

[Table 10] Required record items

2.1.5 BWMS Performance assessment may be hard to carry out under voyage area, vessel condition and weather. [Table 11] is may be used for operational and functional test as a recommendation.

Test item		Test requirements and test time	Remark
Requirement regarding alarm and stopping		Refer to Table 3.35.1	
Operation test	TRC (100%)	60 minutes	(1) Alarm and shutdown are not to be occurred. When alarm and shut down are activated, the test is to be performed again. (2) Operation test is to be carried out for both ballast and de-ballast mode. (A) For land-based testing, (a) Operational margin is ± 7% of applicable treatment capacity. (b) TRC and Minimum treatment capacity are to be carried out for operation test. (c) Alarm and shutdown due to flow rate can be overridden for minimum treatment capacity. (B) For shipboard testing, (a) Operational margin is to be adjusted by agreement between the manufacturer and the Society considering the condition of the vessel. (b) TRC is to be carried out for operation test.
	Minimum Treatment Capacity	30 minutes	
Flow variation test (ballast/de-ballast mode, each carried)		TRC(100%) → Minimum treatment capacity → TRC(100%)	(1) Flow variation test is to be applied for land-based testing only. (2) Alarm is to be allowed only one time when measurement is done by DPD type sensor and TRO concentration exceeds the permissible range. Alarm or shutdown is not allowed for any other operational parameters. (3) Flow variation is to be carried out as quickly as possible. (4) Each flow test is to be sustained for at least 10 minutes. (5) Alarm and shutdown due to flow rate can be overridden for minimum treatment capacity.
Emergency Operational test (bypass mode)		-	-
Emergency stop test		-	-
Open inspection		The main pressure components (e.g., filters, UV Chamber, electrolytic cell, etc.)	-No damage or wear.
Hydrostatic test		1.5 times the design pressure for 30 minutes	(1) Equipment is to be subjected to hydraulic pressure only. (2) No damage, leakage or wear. (3) Test report of certificate from other certification body can be acceptable. (4) Hydraulic test may be waived to the equipment which has been already installed for shipboard test before submitting the application. (5) Class 1 and Class 2 pressure vessels are to be applied. Class 3 pressure vessels considered necessary are to be subjected to hydraulic test.

<table>
<tr><th>Test item</th><th>Test requirements and test time</th><th>Remark</th></tr>
<tr><td>High voltage test</td><td>Apply the following test voltage, alternating of a frequency of 50 Hz or 60 Hz, between current carrying parts and between current carrying parts connected and earth for 1 minute.
For the equipment where the application of the test voltage is not desirable, the test voltage is applied after removing the
<table><tr><th>rated voltage: Un(V)</th><th>test voltage (V)</th></tr><tr><td>Un≤65</td><td>2 × Un +500</td></tr><tr><td>65<Un≤250</td><td>1,500</td></tr><tr><td>250<Un≤500</td><td>2,000</td></tr><tr><td>500<Un<690</td><td>2,500</td></tr></table>circuits.</td><td>(1) No identified abnormality
(2) Printed circuits with electronic components may be removed during the test;
(3) High Voltage test is to be carried out before operation and functional test
(4) When circuit is electrically connected, high voltage test can be carried out on main power source rather than on each electronic and electric component.
(5) High voltage test and insulation resistance test are to be applied for land-based testing only.</td></tr>
<tr><td>Insulation resistance test</td><td>Measure the insulation resistance between current carrying parts and between current parts and earth when measured with the following application voltage.
For the equipment where the application of the test voltage is not desirable, the test voltage is applied after removing the
<table><tr><th>Rated voltage: Un (V)</th><th>Test voltage (V)</th></tr><tr><td>Un≤65</td><td>2 × Un, min. 24</td></tr><tr><td>Un>65</td><td>500</td></tr></table>circuits.</td><td>(1) The insulation resistance (MΩ) is not less than the value specified in the following.
<table><tr><th>Rated voltage</th><th>Before test</th><th>After test</th></tr><tr><td>Un≤65</td><td>10</td><td>1.0</td></tr><tr><td>Un>65</td><td>100</td><td>10</td></tr></table>(2) Insulation resistance test is to be carried out just before & after high voltage test as well as at the end of the operation and functional test.
(3) When circuit is electrically connected, insulation resistance test can be carried out on main power source rather than on each electronic and electric component.</td></tr>
<tr><td colspan="3">* Note
If necessary, load test which excess TRC (100 %) may be required to verify the performance of the BWMS.</td></tr>
</table>

[Table 11] Operational and functional test items

2.2 Ballast Water Management Plan (BWMP) (Reg. B-1)

2.2.1 Each ship must have the BWMP on board in accordance with Guideline 4 (Res.MEPC.127(53)) and implement a BWMP. Such a plan shall be approved by the Administration or KR. The plan should be specific to each ship and shall at least:

.1 detail safety procedures for the ship and the crew associated with Ballast Water Management as required by this Convention;

.2 provide a detailed description of the actions to be taken to implement the Ballast Water Management requirements and supplemental Ballast Water Management practices as set forth in this Convention;

.3 detail the procedures for the disposal of sediments:

ⅰ) at sea; and

ⅱ) to shore;

.4 include the procedures for coordinating shipboard Ballast Water Management that involves discharge to the sea with the authorities of the State into whose waters such discharge will take place;

.5 designate the officer on board in charge of ensuring that the plan is properly implemented;

.6 contain the reporting requirements for ships provided for under this Convention; and

.7 be written in the working language of the ship. If the language used is not English, French or Spanish, a translation into one of these languages shall be included.

2.2.2 If "BWMP for BW exchange standards" only had been approved, "BWMP for Ballast Water Management System" shall be approved additionally prior to installation of BWMS.

2.2.3 Although BWMP approved in accordance with the standard of Res.A868(20) is not an official plan complying with the requirements of BWM Convention, an IBWM Certificate (or Statement of Compliance for IBWM) can be issued. But, this plan is only valid until the plan requires revision due to the new installation of ballast water management system on board existing vessel, and then, BWMP developed in accordance with Res.MEPC.127(53) must be re-approved.

2.2.4 BWMP approved by this Society for itself in accordance with Res.MEPC.127(53) without authorization from the flag Administration shall be re-approved (stamping with the Administration seal) through consultation with the KR's Environment & Piping Team when authorized by the subject flag Administration in the future.

2.2.5 BWMP must be approved by KR Environment & Piping Team.

2.3 Ballast water record book (BWRB) (Reg. B-2)

2.3.1 Each ship should have on board a Ballast Water record book that may be an electronic record system, or may be integrated into another record book or system.

2.3.2 Ballast Water record book shall at least contain the information specified in Appendix Ⅱ.

2.3.3 Ballast Water record book entries shall be maintained on board the ship for a minimum period of two years after the last entry has been made and thereafter in the Company's control for a minimum period of three years.

2.3.4 In the event of the discharge of Ballast Water pursuant to regulations A-3, A-4 or B-3.6 or in the event of other accidental or exceptional discharge of Ballast Water not otherwise exempted by this Convention, an entry should be made in the Ballast Water record book describing the circumstances of, and the reason for, the discharge.

2.3.5 The Ballast Water record book shall be kept readily available for inspection at all reasonable times and, in the case of an unmanned ship under tow, may be kept on the towing ship.

2.3.6 Each operation concerning Ballast Water should be fully recorded without delay in the Ballast Water record book. Each entry should be signed by the officer in charge of the operation concerned and each completed page should be signed by the master. The entries in the Ballast Water record book should be in a working language of the ship. If that language is not English, French or Spanish the entries should contain a translation into one of those languages.

2.4 Survey for BWMS - Res.MEPC.125(53) revoked by Res.MEPC.174(58)

2.4.1 It shall be verified that the following documentation is on board in a suitable format:

.1 Copy of the Type Approval Certificate of BWMS;
.2 A statement from the Administration, or from a laboratory authorized by the Administration, to confirm that the electrical and electronic components of the BWMS have been type-tested in accordance with the specifications for environmental testing;
.3 Equipment manuals for major components of the BWMS;
.4 An operations and technical manual for the BWMS specific to the ship and approved by the Administration, containing a technical description of the BWMS, operational and maintenance procedures, and backup procedures in case of equipment malfunction;
.5 Installation specifications and installation commissioning procedures; and
.6 Initial calibration procedures.

2.4.2 It shall be also verified that:

.1 The BWMS installation has been carried out in accordance with the technical installation specification;

.2 The BWMS is in conformity with the Type Approval Certificate of BWMS issued by the Administration or its representative;

.3 Installation of the complete BWMS has been carried out in accordance with the manufacturer's equipment specification;

.4 Any operational inlets and outlets are located in the positions indicated on the drawing of the pumping and piping arrangements;

.5 The workmanship of the installation is satisfactory and, in particular, that any bulkhead penetrations or penetrations of the ballast system piping are to the relevant approved standards;

.6 The Control and Monitoring Equipment operates correctly. The Control Equipment shall also be able to store data for at least 24 months, and shall be able to display or print a record for official inspections as required; and

.7 The BWMS is provided with sampling facilities so arranged in order to collect representative samples of the ship's ballast water.

2.5 Considerations for a case where BWMS is installed in dangerous space (Rev.39 2014.9.1)

2.5.1 A case where a BWMS is installed in dangerous space of oil or chemical tankers, the applicable safety measures shall be provided in accordance with IEC 60092-502:1999 'Electric installations in ships-Tanker Special features' required by SOLAS II-1/45.11.

2.5.2 Considerations for a case where BWMS is installed in enclosed space protected by air lock on open deck

.1 General

Explosion proof or non-explosion proof electric components consisting of BWMS is normally installed in separated rooms (e.g., BWMS control room and BWMS treatment room) divided by gas-tight bulkhead respectively. A case where nonexplosion electric components are installed in gas safe space, the entrance shall be protected by pressure or air lock, and cofferdam shall be arranged below the room to avoid arrangement adjacent to cargo tanks. And also, the hold ventilation discharge of each place should be separated by a safe distance.

.2 Safety measures in spaces protected by air lock

Safety measures by air lock shall be in compliance with para' 4.1.5.2 or 4.1.5.3 and following practices shall apply in accordance with the grade of dangerous space.

[A case where BWMS is installed in dangerous zone 2]

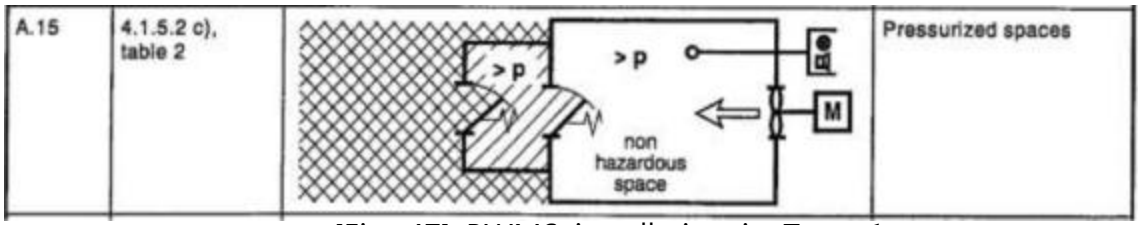
The doors to be installed in entrance shall be Self-Closing Gastight Doors, and Holding Back Arrangement should not be installed. The mechanical ventilation system should be provided in the protected space, audible and visible alarms should be activated in the continuously attended space in case of ventilation system failure.

[Fig. 46] BWMS installation in Zone 2

[A case where BWMS is installed adjacent to dangerous zone 1]

The type of doors to be installed in the entrance is same as above, and supply type of ventilation to pressurize a minimum over-pressure of 25pa with respect

to the adjacent air locked and protected space respectively shall be installed. In case of pressure failure in the protected space, an audible and visible alarm shall be activated in the continuously attended space, and after a short while, the power supply for nonexplosion electric facilities installed in safety space should automatically be shut off from the outside of the safety space.



[Fig. 47] BWMS installation in Zone 1

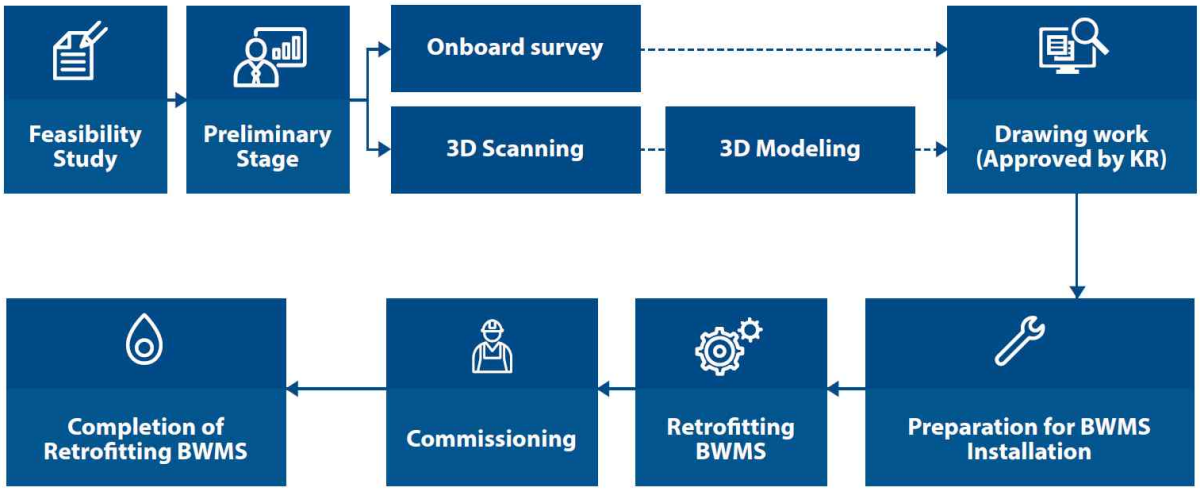
.3 the measures for the hold ventilation discharge of safety zone

The hold ventilation discharge between the safety zone and hazardous zone should be separated by a minimum safety distance. For example, the air inlet of safety space shall be maintained with an additional safety distance of 1.5m from dangerous space, and air outlet shall be installed outside of dangerous space.

Section 2. Consideration for survey of existing vessel

1.1 Procedure for installation of existing vessel

1.1.1 BWMS for existing vessel is normally installed as described on Fig. 48.



[Fig. 48] BWMS installation procedure for existing vessel

1.2 Survey preparation for existing vessel

1.2.1 Drawing approval is to be confirmed. Drawing approval will be carried out by environmental and piping team in KR. Surveyor must confirm whether "H" or "C" comment has been remarked on approval letter or not.

1.2.2 Product certificate(in case where the vessel is Korean flag, product certificate must be issued for Korean Government) is to be confirmed. Surveyor is requested to contact environmental and piping team in case where the major deviation is founded. If the deviation is related with Type Approval, surveyor should contact marine and ocean equipment team.

1.2.3 In principal, drawing approval will be confirmed;

- Detail drawing of manufacturer(submitted by owner or manufacturer)

- OMSM
- BWMP
- Manual
- Arrangement drawings for installation
- Piping diagram
- Arrangement drawings for electrical installation
- Power consumption
- Power diagram
- Electric Load Analysis
- G9 document (If necessary)

1.2.4 Survey for product certificate is as follows

- Visual inspection by drawing and specification
- hydro testing (if required)
- Insulation and high voltage testing for control and starting panel
- Performance testing(Except Biological Efficacy testing)

1.3 Survey for exsiting Vessel

1.3.1 General requirement for survey with approved documents

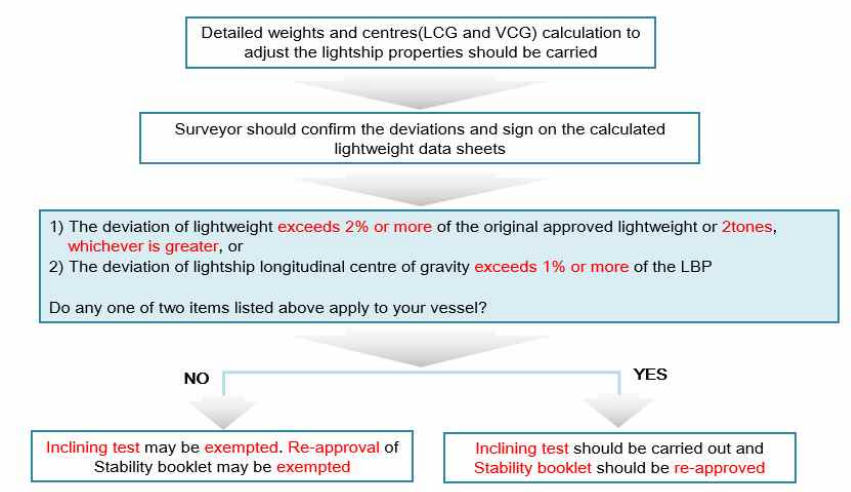
- Installation is in accordance with installation guidance of manufacturer
- Installation according to Type Approval
- Installation of components is to be in accordance with technical documents of components manufacturer
- Pipe ends for suction and discharge comply with approved piping diagram
- All penetrations or ballasting pipe comply with approved documents

- Control equipment should be able to store data for at least 24 months
- Control equipment should be able to display or print a record for official inspections as required
- Sampling point must be prepared.

1.3.2 Fixture for installation of BWMS

- Heavy components -> Enough fixture
- Light weight components -> supporting can be installed on hull
- Dimension, weight, location and etc are be considered for appropriate installation(weight is to be evenly distributed).
- Fixture is to be steel and is to be installed on hull. Lower tween decks are to be reinforced -> BWMS is to be uniformed with Lower tween decks(such as Beam, Girder, Floor, Web and etc). If hull is not exist, additional stiffener is to be installed.
- Class approved steel (Grade A) is to be used for strengthen of hull
- Arrangement is to be considered bilge
- Welding Fillet: Above F2

1.3.3 Ship's stability check (Inclination test) procedure is as follows.



[Fig. 49] Ship's stability confirm procedure

1.3.4 Consideration of Electric Load

Power reserves is to be over 90% even though maximum load of ship include BWMS max power consumption.

1.3.5 Consideration of hazardous area

- If vessel carry flammable cargo in accordance with Ballast IMSBC Code or IMDG Code(SOLAS Reg.II-2/19), hazardous zone will be designated in accordance with IEC 60092-502.
- Electric components can not be installed in hazardous zone, unless the electric components are explosive proof type. Surveyor should confirm all electric components are comply with IEC60092-502 and IEC60079 series.

1.3.6 Consideration of piping

.1 Rule Pt.5 Ch.6 402.2.(2) (Drainage of compartment other than machinery spaces- Tanks)

- All tanks including double bottom tanks are to be provided with suction pipes, led to suitable power pumps, from the after end of each tank. Where fore and after peak tanks are used as fresh water tanks and small capacity, a hand pump may be substituted.
- All ballast tanks are to be connected to at least two(2) power driven ballast pumps. One of which may be driven by the propulsion unit. Bilge, sanitary and general service pumps driven by independent power may be accepted as independent power ballast pumps, provided that they are connected properly to the line. However, gravity discharge from top side tanks are to be complied with 303. 2 (1) (B) of the Guidance. And, where cargo pump is arranged for de-ballasting in emergency as Pt 7, Ch 1, 1003. 2 (2), the cargo pump may be accepted as one(1) independent power ballast pumps,

.2 Rule Pt.5 Ch.6 406.7 (Ballasting Piping System)

- Ballast piping system is to be provided with a suitable provision such as a

non-return valve or a stop valve which can be kept closed at all times excluding the time of ballasting and de-ballasting and which is provided with an indicator to show whether it is open or closed, in order to prevent the possibility of water inadvertently passing from the sea to the ballast tanks or of ballast passing from one ballast tank to another. Where butterfly valves(except remote control valves) are used, they are to be of type with positive holding arrangements, or equivalents, that will prevent movement of the valve position due to vibration or flow of fluids.

- Remote control valves, where fitted, are to be arranged so that they will close and remain closed in the event of loss of control power. Alternatively, the remote control valves may remain in the last ordered position upon loss of power, provided that there is a readily accessible manual means to the valves upon loss of power. Remote control valves are to be clearly identified as to the tanks they serve and are to be provided with position indicators at the ballast control station.

.3 Guidance Pt.5 Ch.6 406.1 (Bilge suction pipes and ballast suction pipes passing through deep tanks) In application to 406. 4 of the Rules, the bilge suction pipes and ballast suction pipes passing through deep tanks are to be dealt with under the following requirements.【See Rules】

- For the bilge suction pipes passing through deep tank serving as the exclusive ballast tank, welded pipe joints may not be required if flange joints corresponding to a nominal pressure one rank higher than that according to the design pressure are used.
- In case where gravitational ballasting/deballasting is intended by using sea chests provided in the exclusive ballast tanks, double stop valves being operable from a position on the freeboard deck are to be provided.
- Suction pipes such as the bilge suction pipes and ballast suction pipes are not to pass through deep tanks carrying cargo oil, except that in case where the pipes are installed in pipe tunnel provided within the deep tanks.
- In the application of the requirements specified in (1) to (3) above, bilge hoppers are to be regarded as deep tanks.

1.3.7 Documents kept onboard

- A copy of BWMS Type Approval Certificate
- Certificate or letter of environmental testing of electric components (if applicable)
- Installation manual
- Calibration records for sensors and instruction

Section 3. Certificates, guidelines and checklists[19)]

1.1 Issuance of certificates (Rev.47 2018.7.1)

1.1.1 Certificate shall be issued after an initial survey and the surveyor will provide the owner with information that BWMP shall be approved by head office prior to completion of the survey.

1.1.2 BWM certificates are issued on OASIS.

1.1.3 The ships registered under the flag States which ratified this Convention shall be issued in the form of IBWM Certificate, and the ships registered under the flag States which not ratified this Convention shall be issued in the form of Statement of Compliance.

1.1.4 In case where Statement of Compliance for BWM would be replaced with BWM Certificate on or after entering into force of the Convention, periodical survey or occasional survey shall be carried out prior to issuing BWM Certificate (IN). and the completion date on the Certificate will be the same as the completion date on the Statement of Compliance.

1.1.5 How to draw up BWM certificates

.1 Gross tonnage means the gross tonnage calculated in accordance with the ITC 1969;

.2 Ballast water capacity (㎥) shall be inscribe referring to BW Capacity in the approved BWMP;

19) For the form of the checklist, refer to Figure 48. However, KR-CON checklist or KR-OASIS program shall be used due to the fact that checklist differs according to vessel type and keel laid date.

.3 Method of ballast water management used shall be selected among the following items:

ⅰ) Ballast water Management System

ⅱ) Sequential Method

ⅲ) Flow-through Method

iv) Dilution Method

v) Prototype Ballast water Treatment technology (D-4)

.4 If the method of ballast water management used is a ballast water management system, the manufacturer's name and the date of installation of the system shall be filled up;

.5 If the method of ballast water management used is pumping-through method, "Pumping-through method" shall be filled up.

.6 The principal ballast water management method should be one or more of the following (The same as BWM.RD):

in accordance with regulation D-1

in accordance with regulation D-2

(describe).....

the ship is subject to regulation D-4

.7 If the method of ballast water management is marked in the column of D-4, the surveyor shall contact the Head office for a possible approval from Administration.

1.1.6 Where a ship operating with D-1 requirement intends to comply with D-2 requirement, an occasional survey is required to issue a certificate.

Survey Checklist for IBWM Initial Survey

Ship's particular **Report No :**

Name of Ship	test		
Class Number (KR)			
Ship Type	Other Cargo Ship(Container, General Cargo, PCC...)		
Construction Date (K/L)	1/1/2018	**Current Date**	
Gross tonnage	GT	**Deadweight tonnage**	dwt
Freeboard length	m	**Overall length**	m
UMA	◉ Yes ○ No	**Flag**	

Navigation bridge

1. Plans and Designs

examining the design and construction ❑
(BWM Convention-Reg.B-5)

Accommodation

1. Active substances

confirming that, if applicable, dosage instruction for active substances or preparations are available on board ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

2. Certificate

after satisfactory survey, the International Ballast Water Management Certificate should be issued. ❑

3. Documentation

confirming that the Ballast Water Management Plan has been provided ❑
(BWM Convention-Reg.B-1)

confirming that the Ballast Water Record Book has been provided ❑
(BWM Convention-Reg.B-2)

verifying that the BWMS is in conformity with the Type Approval Certificate of BWMS issued by the Administration or its representative ❑
(BWM Convention-note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

confirming that certificate(s) for type approval of ballast water management system(s) are available ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

confirming that a statement has been provided by the Administration, or from a laboratory authorized by the Administration, confirming that the electrical and electronic components of the ballast water management system(s) have been type-tested in accordance with the specifications for environmental testing contained in Part 3 of the Annex of the Guidelines for Approval of Ballast Water Management Systems (G8) ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to regulation D-2 is applicable)

confirming that equipment manuals for major components of the ballast water management system(s) have been provided ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

confirming that an operations and technical manual for the ballast water management system(s) specific to the ship and approved by the Administration, containing a technical description of the ballast water management system(s), operational and maintenance procedures, and backup procedures in case of equipment malfunction has been provided ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

confirming that installation specifications for the ballast water management system(s) have been provided ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to

Survey Checklist for IBWM Initial Survey test /

Reg.D-2 is applicable)

4. Plans and Designs

examining the ballast water management plan ❑
(BWM Convention-Reg.B-1)

examination of plans for the installation of ballast water management systems ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

if applicable, examination of plans for the installation of prototype ballast water treatment technologies ❑
(BWM Convention-Reg.D-4)

Engine room

1. Active substances

confirming that, if applicable, sufficient active substances are provided on board ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

2. BWM recording device

confirming that if applicable the ballast water management recording device(s) are operable and that there is a sufficient supply of consumables for the recording device(s) on board ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

3. BWMS installation

verifying that the BWMS installation has been carried out in accordance with the technical installation specification ❑
(BWM Convention-note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

verifying that the installation of the complete BWMS has been carried out in accordance with the manufacturers equipment specification ❑
(BWM Convention-note, this survey requirement is relevant only when the performance standard according to regulation D-2 is applicable)

verifying that any operational inlets and outlets are located in the positions indicated on the drawings of the pumping and piping arrangements ❑
(BWM Convention-note, this survey requirement is relevant only when the performance standard according to regulation D-2 is applicable)

confirming the satisfactory installation and operation of the ballast water management system, including any audible or visual alarms ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

4. Control and Monitoring Equipment

verifying that the Control and Monitoring Equipment operates correctly; ❑
(BWM Convention-note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

5. Documentation

confirming that installation commissioning procedures for the ballast water management system(s) have been provided ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

confirming that initial calibration procedures of the ballast water management system(s) have been provided ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

confirming that, if applicable, a Statement of Compliance for a Prototype Ballast Water Treatment Technology has been provided ❑
(BWM Convention-Reg.D-4)

6. Maintenance for conditions of ballast water treatment system

Confirming that BWMS is in good working condition in accordance with Reg. D-2 ❑

Survey Checklist for IBWM Initial Survey test /

7. Piping and pumping system

Confirming that Ballast piping system and pumping system are in good condition in accordance with Reg. D-1 ❑

verifying that any operational inlets and outlets are located in the positions indicated on the drawings of the pumping and piping arrangements ❑
(BWM Convention-note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

8. Prototype ballast water treatment

verifying that, if applicable, the prototype ballast water treatment technology installation has been carried out in accordance with the approved Programme and that the workmanship of the installation is satisfactory ❑
(BWM Convention-Reg.D-4)

9. Prototype Ballast Water Treatment

Confirming that Prototype Ballast Water Treatment technologies and its system is in a good working condition in accordance with Reg. D-4 ❑

10. Sampling facilities

confirming that sampling facilities are provided and so arranged in order to collect representative samples of the ships ballast water from the ballast water management system(s) intake(s) before the ballast discharge points and any other points necessary for sampling ❑
(BWM Convention-Reg.D-3 / note, this survey requirement is relevant only when the performance standard according to Reg.D-2 is applicable)

Flag Requirements

1. confirming that the requirements of the ship's flag administration are satisfactory ❑

Checked by : _____/_____

Verified by : _____

 3 / 3

[Figure 50] Check-list form in KR-CON

Section 4. IACS UR M74 and KR Rule Pt.9 Ch.10

1.1 Application

1.1.1 IACS published UR M74 on September 2015, for the purpose of providing specified requirements for shipyards, ship owners and makers of BWMS, and facilitating smooth implementation of the BWM Convention.

1.1.2 Rev.1 published on May 2016.

1.1.3 UR M74 provided the following contents:

.1 General installation requirements, including requirements for piping and valves, sampling facility, and safety arrangement for hazardous area, etc.
.2 Additional installation requirements for Tankers[20], including two independent BWMSs for ballast tanks in hazardous area and non-hazardous area, isolation arrangement for ballast piping between hazardous area and non-hazardous area, etc.
.3 Installation requirements for ventilations;
.4 Other special installation requirements[21];
.5 Automation Requirements for by-pass or override operation of BWMS

1.1.4 Revision 2 is currently under consideration by the Project Team of Machinery Panel (PM11902b) with the following objectives:

.1 Categorization of BWMS technologies and identification of the potential hazards for each BWMS category (safety hazards will move from the UR M74 to an UR Fxx[22])
.2 Extension of the Annex I[23] to all BWMS categories (arrangement of a single

20) Additional requirement is related to IEC60092-502

21) Special installation requirement is related to length of pipe and number of connections

22) UR F: Unified Requirement for Fire Protection

23) Current Annex I (IACS UR M74 Rev.1) is demonstrate the BWMS with "BWMS which does not require after treatment" and "BWMS which requires after treatment".

BWMS on tankers)

.3 Improve the vague expressions to avoid interpretations and realign the definitions with IMO Convention and Codes and IACS Urs and SCs.

.4 Clarify the applicability and scope of the risk analysis and Classification certification

.5 Tackle the issues raised by the challenge of retrofit installation onboard existing ships

1.2 Focuses for various survey

1.2.1 Focus on plan approval

.1 Confirming if the ballast pump rated capacity matches with the BWMS treatment rated capacity (TRC) via checking the type approval certificate of BWMS.

.2 Checking the arrangement of bypass valves and sampling points in the ballast water management system layout.

-Sampling point: should be as close to the outboard discharge valve as possible, and should be in the straight part of the pipeline.

-Bypass valve: must be equipped, and when the bypass valve opens, it should be able to activate the alarm and record in the system.

.3 For tankers installed with either two BWMSs (one for ballast tanks in hazardous areas and the other for ballast tanks in non-hazardous areas) or one single BWMS, appropriate isolation is to be arranged between the ballast piping serving the cargo area and the piping serving non-cargo areas.

.4 If dangerous gas can be produced by BWMS operation, normally gas release devices and monitoring measures for independent cut-off shall be provided, and the openings of gas release devices shall lead to the safety area of the open deck. It is an exception for mainstream electrolysis system producing H2 without having "gas release devices". This is ok as long as there are tests that show that H2 levels in relevant tanks (ballast water tanks) are clearly below LEL.

1.2.2 Focus on Installation survey

.1 Verification of the Type Approval certificate.

.2 Verification of the approved drawings.

.3 Checking whether the operation manual is the same as the one that was the basis for type approval.

.4 Verification of the management plan BWMP.

.5 Installation inspection: base, pipeline, cable, instrument, etc.

.6 Function test, refer to Annex 5 to MEPC 72/WP.9[24)]

.7 Alarm point test.

.8 Sampling point.

1.2.3 Focus on surveys after Installation

.1 Verification of the management plan.

For the ship route to the US, 33 CFR 151.2050(g) as below is to be complied with.

* 33 CFR 151.2050(g) : Maintain a ballast water management (BWM) plan that has been developed specifically for the vessel and that will allow those responsible for the plan's implementation to understand and follow the vessel's BWM strategy and comply with the requirements of this subpart. The plan must include -

  (1) Detailed safety procedures;
  (2) Actions for implementing the mandatory BWM requirements and practices;
  (3) Detailed fouling maintenance and sediment removal procedures;
  (4) Procedures for coordinating the shipboard BWM strategy with Coast Guard authorities;
  (5) Identification of the designated officer(s) in charge of ensuring that the plan is properly implemented;
  (6) Detailed reporting requirements and procedures for ports and places in the United States where the vessel may visit; and
  (7) A translation of the plan into English, French, or Spanish if the vessel's working language is another language.

24) Detail testing method will be discussed at MEPC 73th

.2 Verification of record, including the alarm, test, etc.
.3 Witness of necessary functional test and alarm point test.
.4 Verification of possible sample test record.
.5 When BWMS fails, bypass function should be used to test.
.6 The bypass activation alarm of the ballast water management system, control and detection equipment shall record the bypass time.

1.2.4 Focus on onboard testing of BWMS

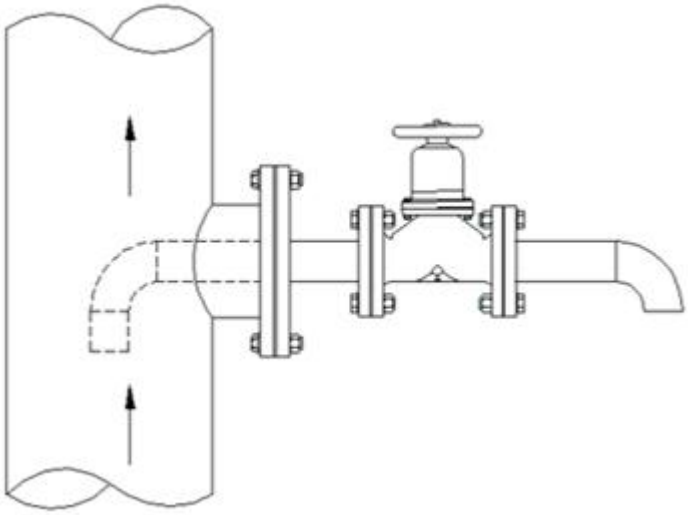
The onboard testing of BWMS is to verify the system function after installation on board is in compliance with Regulation D-2 as approved in accordance with the G8 Guidelines, and the following might be focused by the surveyor:

.1 Test plan to be reviewed prior to the test, with a view that the amount of ballast water to be tested on board shall be consistent with the normal ballast operations of the ship;
.2 Before treatment, the amount of the ballast water in the tanks to be tested is to be confirmed;
.3 During the treatment, the BWMS shall be operated at the TRC as approved;
.4 After treatment, sampling operations are to be verified as per the operation instruction of the Manufacturer, and then the samples are to be checked;
.5 Other items specified in the testing instruction of the Manufacturer.

1.3 Examples for items raised during the onbaord surveys to BWMS

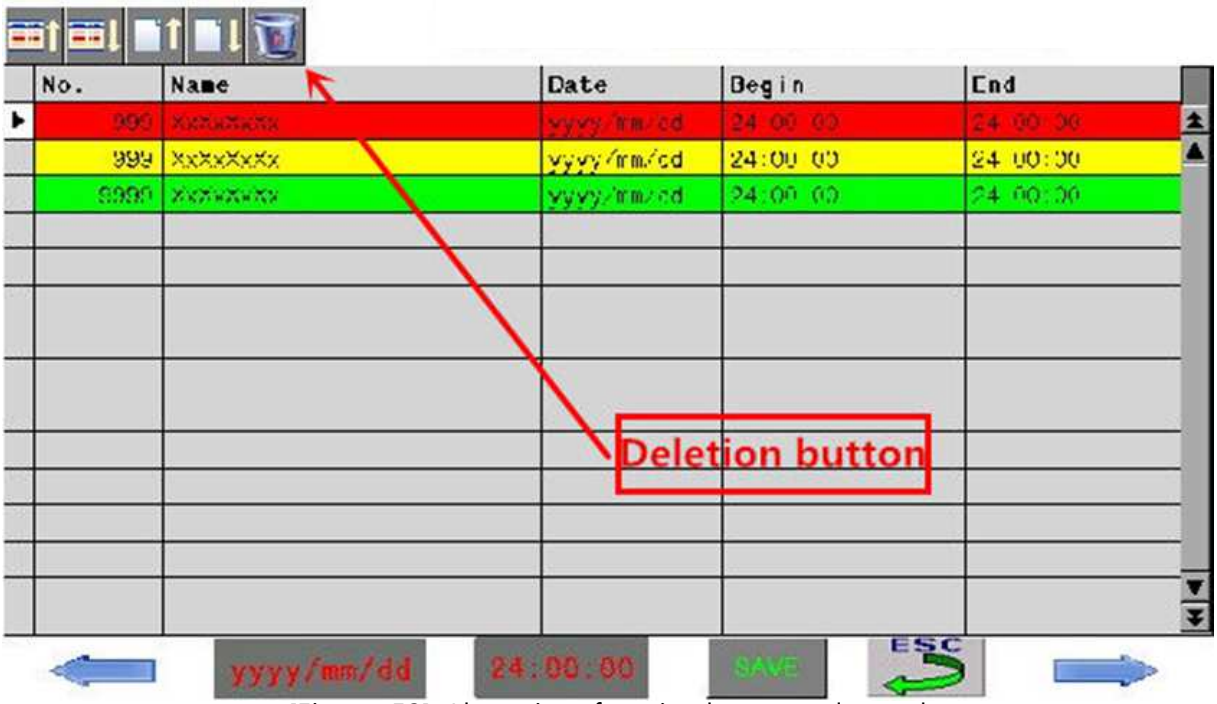
1.3.1 For oil tanker, if the BWMS was installed in the cargo area, the interlock of ventilation and appropriate means of piping disconnection (spool pieces) shall be considered.

1.3.2 The installation direction of the sample tube is installed in the wrong direction (not opposite to ballast flow) by the operator. The problem was solved by installing the sample pipe in the opposite direction from the ballast water flow.



[Figure 51] Sample tube installation

1.3.3 For all alarm contents displayed in the ballast water treatment system (BWMS), including the alarm contents of bypass valve opening work, etc., records can be deleted in the control panel (after it was reset and no longer active). However, this does not mean that it is deleted from the alarm log and thus still available when PSC asks to see the alarm log. These operations should be recorded into the onboard maintenance record for reference of the PSC or other inspectors and maintenance service engineers.



[Figure 52] Alarm interface in the control panel

1.3.4 Accuracy of the BWMS TRO sensor is crucial to the stable and effective operation of BWMS and to ensure that the ballast water treatment meets the D-2 standard. However, the calibration method for the sensor is relatively rare.
One experience is to continue to use the sensor within one year according to the calibration report (third-party report) of the TRO sensor at the time of delivery. Another experience is that if the TRO reagent is replaced as indicated in the OMSM (and used within the expiry date stated by the reagent manufacturer), the TRO sensor's accuracy is ok. A TRO sensor has typically a ±10% uncertainty, but there is no better alternative.

Technical Information of BWMS
for Ship-owner and surveyor

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Note.1) Please be informed that the figures in this guidance is reference purpose only to help for easy understanding on the given content and it is not directly related with given content.

Note.2) The "Failure and Issues with BWMS on board" section in Chapter 3 Section 2 Article 2 identified in this guide is a summary of the survey responses from KR-classed ships which operate the BWMS. Please note that it does not refer to a specific BWMS, and the table does not represent all cases.

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