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Technical Information of BWMS for Ship-owner and surveyor

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Marine and Ocean Equipment Team

Korean Register

Summary

1. Ballast Water Managment Convention entered into force on 8 september 2017 and all of vessels applied by the Convention which choose regulation D-2 standard as ballast management measure is installing ballast water management system on board. However, there is no guidance clearly summarized for considerations of ship type, voyage and the other matters. Therefore, Korean Register has published this guidance focused on characteristics of each BWMS type, considerations for retrofit, operation and maintenance and check point for survey that should be recognized by shipowners including crews and surveyors.

2. This guidance consists of three Chapters which are General of BWMS (Ch. 2), Considerations of BWMS for shipowners (Ch. 3) and Considerations of BWMS for surveyors (Ch. 4). We believe that it will be helpful to shipowners, referring Chapter 2 & 3 and to surveyors, referring Chapter 2 & 4.

3. In "Chapter 2 General", it will be used for references when crews and surveyors conduct operation and survey via introduction regarding requirements of the Convention and technical analysis for each type of BWMS. In addition, considerations for each ship type is summarized by referring IACS UR M74 and Part 9 of Rules of this Society and operation limitations of BWMS to be checked on board are summarized , based on experience of type approval of USCG and Korean Government.

4. In "Chapter 3 Considerations of BWMS for shipowner", standard and core information regarding operation and maintenance is summarized and the instances from the ships classified by this Society were surveyed and the results from analysis of the instances were summarized. And further this guidance contains BWMS PSC Guide-lines to assist preparation of ships against PSC inspection. However, this guidance does not contain problems from certain BWMS in instances of existing installation or one-off problems.

5. "Chapter 4 Considerations of BWMS for surveyors" addresses notifications, certification, guide and checklist for survey, and particularly, the examples are listed regarding performance testing which is one of the core surveys.

6. Lastly, it shall be noted that the challenging issues identified in this guidance and some problems identified by shipowners may be able to be generally occurred from given type of BWMS, not a specific production or certain 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

'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 after the requirements for entry into force thereof have been met on 8 September 2016. Upon adopting the Convention, regulation D-2 which specified the concentration of viable aquatic organisms in ballast water discharged from ships was established to prevent introduction of Harmful Aquatic Organisms and Pathogens through ships' ballast water. In accordance with regulation B-3, therefore, existing vessels on international voyage as well as new vessels shall install a ballast water management system (BWMS) to meet the standard of regulation D-2 until the first or second IOPP renewal survey after 8th September 2017.

With regard to existing vessels having obligation of BWMS installation, it should be considered that, the first, in retrofitting perspective, BWMS should be additionally installed in a limited space as well as it should be harmonized with existing piping and electric & electronic equipment, and the second, in operational perspective, shipowners and crews need to take some time to be familiar with operation and maintenance of BWMS since it is a new equipment.

This guidance, therefore, is focused on items to be checked during installation, operation and inspection after initial survey. In addition to technical information analysis of this Society having conducted type approval testing on behalf of various Administrations, this guidance has been developed after analyzing and identifying troubles of BWMS based on database from existing ships on voyage. So, it is expected that this guidance will be usable to smoothly solve the problems and operation of BWMS further.

Notice) 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.

Chapter 2. General of BWMS

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

1. Ballast Water Management Convention and BWMS Code

A ship shall install the BWMS on board to meet the standard in regulation D-2 and type approval of BWMS is incorporated on a legal basis in accordance with regulation D-3. In accordance with regulation D-3.1, therefore, a BWMS willing to install on board shall be approved by Administration taking into account 'Guidelines for approval of ballast water management systems (G8)' under regulation D-3.1.

Guidelines for approval of BWMS (G8) was developed at fifty third session of MEPC in 2005 (Res. MEPC. 125(53)) and it was revised at fifty eight session of MEPC in 2008 (Res. MEPC. 174(58)). So far September 2018, it is that the most of BWMSs have been type approved taking into account G8 revised in 2008. As requested from shipping industry, IMO (International Maritime Organization) made a decision to revise G8 at sixty seven session of MEPC in 2014 with a view to consolidate the requirements for type approval of BWMS and the discussion for revision of G8 was completed at seventy session of MEPC in 2016 after intensive discussion during two years, then finally '2016 Guidelines of approval of Ballast Water Management Systems (G8, Res. MEPC. 279(70))' has come into the world.

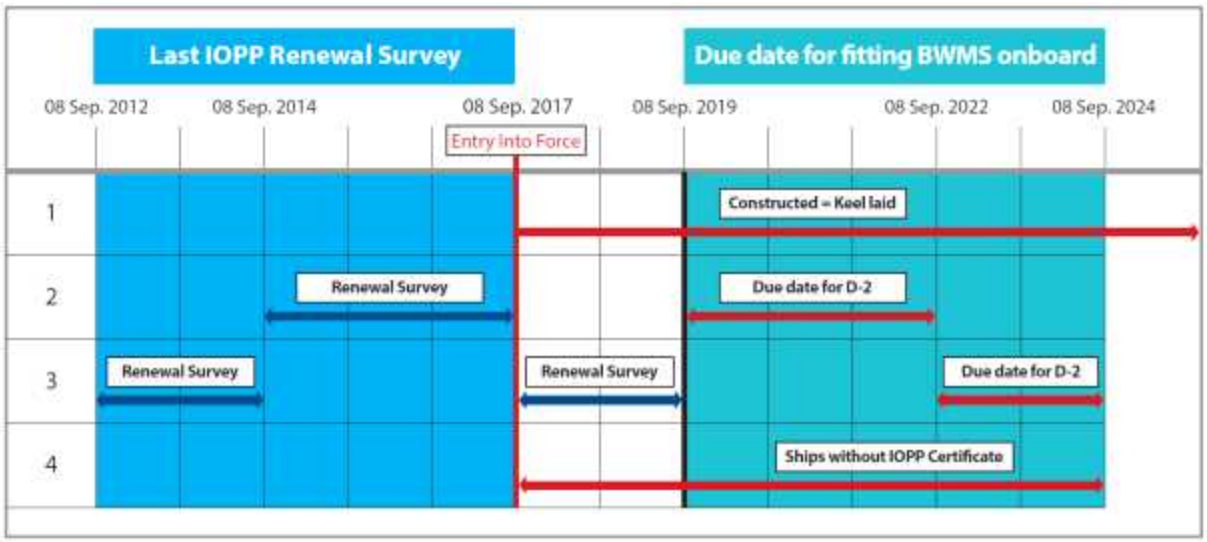
After then, IMO made mandatory status from '2016 G8' to 'Code for approval of Ballast Water Management System (Res. MEPC. 300(72), hereafter 'BWMS Code')' in order to make Guidelines 8 to be applied by all of Parties and Member States.

2. Application of G8 and BWMS Code

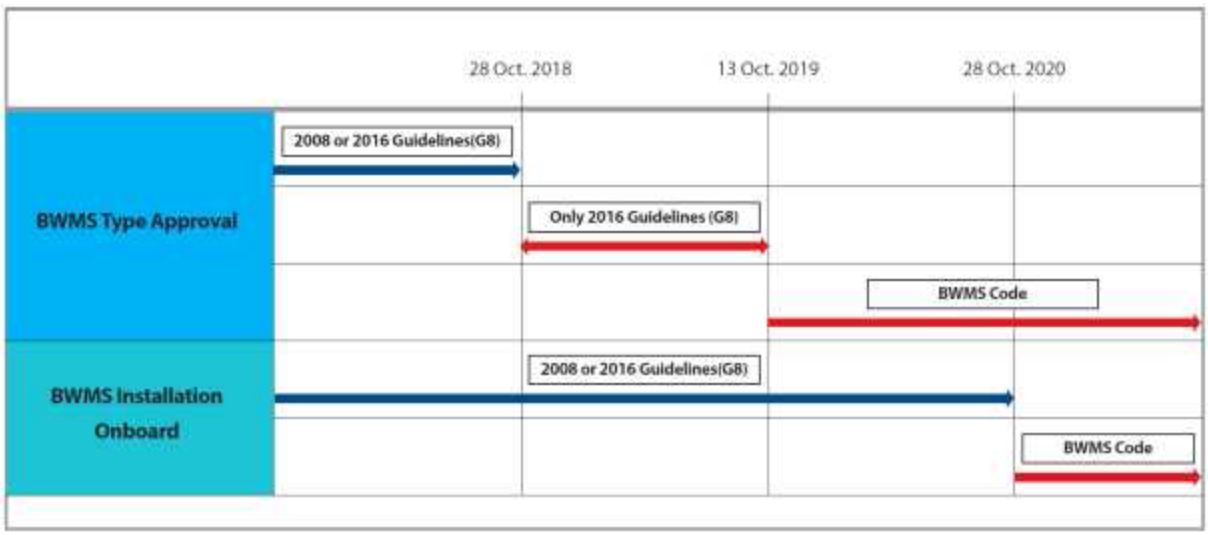
To confirm that BWMS was properly installed or is being installed on board, we should know application date of G8, 2016 G8 and BWMS Code.

In accordance with '2016 Guidelines of approval for Ballast Water Management

(Res. MEPC. 279(70), hereafter '2016 G8'), a BWMS to be installed on or after 28th October 2020 on board shall be approved by 2016 G8 or BWMS Code, and BWMS approved by G8, 2016 G8 or BWMS Code can be installed before 28 October 2020. Installation date shall be the contractual date of delivery of the BWMS to the ship, in case of the absence of such date, it shall 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 BWMS Code, a BWMS approved taking into account the 2016 G8 shall 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 taking into account 2016 G8.

3. Ballast Water Management in USA

USA has not ratified to the BWM Convention, and Ship's Ballast Water discharged in jurisdiction of USA is manage by their own Code (Code of Federal Regulations, CFR). USA published final rule for Ballast Water Management in 2012. With regard to ballast water management, 33 CFR 151 subpart C (in the Great Lakes and Hudson River) and D (in water of the United States) Ballast Water Management for control of non-indigenous species.

In accordance with 33 CFR 151.2025, USA allow only four ballast water management measures, 1) no discharging 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 ballast water and 4) allow to use public water system in USA. Therefore, it is expected that most of vessels will manage ballast water through BWMS approved by USCG.

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

USA specified standard, procedures and requirements of type approval for BWMS in 46 CFR 162.060. USCG applied Independent Laboratory (IL) System for type approval of BWMS and USCG only approves the BWMS tested by IL recognized from USCG and Korean Register is the only IL approved from USCG in Asia.

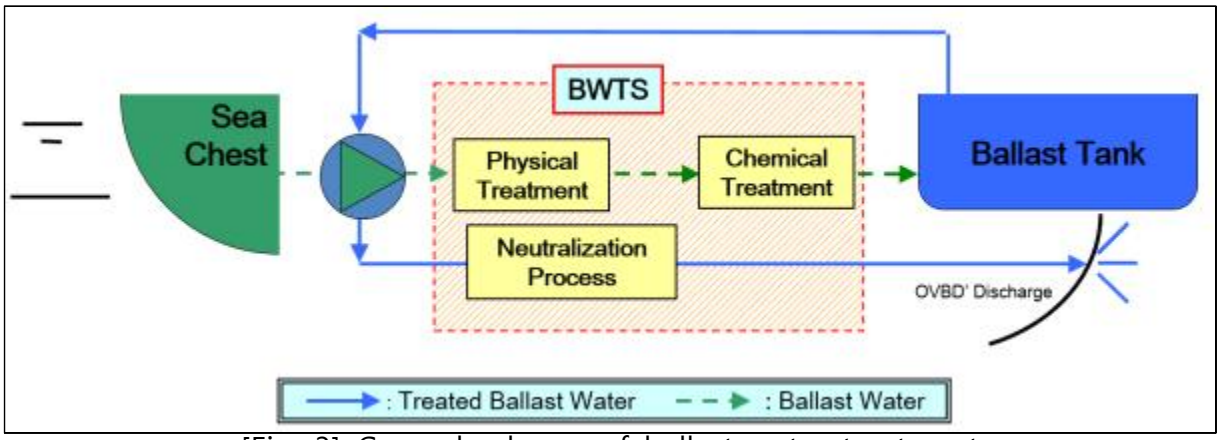
At that time publishing final rule for ballast water manage in USA, there was no BWMS type approved by USCG. Therefore, USA established provision for Alternative Management System (AMS) in 33 CFR 151.2026 and USCG approved

application of AMS that BWMS approved by foreign Administrations pursuant to BWM Convention, as temporary measure to ballast water management until USCG type approved BWMSs are ready. If a vessel using installed AMS prior to date that the vessel is required to comply with the ballast water discharge standard (BWDS) in accordance with 33 CFR 151.2035, the vessel can use AMS until 5 years from the date that the vessel is required to comply with the BWDS in accordance with 33 CFR 151.2035. Upon 5 years after the date, the AMS on board shall be type approved by USCG or the vessel shall replace AMS to BWMS type approved by USCG.

There are many cases that conversion of components or structure for many BWMSs approved as AMS, especially early models type approved by foreign Administrations, has been changed comparing components or construction structures of BWMS type approved by USCG due to fact that manufacturers had frequently upgraded their BWMS of them so far. To approve individual AMS model as USCG type approved BWMS model USCG needs technical review on the AMS model and will make a decision to be able to approve AMS as equivalent to USCG type approved BWMS or identify matters to be required for approval of AMS after case-by-case review process.

Section 2. Technical specification of each type of BWMS

1.1 General treatment technology of BWMS



[Fig. 3] General scheme of ballast water treatment

1.1.1 General scheme[1)] of BWMS was shown in Figure 3. For physical treatment, ballast water passes through filtration system which generally filters larger than 50 micrometers of aquatic organisms and solid. After then, smaller than 50 micrometers of aquatic organisms in ballast water were treated by chemical treatment, e.g. using chlorine and then treated ballast water is injected to ballast tank.

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

1.1.3 Physical and chemical treatment process are mainly performed for sterilization of micro-organisms or bacteria. To do so, there are several available methods, such as irradiation of Ultra Violet (UV), elimination of dissolved oxygen in water and injection of chemicals such as ozone as biocide.

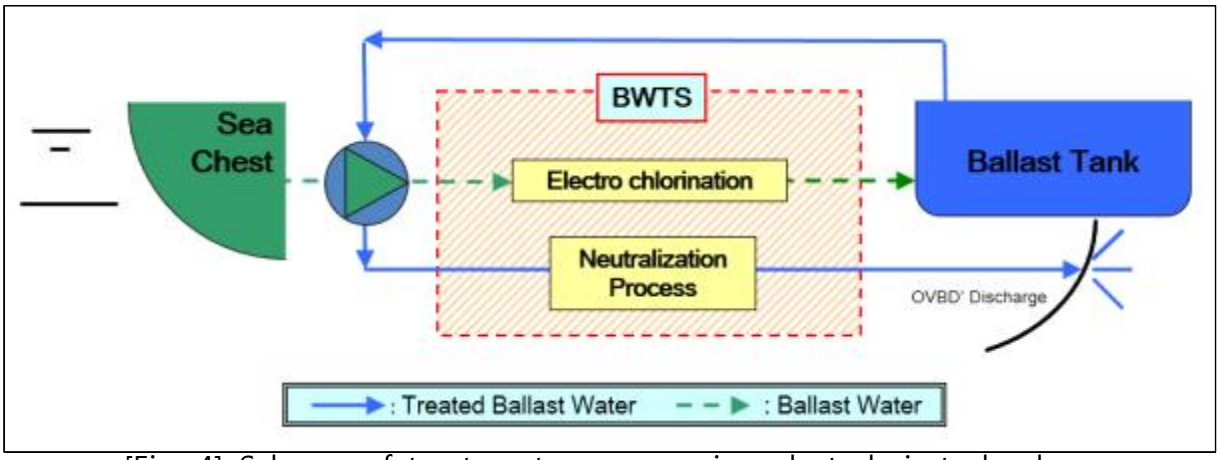
1.1.4 Major treatment technologies of BWMS were shown in below Table.

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] Scheme of treatment process using electrolysis technology

1.2.1 Type of BWMS using electrolysis technology

1.2.2.1 Full flow electrolysis technology

With regard to full flow electrolysis technology, in case of BWMS combining with filtration system, a filter removes larger than 50 ㎛ size class of aquatic organisms and sediments and the other size classes of aquatic organisms are removed by hypochlorite generated from electrolysis unit. When full flow electrolysis technology is compared with side stream electrolysis technology, the main difference is that the electrolysis unit to generate hypochlorite are directly connected with main

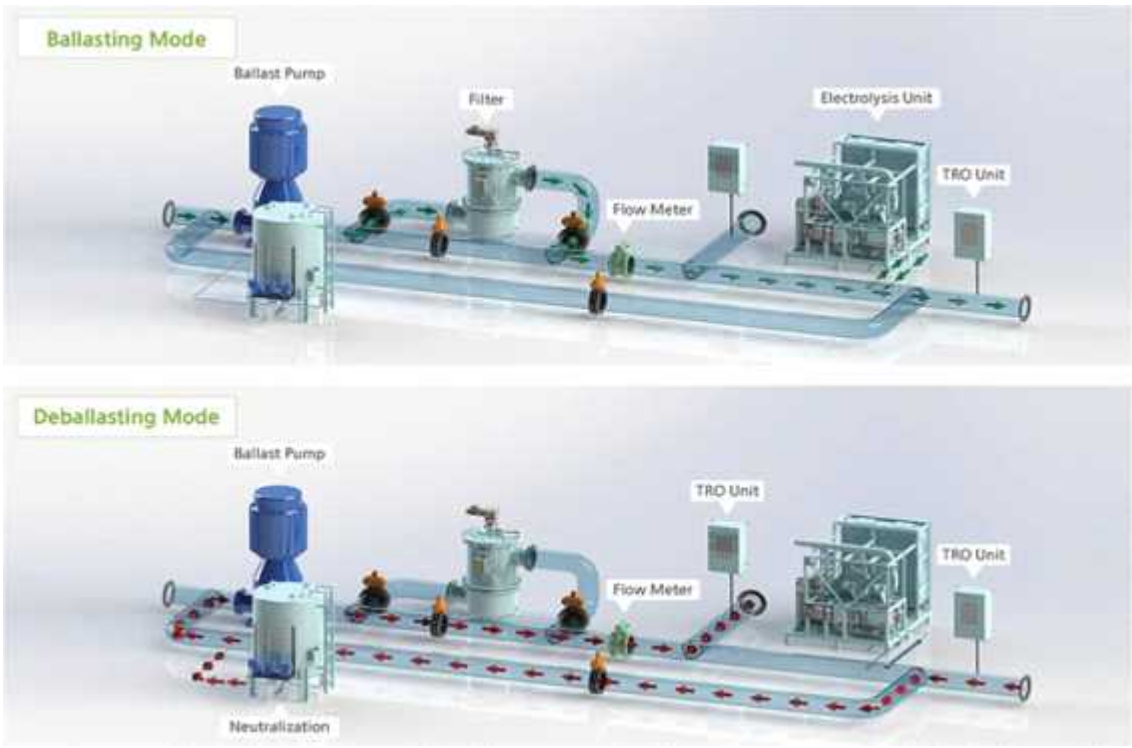
2) Active substances: a substance or organism, including a virus or a fungus that has a general or specific action on or against harmful aquatic organisms and pathogens

line after ballast P/P as consisting of one piping line. General arrangement of BWMS using full flow electrolysis technology is shown in below Figure.

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

1.2.2.1 Side stream electrolysis technology

With regard to side stream electrolysis technology, larger than 50 ㎛ size classes organisms and sediments are removed through filter system and some small portion of filtered ballast water from main ballast water pipe is injected to electrolysis unit for production of high concentration of hypochlorite. The other size class of aquatic organisms is removed by injection of generated high concentration of hypochlorite to main ballast water pipe. When side stream electrolysis technology is compared with full flow electrolysis technology, high concentration of hypochlorite is produced by passing high current to relatively small volume of salt water. Comparing full flow electrolysis technology, it has an advantage that a BWMS using side stream electrolysis technology is able to be installed relatively easily in narrow space since it is smaller than full flow electrolysis technology. General arrangement of BWMS using side stream



[Fig. 6] General arrangement of ballast water management 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 and kills the organisms. The chemical composition of active substances produced by each manufacturer may be different from each other.

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

1.2.4 Issue of TRO Sensor

A BWMS using electrolysis technology is representative of the 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 TRO (Total Residual

Oxidant) sensor is used to confirm the concentration of the active substance. The principle of TRO sensor is that very small portion of seawater is injected to cuvette and it makes change the color of injected seawater by well mixing DPD solution and Buffer solution and then sensor estimate the concentration of residual oxidants in seawater by reading level of changed color of seawater. It shall be noted that there are expiration date of DPD solution and buffer solution to be used for measuring TRO. Further, caution, preventive maintenance and inspection is required to prevent the interruption of normal operation by scale (accumulation of salt crystal and organic matters) in cuvette for sensing and in line for injection of seawater.

Recently, amperometric type TRO sensor has been developed to solve the issues regarding maintenance of existing DPD type TRO sensor and many manufacturers are trying to develop TRO sensors. However, DPD type TRO sensor is widely used for BWMS that makes use of Active Substances.

1.2.5 Hydrogen gas

Seawater pass through electrode of electrolyzer in BWMS using electrolysis technology and below reaction is occurred at 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 electrolysis of seawater, hydrogen gas is generated in accordance with above reaction equation and it is recognized that explosive gas can be generated. To address this matters, it is required that BWMS shall be shut-down in case of overload of an air blower/fan as described on Table 3.35.1 of Sec 35, Ch 3 in Guidance for Approval of Manufacturing process and Type approval, etc. (but, if blowers has doubled and can be automatically started, shut-down of BWMS is not required). In addition, it is required for activation of alarm at LEL[3)]

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

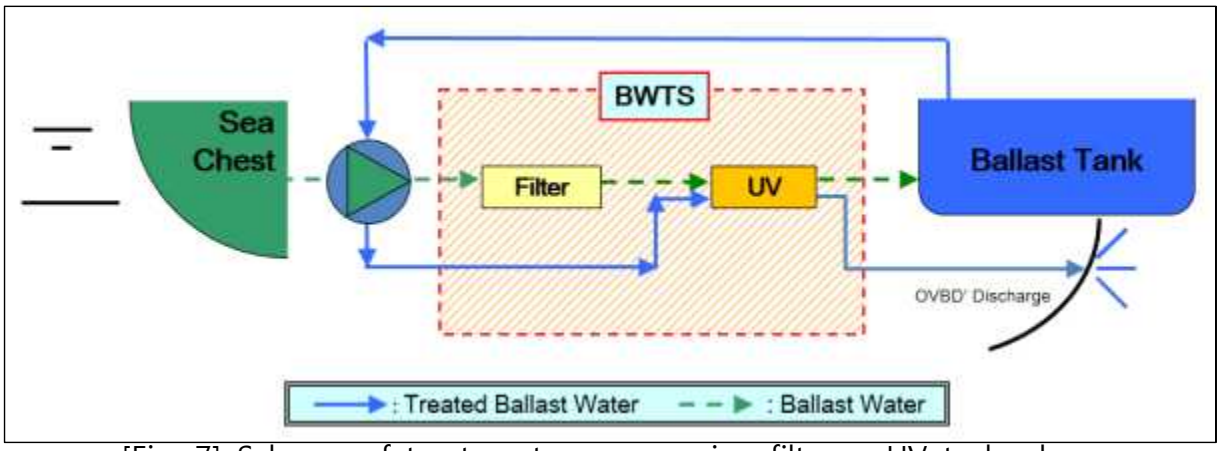
30% and shut-down at LEL 50%. Further, in accordance with 3505 provision of the Guidance, the concentration of explosive gases is not to exceed 50% of the LEL and even after stopping the operation of electrolysis unit, considering a possibility of explosive gas persistence in the ventilation pipe, gas ventilation operation of the unit is to be sustained for a certain time period according to the manufacturer's recommendations, but not for less than 3 minutes. Detector(s) is also to be installed in the ventilation pipe of explosive gases. The detector(s) is to be activated above the designated concentration level. Then, the BWMS is to be stopped and a visual and audible alarm is to be activated.

1.2.6 Operation limitation depending on salinity

As paragraph 1.2.5 mentioned above, electrolysis unit requires salt to generate hypochlorite. Therefore, if BWMS using electrolysis technology was installed on vessels to voyage in brackish and fresh water, it should be considered for operation limitation of BWMS depending on salinity of water to be operated. This limitation is specified on type approval certificate with normal operational salinity range and it should be considered for operation plan of BWMS and schedule for voyage of a ship.

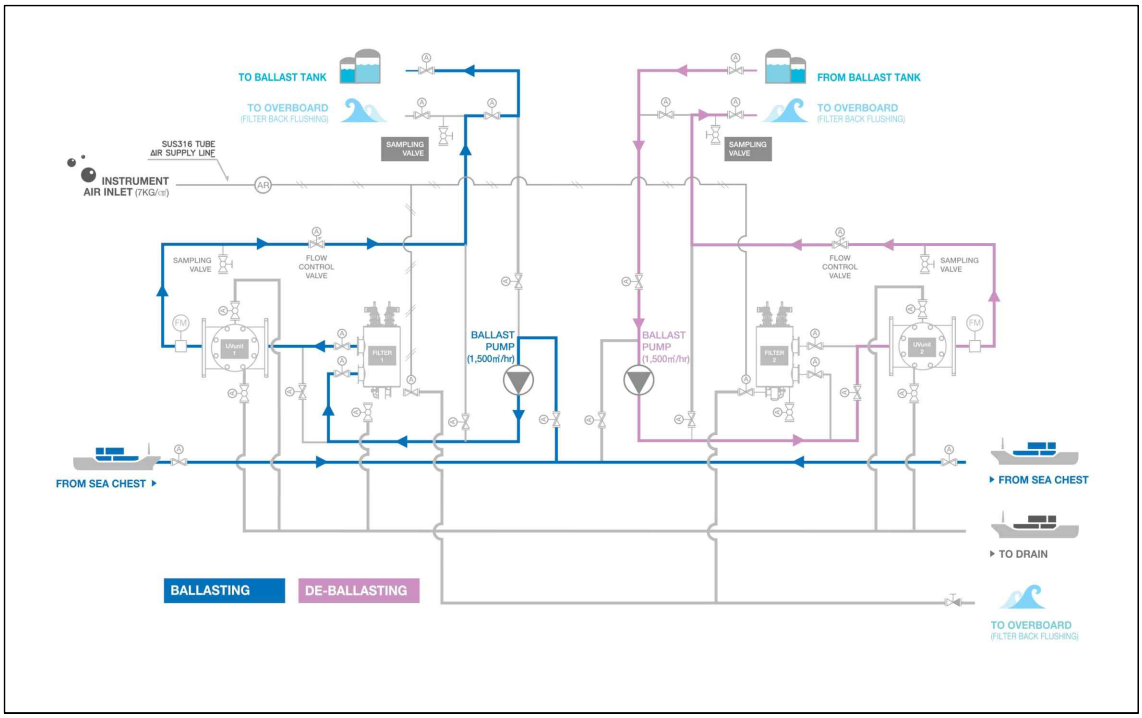
Recently, many of BWMS manufacturers using electrolysis technology have prepared a solution that seawater is stored in Aft Peak Tank (A.P.TK) during ship's voyage in seawater area, and when a ship operates in low salinity area, the seawater stored in A.P.TK is properly mixed with low salinity water to meet salinity range on type approval certificate during operation in low salinity area. As another similar measure with aforementioned, brine tank with high level salinity is additionally installed to solve the salinity operation limitation for electrolysis unit.

1.3 Filter + UV treatment technology



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

1.3.1 In case of filter + UV technology, the first, a filter removes larger than 50 ㎛ size class of aquatic organisms and sediments, after that, the other size classes of aquatic organisms are sterilized by irradiation of Ultra Violet light. General arrangement of BWMS using filter + UV treatment technology is shown in below Figure.



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

1.3.2 Depending on type of BWMS using UV treatment technologies, it is divided as operating UV chamber for only ballasting or both of ballasting and de-ballasting. This can be checked by referring type of BWMS approved and

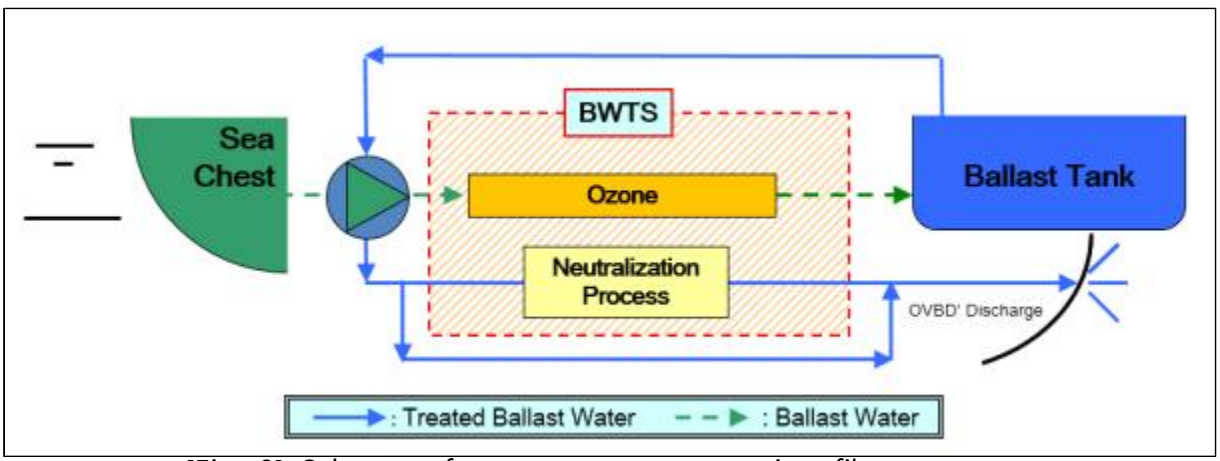
Operation, Maintenance and Safety Manual (OMSM) and it shall be noted that biological efficacy of BWMS using UV technology can be secured when the BWMS should be operated in accordance with operation method recognized by its manufacturer.

1.3.3 UV Lamp of BWMS using UV treatment technology is usually M.P. (Medium Pressure). UV lamp of BWMS is significantly different with UV lamps for UV type water purifier in our daily lives, it shall be noted that it can be occur problem regarding HSE, if a crew was exposed to light of UV Lamp of BWMS.

1.3.4 Comparing to the other type of BWMS, the amount of electricity consumption of UV treatment technology is relatively higher. However, recently, the amount of electricity consumption has been reduced to the similar level of the other BWMS by applying additional electric/electronic module, and some type of BWMS with a lower amount of electricity consumption than the other general BWMS has been launched.

1.3.5 In case of ships entering the jurisdiction of USA, some of BWMSs using UV treatment technology have two mode, so called IMO Mode and USCG Mode. With regard to this matter, in case of ships entering ports in USA, officer in charge shall note that BWMS should be operated taking into account the amount of electricity consumption and operation of BWMS under approved condition.

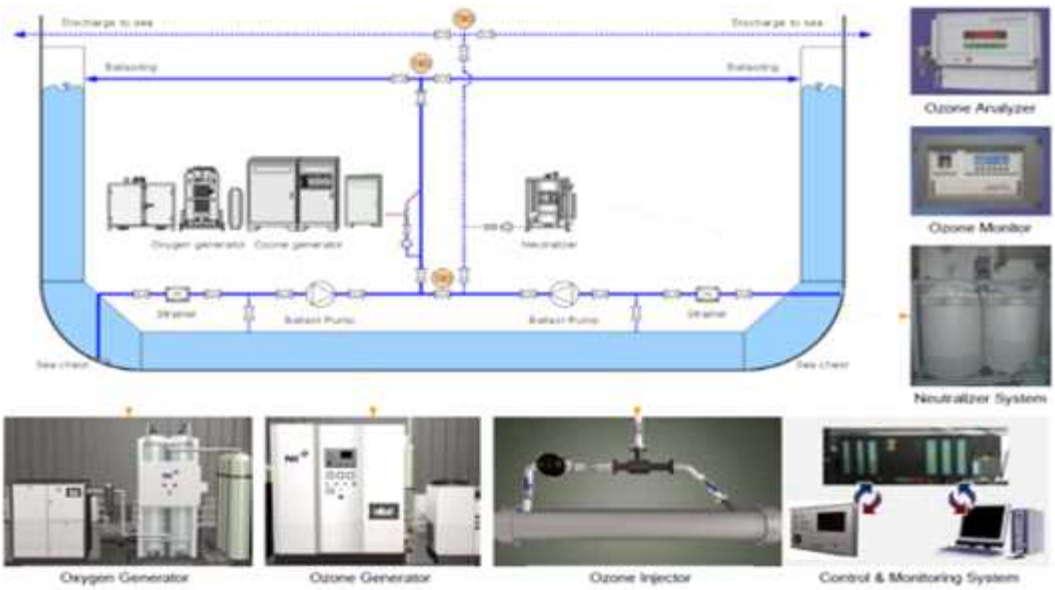
1.4 Ozone treatment technology



[Fig. 9] Scheme of treatment process using filter + ozone

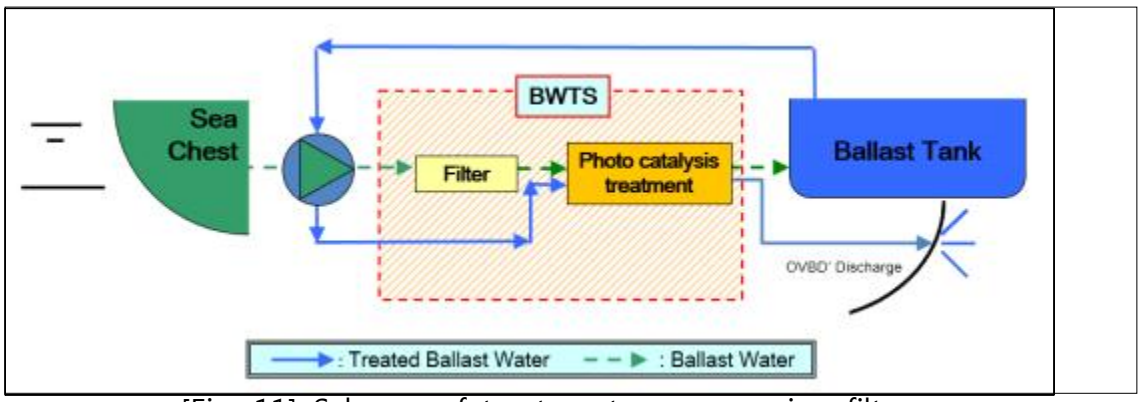
1.4.1 There is an advantage of BWMS using ozone treatment technology that it

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



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

1.5 Filter + photocatalysis treatment technology



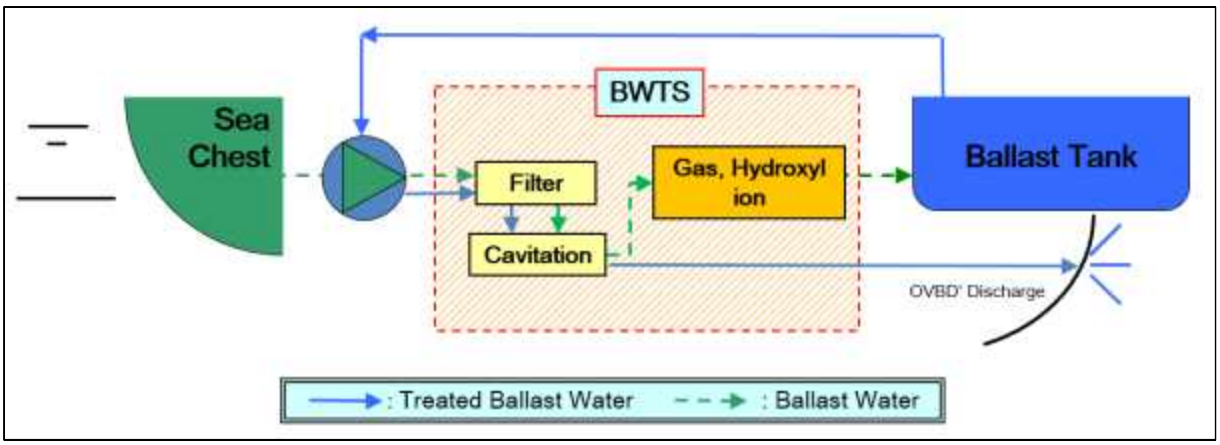
[Fig. 11] Scheme of treatment process using filter + Photocatalysis treatment technology

1.5.1 This technology has an advantage that does not use chemicals. First, a filter removes larger than 50 ㎛ size class of aquatic organisms and sediments, and

then, the other size classes of aquatic organisms are sterilized by radicals generated from irradiation of light to Titanium Dioxide.

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

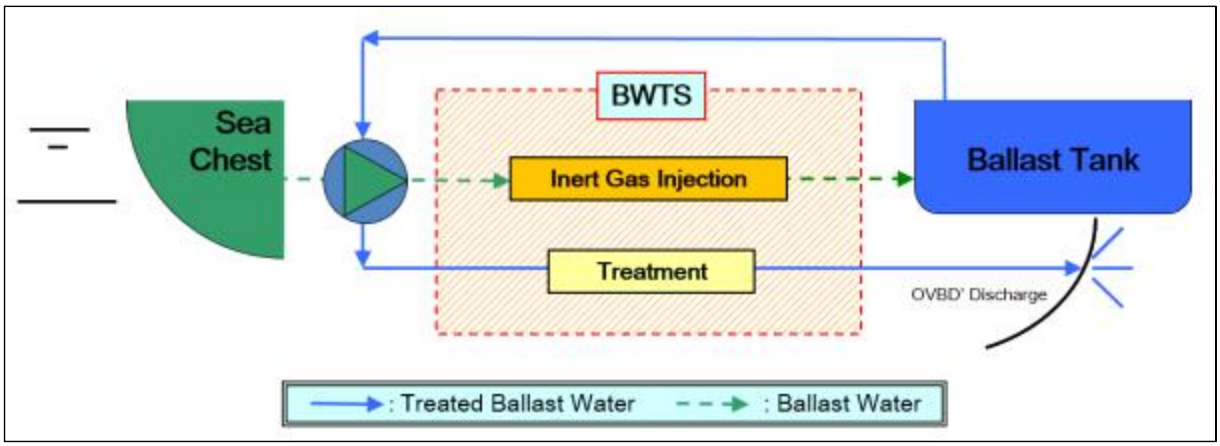
1.6 Filter + Cavitation + Nitrogen treatment technology



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

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

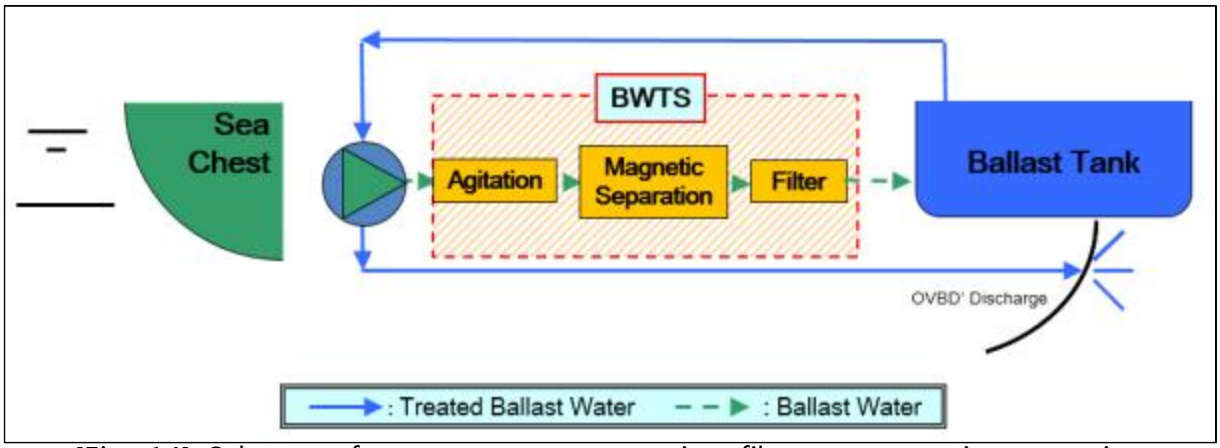
1.7 Inert gas treatment technology



[Fig. 13] Scheme of treatment process using inert gas treatment technology

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

1.8 Filter + Magnetic separation treatment technology



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

1.8.1 This system has a process that magnetic powder is added in up-taking ballast water and ballast water is stirred to absorb aquatic organisms in magnetic powder and then magnetic powder with aquatic organisms is separated from

ballast water using magnet. This system does not need neutralization or re-treatment due to the fact that it does not use chemicals for sterilization and does not make water quality changed.

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 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 de-ballasting only.

5) In case where balllast tanks adjacent to cargo oil tanks 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 joints with cargo oil pipes. Further, a warning notice is to be posted stating that spool pieces are to be removed except for emergencies. By-pass mode is permitted as an Emergency Ballasting Mode referred by MEPC 70. However, it shall 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 of flash point below 60 ℃

1) For oil tankers carrying cargo oil with a flash point of 60 ℃ or less, they are classified as Zone 0, Zone 1 and Zone 2 according to the probability and risk of 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, special consideration for explosion-proof requirements should be taken into account.

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 dangerous zone in an oil tanker carrying cargo oil with flash point below 60 ℃

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

1.3.3 Considerations for Installation of BWMS using Direct Treatment Type

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

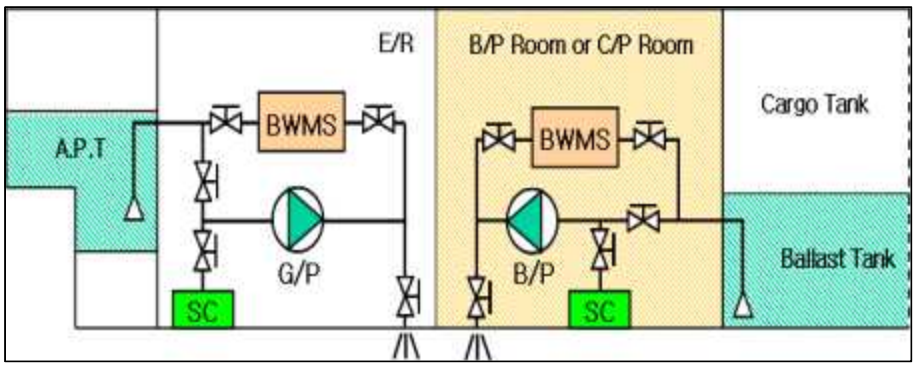
2) Oil tankers with a flash points below 60°C are to be installed outside the hazardous zone, except for explosion-proof type approved electrical equipment.

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

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 may be installed here. [Figure 15] is a schematic diagram of the installation in a cargo pump room.

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

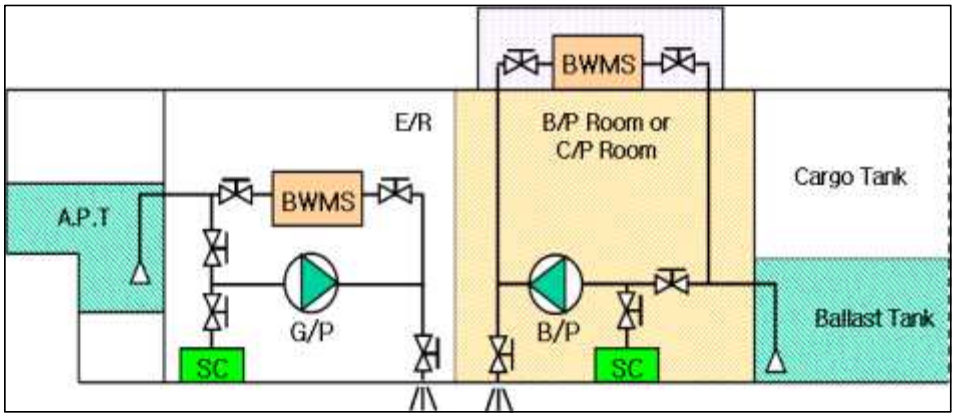


[Fig. 15] Installation of BWMS in Pump Room

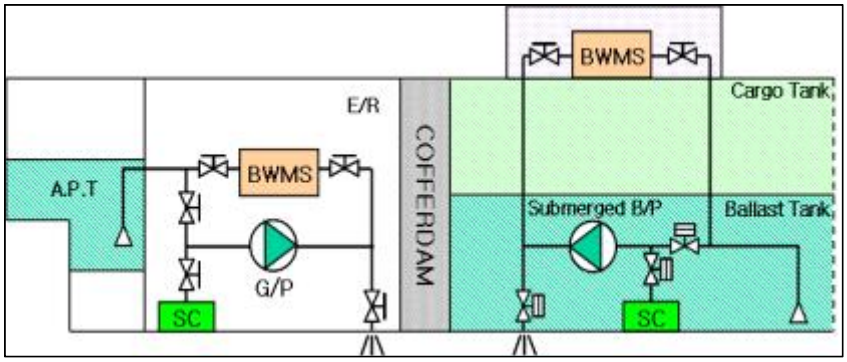
5) Installation in Areas other than Engine Room or Pump Room

- 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.

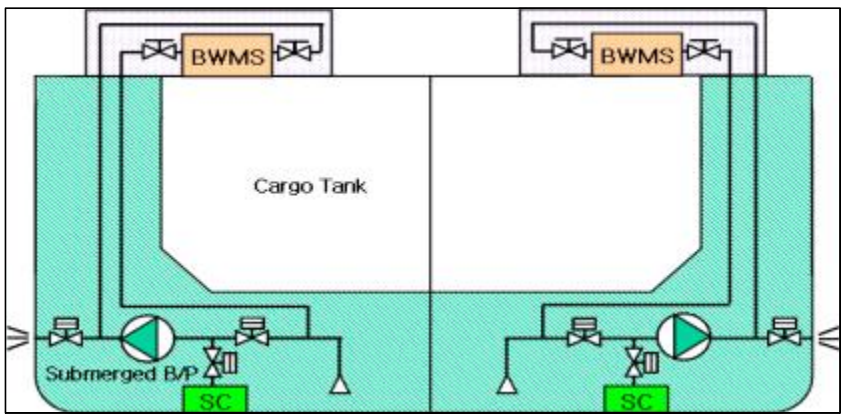
- In this case, the BWMS may be installed on upper deck. [Figure 16] is a schematic view of an example where BWMS is installed on the deck. The following should be considered when installing the BWMS on upper deck.



[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 case of installing ballast water system at the upper part of the deck and treating the ballast water by directing the ballast water to the upper part of the deck, consideration should be given to reduction of the ballast water pump head. Also, when ballast water moves from a high place to a low place, 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. So in case of that there are leak fators such as flanges, valves, etc. in this location, the BWMS Room can be the hazardous zone 2 where the zone shall be explosion-proof suitable.

- However, if appropriate safety measures are taken in according with 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 shall be given to the installation of a ballast pump with a high head to send ballast water to the place where the BWMS on the deck is installed.

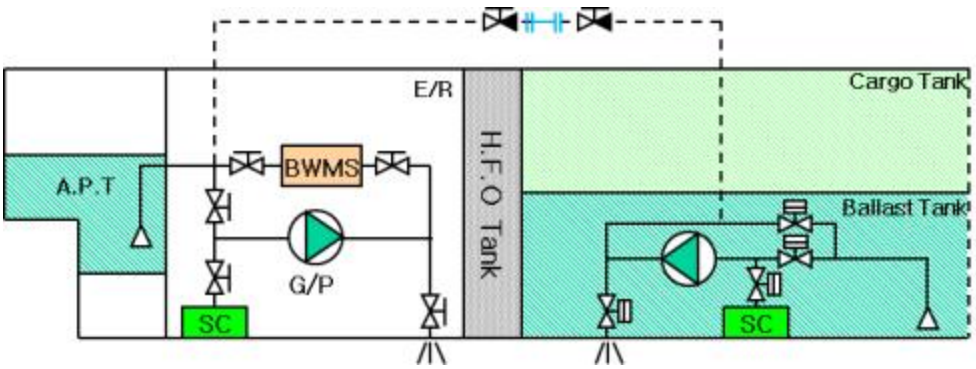
- In the case of the BWMS type which is generated in the process of seawater, the dangerous gas discharge pipe should be led to a safe zone outside the enclosed area because there is a possibility that it accumulates in the enclosed area in case of dangerous gas leakage.

- The BWMS Room shall be equipped with a mechanical ventilation system capable of ventilation six times per hour in preparation for the leakage of hazardous gases.

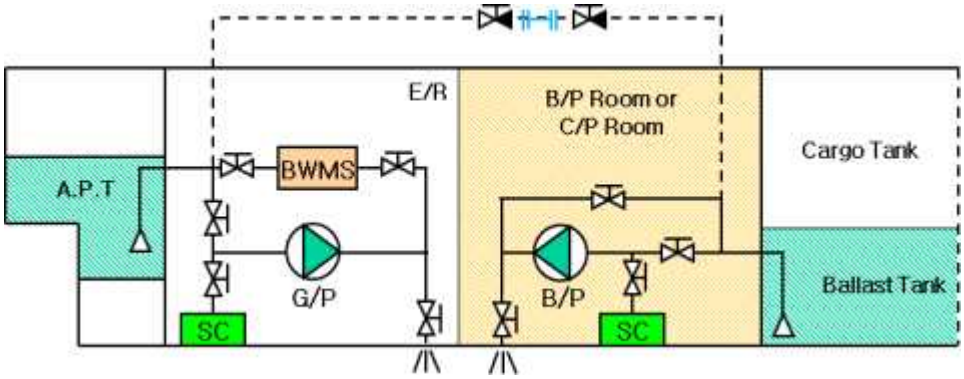
- If BWMS is installed on exposed decks without a separate enclosed space in the BWMS Room, it should be checked whether it is more than IP 54[4)] for each equipment.

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 & 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 discharged only through the neutralization process without going through the processing module again. That is, it can not 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 shall be selected first. Because it is connected to the main ballast water system, the capacity of the BWMS is to be not less than the total capacity of the ballast pumps or submersible ballast pumps located at least in the pump room.

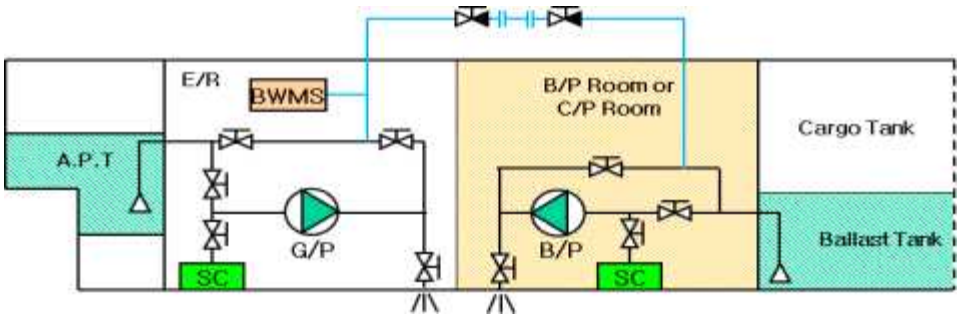
- Ballast pumps are to be installed separately for the ballasting and de-ballasting. For ballasting, it can be considered the use of a separate ballast pump or G/S

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 de-ballasting.

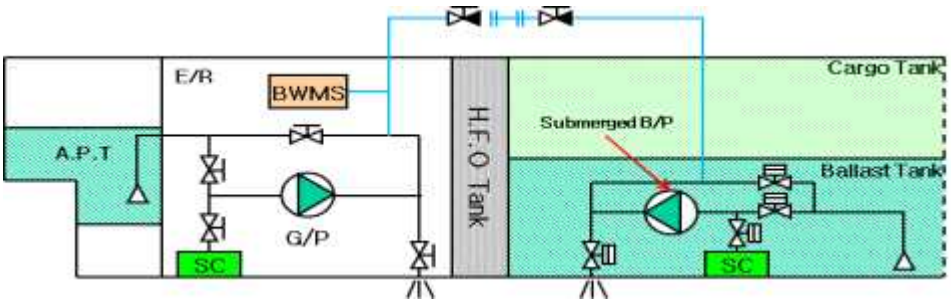
1.3.4 Considerations for installing BWMS in Injection-type

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

2) Oil tankers with a flash point below 60°C are to 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 which an ozone generator is installed to treat ballast water, an ozone gas leak detector shall be installed to activate alarm when the ozone gas leaks. In addition, pipes of supplying O_3 installed at the zone except for weather deck shall be managed specially by using the ways such as using doble pipes or welded joint SUS pipes.

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

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

6) The discharge pipe shall be a fully welded joint without flange joints, however the number of the flange joints shall be minimized and a hydrogen gas detector shall be installed nearby the flange joints in case where the flanges are used.

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

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

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

10) If the equipments regarding BWMS installed in the engine room inject the substances for treatment in main piping of the ballasat pump installed in the pump room, the following requirements shall be satisfied.

- The equipments shall be used only when injecting the substances.
- The substances shall be injected on deck, not in piping penetrating the bulkhead between the engine and pump room.
- In order to prevent backflow of injection pipe, 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 as hazardous zone such as the piping installing TRO (Total Residual Oxidant) sensor or gas detector, an approved explosion-proof BWMS shall be installed even if the equipments (e.g. TRO sensor, gas detector, etc.) is installed out of the hazardous zone.

1.4.2 If the BWMS installed in safety zone, a type and status of the installation shall be appropriate in 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 equipments such as sensors and automatic control valves which are installed on a pipe of ballast water to automatic control of a treatment system shall 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 hazardous zone shall be provided with multi-pole linked the disconnection switches installed in a safe zone.

2) In addition, the disconnection switches shall be clearly labelled to identify the electrical equipment to be connected with, and further effective means shall be provided to prevent risks due to incorrect operation.

1.5.4 Monitoring of Insulation Level

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

1) Upon feeders and distribution circuits connecting to electrical equipments and passing through the hazardous zone, excluding intrinsically safe circuits, the insulation level shall be monitored, and the alarm shall be activated in case where resistance of insulation 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 shall be independent of similar equipment serving cargo tanks and of cargo tank themselves.

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

3) The injection system can be a pump installed in the machinery zone when injecting from the tank deck and installing a check valve.

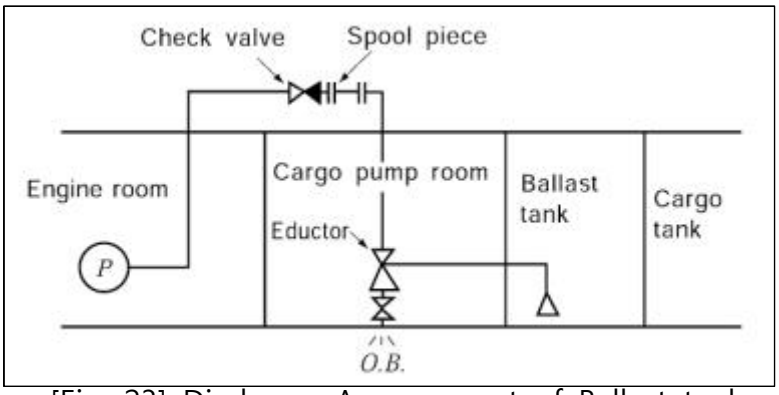
2.1.2 Injection of ballast in cargo tanks can be carried out at the deck position using a dedicated ballast pump. However, The injection pipe shall not be connected to the cargo tank or cargo pipe in a fixed manner, and a check valve shall be provided.
The loading of ballast water in cargo tanks can be done without any treatment in Emergency ballasting mode, but in the case of general ballast loading, the whole process must be done through BWMS.

2.1.3 Discharge water of dedicated ballast tanks adjacent to cargo tanks may 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 and other substances transported from the engine room to the pump room.

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.

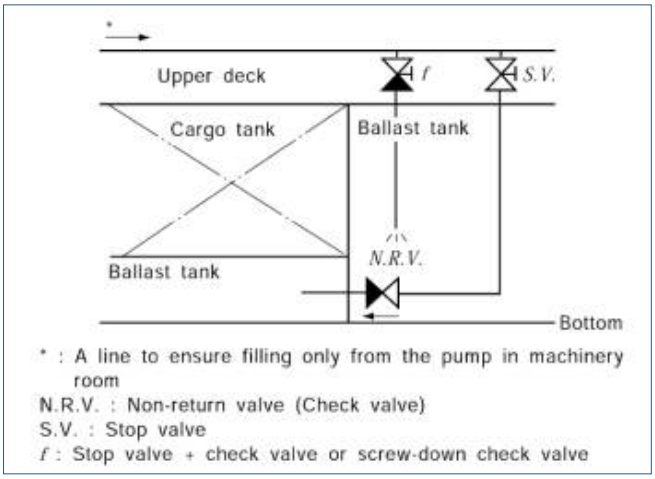
Therefore, even when operating water is transported, it sall be arranged as shown in [Fig. 23].

2.1.4 The separation requirements (two pairs screw tightening check valves, spool piece or water seal or double block bleed valve) shall 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 cases where pipes exclusively used for filling but can not be used for discharging are fitted with stop valves and check valves that are operable from weather deck or stop valves on weather deck. Also, stability requirements must be sustained in the event of progressive flooding due to damage in the piping system and due consideration shall 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 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 Having a Flash Point Below 60℃

1) For chemical takers carrying chemical cargoes having a flash point of 60℃ or below, dangerous space is classified under Zone 0, Zone 1, and Zone 2 according to the probability of 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 for explosion-protection requirements shall be taken into account.

2.2.2 In chemical tankers carrying chemical cargoes having a flash point above 6 0℃, 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 shall be installed in a non-hazardous area, or shall be certified as safe for use in a hazardous area. Any moving parts, which are fitted in hazardous areas, shall be arranged so as 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.

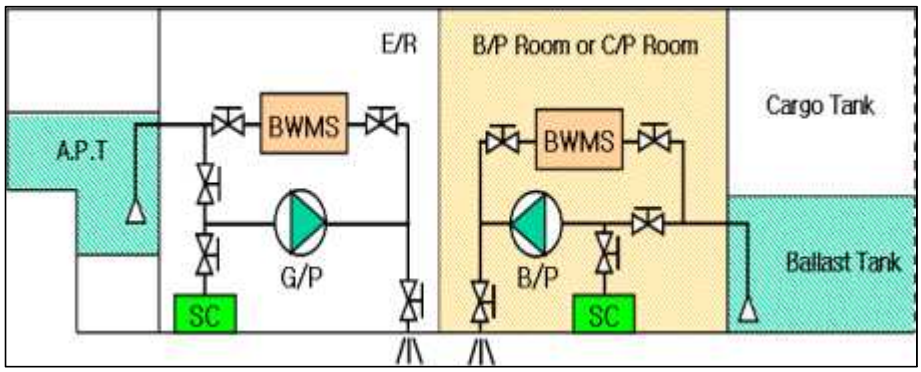
2) Chemical tankers with a flash points below 60°C are to be installed outside the hazardous area, except for explosion-proof type approved electrical equipment.

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

4) Installation of BWMS in Cargo Pump Room or Ballast Pump Room.

- For chemical tankers where there is a cargo pump room or a ballast pump room, a ballast water treatment system may 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 considered to be a hazardous zone shall be explosion-proof of the approved type.



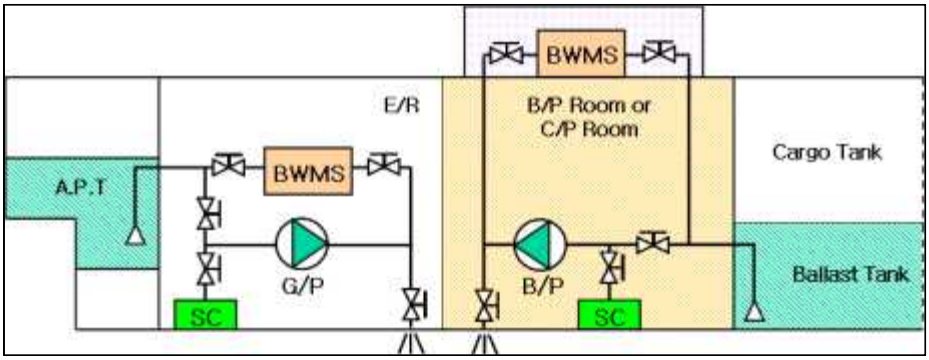
[Fig. 25] Installation of BWMS in Pump Room

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

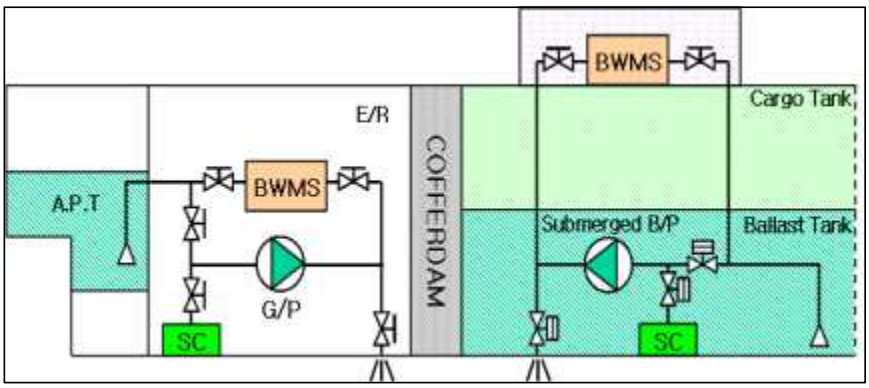
- In the case of a chemical tanker with a lack of a pump room or a pump

room, it is difficult to find a zone to install in chemical tankers not having a cargo pump room or ballast pump room.

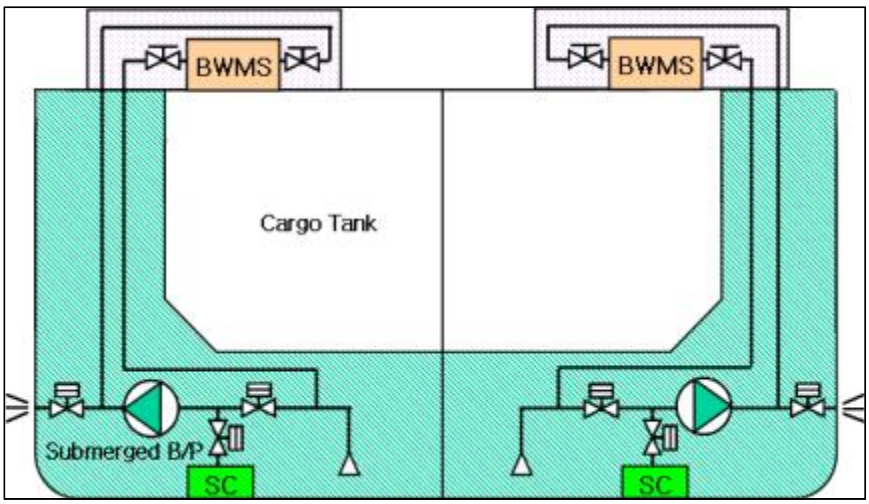
- In this case, the BWMS may be installed on upper deck. [Fig. 26], [Fig.27] and [Fig.28] is a schematic view of an example where BWMS is installed on the deck of cargo zone. The following shall be considered when installing the BWMS on upper deck.



[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

- In case that the BWMS is installed on ship's upper deck requiring ballast water to be pumped up to the BWMS, head loss of the ballast pump shall be considered. Also, 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 shall be considered.

- If the BWMS is installed above upper deck but elevated by means of a cofferdam so that piping connections and openings are located 2.4 meters above the upper deck, the installation area can be regarded as a safe area, and 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 the reason, Electrical equipment installed inside shall be explosion-proof type 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 shall be given to the installation of a ballast pump with high head to send ballast water to the zone where the BWMS on the deck is installed.

- In the case of BWMS type where dangerous gas such as hydrogen gas is generated in the process of processing seawater, the dangerous gas discharge pipe shall be led to a safe zone outside the enclosed zone because there is a possibility of accumulating in dangerous gas leakage area.

- The BWMS Room shall be equipped with a mechanical ventilation system capable of ventilation six times per hour in preparation for the leakage of hazardous gases.

-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 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.

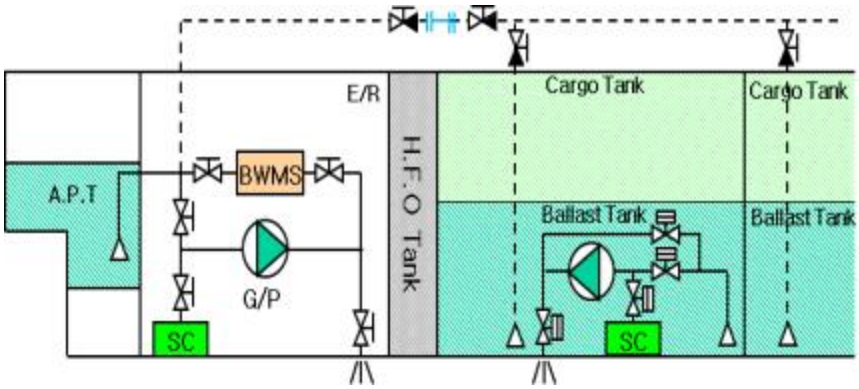
- Where such ballast water is to be injected, it is to be possible to be led directly from the ballast water pipe above the exposed deck to the ballast tank. Refer to Section 3.2.4 for arrangements of related piping systems.

- This arrangement is not only different from the way in which the oil tanker's direct treatment is installed only 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 the direct treatment method (electrolysis method) is installed only in the engine room, as shown in [Fig. 29] and [Fig. 30] Tubes leading from the upper deck directly to the ballast tanks shall be provided for each tank.

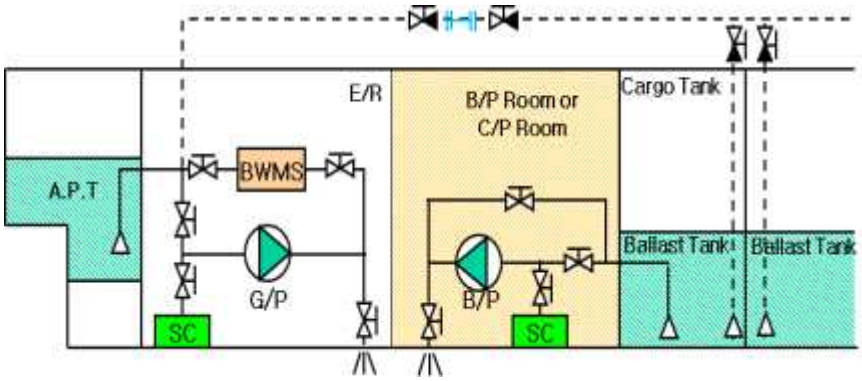
- When designing such a arrangement, the capacity of BWMS shall be selectedfirst. Because it is connected to the main ballast water system, the capacity of the BWMS shall be not less than the total capacity of the ballast pumps or submersible ballast pumps located in the pump room.

- 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.

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



[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 includes side stream electrolysis chemical injection and ozone injection treatment.

2) Oil tankers with a flash point below 60 °C shall 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 alarm in case of leakage is required to be installed in which the ozone generator is installed. Also, due consideration shall be given to 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 shall be confirmed whether it is grade of IP 56 or more of each equipment.

5) If the BWMS is such a type that generates hazardous gas such as hydrogen gas after treatment, discharge pipes of the hazardous gas shall be led to a safe area outside the enclosed space.

6) The discharge pipe shall be a fully welded joint without flange joints, but if flanges are used, the number shall be minimized and a hydrogen gas detector shall 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 can not be installed inside the engine room and shall be installed in a separate place.

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

9) The cargo operation is 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 case where the BWMS related equipment installed in the engine room 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 shall 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 Those sampling directly from ballast pipes such as a TRO(Total Residual Oxidant) Sensor Unit or a Gas Sensor Unit shall be of approved explosion-proof type even when installed outside the dangerous areas.

2.4.2 If installed in a safe space, the electrical equipment shall 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 tank are to be connected at least two power driven ballast pump. One of them can be driven by main engine.
These pumps can also be considered as independent power ballast pumps if the independent 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 may be used. In addition, in the case where a cargo oil pump is installed to be 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 check valve with indicator or stop valve in order to prohibit the flow between ballast tank to ballast tank and overflow from outboard. Where butterfly valve(except remote control valve) is used, The means such as holding device or equivalent to prohibit the movement of valve disk by vibration or fluid flow.

2) Where the remote control valve is installed, the power for control is lose then valve is to be closed and keep its position. Alternatively, where the means easily

operable manually to close the valve at power loss is provided, the position of the remote control valse is to be kept.

3) Installation of sea chest is allowed for ballasting or deballasting by gravity in exclusive ballast tank. But, the related valve is to be controlled from freeboard and double stop valves. It will be designated by BWMS type after effect in force but the most BWMS type is in-line then those installation will 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 case loading the flammable cargo in accordance with IMSBC Code[8] or IMDG code[9], cargo hold and its ventilation duct which loaded the dangerous goods indicated as dangerous zone.

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 3 m from ventilation openings, explosion-proof electrical equipment shall be installed.

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

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

1) Closed ro/ro space or closed car space is classified to 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 case of installation above 450mm , it is allowed if the electrical installation is sealed and protected (IP55 or above) and the surface temperature

8) IMSBC Code : International Maritime Solid Bulk Cargoes Code

9) IMDG Code : International Maritime Dangerous Goods Code

does not exceed 200 °C to prevent 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

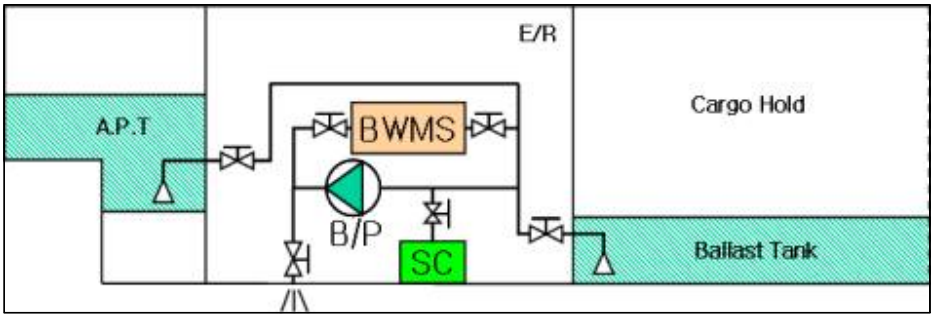
- The below [Fig 31] is the schematic which are Installed BWMS inside Engine Room.

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

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

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

- During anchoring, the vessel do the cargo operation and ventilation system at engine room is operating at minimum purpose but the engine room ventilation system is to be normal operated during operating BWMS using dangerous gas and goods as active substances.



[Fig. 31] Installed BWMS inside Engine Room

2) Installation outside Engine Room

- [Fig 32] is the schematics for Installed BWMS outsied engine room.

- Applicable type of treatment is UV type and Electrolysis type(direct).

- The above arrangement can be applied in case BWMS is installed outside engine room due engine is so small or difficulty of installation of piping.

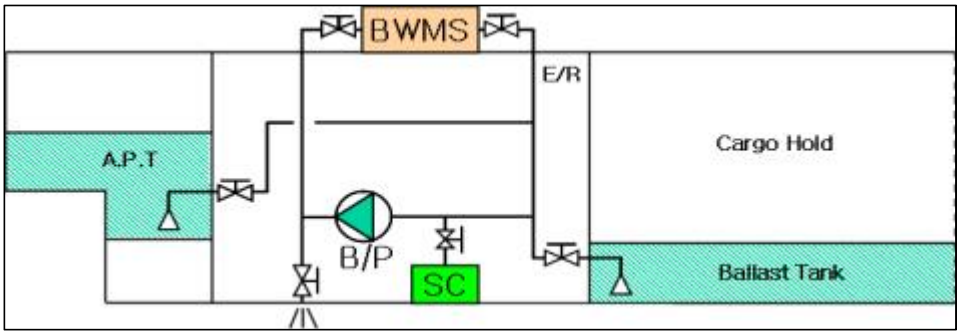
- In case that the BWMS is installed on ship's upper deck requiring ballast water to be pumped up to the BWMS, head loss of ballast pumps shall be considered. Also, excessive vacuum may be found in the ballast pipes when shifting the ballast water downstream from an elevated place, hence countermeasures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

- BWMS is to be installed outside dangerous zone as applicable. But, special consideration such as explosion-proof type to be applied in case of installation on car space, ro/ro space or cargo space as regarded as dangerous zone. Moreover, additional protection measure is to be considered at space which can easily mechanical damaged due to unloading work.

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

- Where BWMS generating the hydrogen gas is installed on closed space, 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 at protected place to prohibit the mechanical damage by cargo.



[Fig. 32] Installed outside Engine Room

3.3.2 Installation of injection type BWMS

1) Where 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 shall be given to piping transferring the generating ozone gas or chemicals such as double wall pipe or full penetrated welded SUS pipes.

3) In case BWMS generate the hazardous gas such as hydrogen gas after treatment, the hazardous gas shall not be leackaged to inside engine room and the discharge pipe led to a safe area outside engine room.

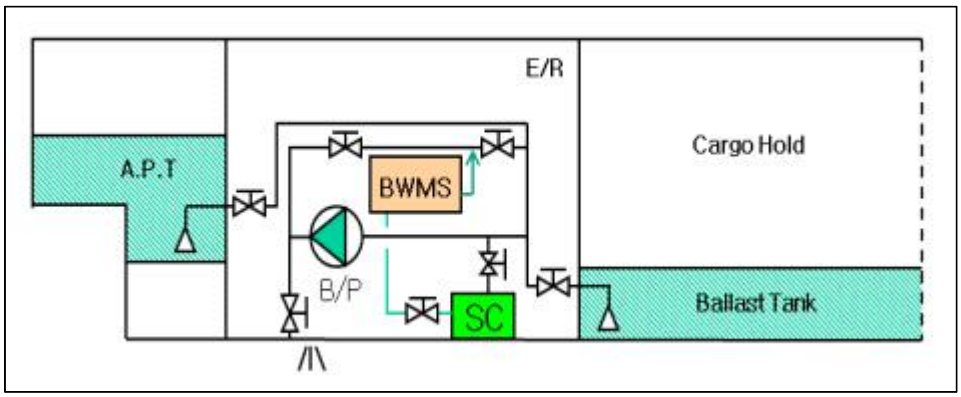
4) The discharge pipe shall be a fully welded joint without flange joints, but if flanges are used, the number shall be minimized and a hydrogen gas detector shall be installed near the flange joints.

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

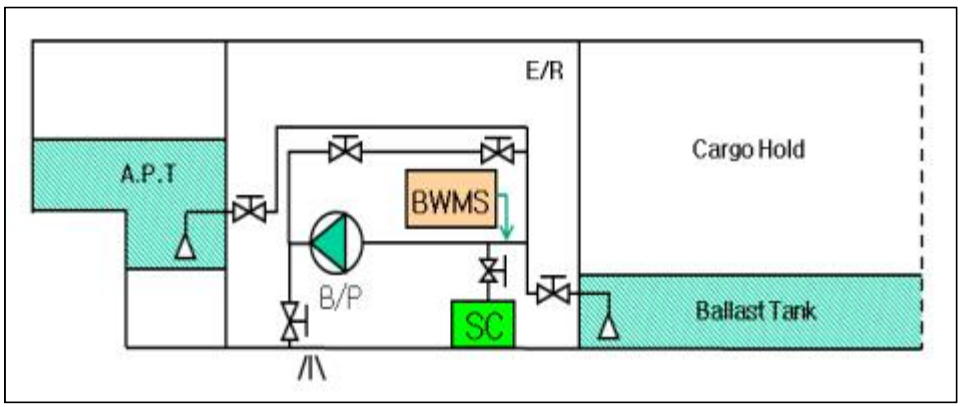
6) When BWMS using chemical substances is installed, the MSDS data shall be kept in the ship at all times, and emergency medicine (emergency) for crew safety shall be kept and managed by the responsible officer. Safety protective gear for the handling of the material must always be provided.

7) The cargo operation is 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.



[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 the situation such that untreated water without BWMS is flowing to ballast tank, audible and visual alarm is to be actiivated and recorded on this situation.

3) All valve related to bypass mode is to be remotely controlled and the automatic detection alarm is to be arranged.

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 to be reflected and untreated water is not be 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) In case of bulk carrier having the large amount of ballast water tank, eductors only for stripping purposes is installed.

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

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

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

Section 4. BWMS Type Approval Limitation

1. General

While 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 meet the Regulation D-2. However, as a test requirement for type approval, it is practically impossible to reproduce all of the world's most challenging conditions. Therefore, it is the System Design Limitation (SDL) of the BWMS proposed as a compromise to 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 select 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 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 parameter of the water quality condition or the operating condition for the BWMS to meet the D-2 Regulation. BWMS Code requires that all type approval certificates specify the range of salinity and water temperature at which the BWMS can operate, as Operation Limitation (See Figure 33. Type Approval Certificate Form).

According to Annex 6.2 of the BWMS Code, a type approval certificate coud 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 Limitation 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)

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 case of USCG Type approval certificate, the first page of the type approval certificate should list the operating restrictions. Depending on the treatment technology of the BWMS, the operating restrictions listed on the type approval certificate are slightly different.

Operating limitations such as Salinity, Temperature, Holding time, Filter Pressure, UVI are limitation conditions for Filteration+UV, generally Salinity, Temperature, Holding time, Electrolyte Feed Temperature, Electrolyte Feed Salinity, Filter Inlet Pressure, TRO are limitation conditions for Filteration+Electrolysis. And Salinity, Temperature, Holding time, Filter Pressure, Active Substance dose are limitation conditions for Filteration+Chemical Injection type.

3.2 Korean Administration

In case of Type approval certificate by R.O.K, 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 BWMS Code will be applied to the amendment of the Law of Ballast Water Management, operating limitation including the range of temperature and salinity during the test will be specified.

3.3 Greek Administration

In case of Type approval certificate by Greek administration for Filteration+Electrolysis type BWMS, as operating limitations, Filteration grade, Nominal rated capacity, Minimum water temperature and Minimum salinity are limitation conditions.

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(per Liter), 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 certificate mainly deals with the installation limitation according to the rules and the conditions that manufacturer or ship owner shall 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/cm) 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. Considerations of BWMS for Shipowners

Section 1. Considerations for operating 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 large capacity. However, since UV system is water-permeable (UV-T) dependent, it does not work well in turbid water. The US Coast Guard interpretation that all micro-organisms released on the US coast shall be killed before de-ballasting, rather than 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 can not be operated, so periodic inspection and replacement is necessary. In addition, special attention shall be given to clogging by using the flushing mode of the filter provided by the manufacturer in order 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[10] 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[11] 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.

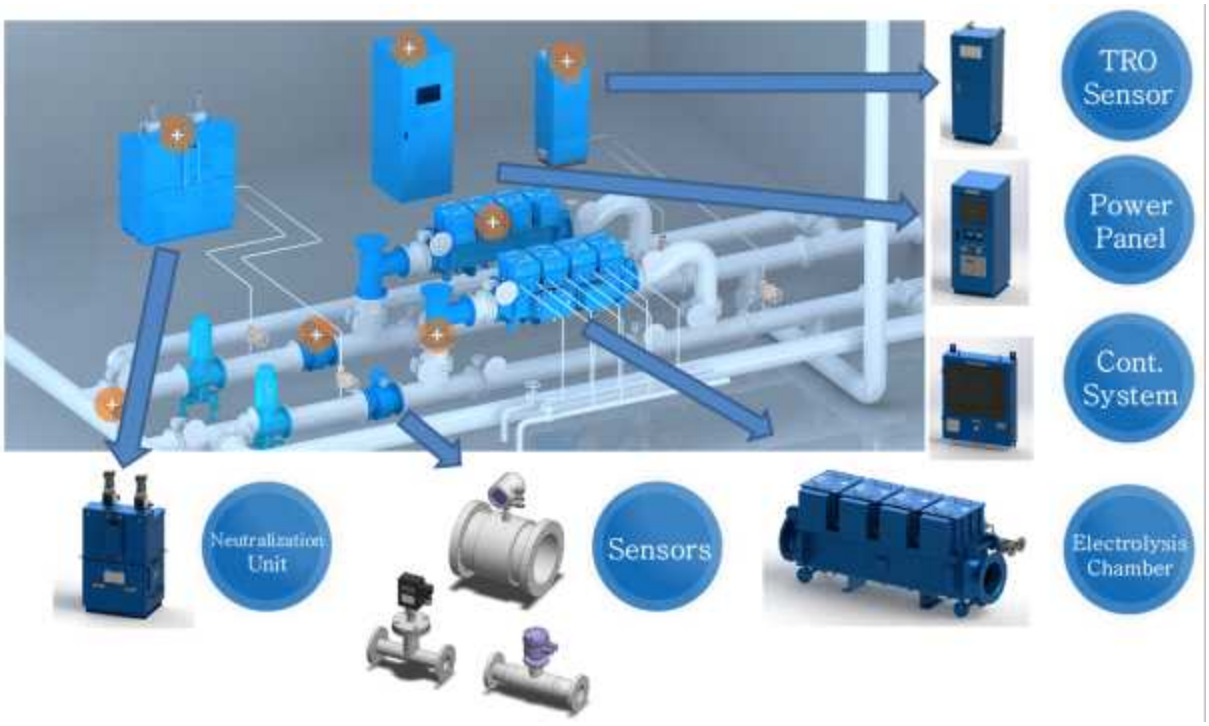
[Table 3-2] Typical maintenance items of UV type BWMS

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

11) 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 rather 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 shall be installed. Finally, 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 and it 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[12]	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 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 6 months	
Flow Meter Unit	Check operation status of TMS[13] Program	Once a month	Conduct self function test
Conductivity Sensor Unit	Clean sensor	Once 6 months	Clean with compressed air brushing
Gas Detection Sensor	Check appearance status of GDS & input cable	Once 3 months	Clean with compressed air brushing
T-Strainer[14]	Clean T-strainer	In case the differential pressure increases to 0.5 bar	

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

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

13) It check the status of the sensors connected to the BWMS called Total Measuring System
Refer to the different names that are called for by each manufacturer.

14) The T-strainer serves as a filter, but the size of the filter is larger than 50 μm (60 to 300 μm)
Filter the particles. Note that most full flow BWMS with a filter other than a T strainer are used
Refer to the different names that are called for 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 due to the fact that 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[15]	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 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.[16]	Once 6 months	
	Calibrate and clean the conductivity sensor at recommended intervals.	Once 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

15) 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.

16) 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 is low because energy is consumed by dispersing chemicals in ballast water. Because the dosing[17] 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, chemicals must be kept in closed containers and it could be dangerous. Using chemicals requires strict safety practices and crew training. Regular storage of chemicals results in additional operating costs compared to UV or electrolysis systems, where electricity is the main cost item.

[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].

17) Chemicals are in liquid form and powder form. In case of powder type, 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 handled with care.

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 ship's size increase. The disadvantage is that it is necessary to manage the safety of the ozone gas because the 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	

Component	Action	Time Interval	Notes
	Check safety valve	Once 3 months	Change if abnormal
	Check oil return line & after cooler	Once 3 months	Clean, if necessary
	Check oil separator element (differential pressure)	Daily	
	Change oil & oil filter element	Once 6 months	Change after initial 500 hours (1 month)
	Change air filter & separator element	Once 6 months	Change after 3000 hours
	Check suction valve & min. pressure valve	Once a year	Change if abnormal
O2 generator	Check filter element	Every 4000 hours	
	Check consumables (repair kit of valves)	Once 2 years	Replace if necessary
O3 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 2 months	
	Check safety, protection equipment	Once a year. Or every 6000 hours	Contact the manufacturer
	Overhaul compressor	Once 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 is reported that many of BWMS operated abnormally due to occurring operational problems of BWMS installed onboard, which is incurring serious additional cost to the shipowner. Therefore, this section discusses a way of preventing operational problems after installation of BWMS.

1. Training

Compared marine & ocean equipment, the BWMS is obviously unfamiliar to crew members. Therefore, training for the system may be a way of solving the most important operational problems. It is important that the training is performed in a consistent method, and more careful attention is required in case where BWMS is designed specifically for ships. 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 obliged the crew to receive the training. According to the relevant provisons,

the shipowner shall let crews who are in charge of ballast water management be trained for following matters in 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 shall construct a curriculum to acquire the insight preventing and resolving 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 training methods using simulation tools developed by the manufacturer are also provided. These methods are effective and the shipowner require comprehensive training materials including operational guidelines that may be updated periodically, organized systematically and specific to the vessel. The shipowners with fleets equipped with various types of BWMS have skilled crews for specific types of BWMS, but the crews may lack knowledge for other types of BWMS. Therefore, having 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 for the crew, but the shipowner must regard managers and port engineers as the trainee. The manufacturers sometimes conduct training sessions at manufacturing plants, but their availability is limited. Therefore, for the technical managers, shipowners shall request their vendors to perform the training at the shipyard or port. Then, the technical managers may provide technical training to crew. If technical managers are trained on various knowledge of BWMS, shipowners will benefit from it.

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 of crew management, it is recommended for using records and certifications. It is desirable that the training is conducted focusing on the operation of the BWMS due to the fact that the training is not always enough to fully acquire and apply the technology of BWMS in practice.

- **Sampling**

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

In particular, as described in Chapter 2, Section 4, if the survey proceeds up to Phase 4 according to the PSC Guidline, the crew shall be well-acquainted with the sampling method in order to demonstrate the integrity of the ship. In addition, if the crew is not well-acquainted with the sampling method, the crews shall pay attention due to the fact that it is a non-conformity reason in phase 2 of the PSC Guidelines.

3. Operation

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

- **Sequence**

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

- **Equipment of filtration**

As the 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 components of the BWMS such as a UV lamp.

- **Storage of Data**

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

- **Consumables**

Chemicals are important for operating several BWMS among the chemicals. It is

very important to confirm method and plan of storing consumables and the expiration date of the consumables. The crews may be dangerous when exposed to chemicals. Therefore, it is necessary to be thoroughly trained to know the way of using them. In addition, relevant values are not able to be measured and indicated abnormally in case where several consumables (e.g. DPD and Buffer solution of TRO sensor) are invalid (out of expiration date), and even if the values are measured and indicated normally, attention is required due to the fact that the matters regarding validity of consumables are most frequently point out during the document review as Phase 1 of PSC Guidelines.

4. Maintenance

Preparing and carrying out maintenance plans, preliminary planning for sediment disposal and planning for consumables usage is a very important issue. Therefore, the risks arising from the BWMS shall be identified and BWMS operated in the enclosed space in the hazardous area shall be precisely reviewed.

- Maintenance plan

Shipowners and manufacturers shall consider the annual survey plan of the BWMS when preparing a safety plan for maintenance. During the survey, a number of service engineers are to confirm components of BWMS, software updates, and the way of accessing to hazardous areas, and the crews shall confirm potential troubleshooting and updated recommendation of the BWMS manufacturer of other ships. During the survey, it is very important to identify the source of the failure and to understand the differences and commonalities between our ships and the others.

A number of BWMS determine the dosage of disinfectant and detect the degree

of neutralization by measurements of TRO (Total Residual Oxidant). Reagents used for the TRO measurements are vulnerable to improper storage and use, and abnormal operation of the TRO sensor may cause a series of problems. In addition, the calibration of TRO sensor is required periodically. For reference, prior to the entry into force of the BWM convention, many vessels equipped with BWMS before the entry into force of the convention did not operate the BWMS. However, when entry into force of the BWM Convention is imminent, the problems occurred by using solution which was used for commissioning. Although the reagents was replaced, crystallized salt grains and other materials may affected adversely the sensor due to performing cleaning operation insufficiently. For that reason, many cases requiring replacement and repair of TRO sensor was identified.

For UV system, the costs for replacement of UV lamp are quite high, and the volume of ballast water may be reduced during ballasting and de-ballasting due to filter clogging in case were filter is applied. Therefore, it is very important to perform training of systems and procedures used onboard.

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

- **Management of sediments**

The problems regarding treatment of sediments occurs when the ballast water is not ballasted by BWMS. Appropriate rate of filtration is effective to remove microorganisms and improve 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 UV lamps BULB shall be replaced frequently and replacement cycle is crucial in case where the lamps cause system failures. The expected lifetime of most UV lamp BULB is not satisfied due to cooling water problems and damage for frequent start-up and shutdown. Therefore, reviewing performance of the consumables is required before and/or after replacement of the consumables.

Several shipowners have acquired variously the ways to operational problems before and/or after installation through their experience with vendors. However, if the vendors is bankrupt, founding the way to solve serious problem occurring in future is concerned. Therefore, it is necessary to re-assess completely whether or not the technical support of the vendors is available prolongedly. However, the shipowners shall arrange separate ways to supply the consumables smoothly due to the fact that it is difficult to estimate the long-term availability for technical support of the vendors completely.

2. BWMS Management Guideline by BWMS type

2.1 UV TREATMENT

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

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	Ignition of UV lamp

failure	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 during 6 hours (3 hours : Ballasting / 3 hours : de-ballasting) 4. Due to the limited availability of service engineers who provide administrative support when trading ships at a remote location, sales networks rarely meet basic standards. 5. Errors of control panel occurred about 1.5 years after installation. The software shall be updated by 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 hired technology of Electrolysis (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 matters of BWMS 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, it is required to confirm whether or not additional construction of BWMS is needed for meeting 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 required to be well-acquainted with the information of new component and systems due to increasing exposure for the new components and systems. 5. The practical training is required to increase understanding of practical operational methods. - Practical training : Training course of 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 for 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 used during the operation may occur.
Reduction in ballast rate	Actural flow rate is reduced by 10 to 20 % of TRC due to backflushing of filters.
Other issues	Error is not notified by system when operating out of valid

and challenges	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 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 due to the fact that the system is complicated.
	Several sensitive sensors, transmitters, indicators and etc. are installed in system and, if maintenance is poor, possibility of occurring malfunction of system is high and the system shall 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. Suppliance 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 required for paying attention to managing chemicals.

2.3 Electrolysis (Side-stream)

[Fig. 44] Example for typical field installation of BWMS hired technology of Electrolysis (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 due to the fact that 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 of 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 having 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 of injection is installed and time of reaction is corrected. In addition, the piping is replaced to the piping with hole to improve the mixing ratio of NaOCl and sea water.
	The fluctuation of electromagnetic flow meter (flowmeter of the electrolysis unit, not flow meter of ballast system) may occur during the 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 the cleaning and reassembling inside of the De-mister, the flow meter of electrolysis unit is operated normally
	The accuracy of the conductivity sensor (seawater) is low. In general, salinity shall be 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 : 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 pressure alarm is activated low in states that blower is stopped.
	Communication of BWMS and IAS shall be designated for two different channel of communication in order not to spend a lot of time searching 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 of that is required during the de-ballasting. Therefore, the performance of the pump must be proved under condition of the de-ballasting operation.
	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 crews occur. 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 shall 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 matters of BWMS 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	1. Limited shelf life of oxidant

challenges	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 of the BWM Convention in 2014 (Res.MEPC.252 (67)) and follows the 4 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. The second phase of a more detailed inspection will be carried out if it is confirmed that an IBWM certificate that is not valid, expired or lost, or 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, etc.

1.2 During the second phase of the detailed inspection, the PSCO confirms the 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, Whether BWMS is operating in accordance with the OMSM. The PSCO can inspect all components to verify that BWMS is working properly. This

detailed inspection can lead to a sampling step.

1.3 In the third phase of indicative analysis, an indicative analysis to measure the dissolved oxygen concentration and residual chlorine concentration as a indirect measuring means, and ballast water sampling for this will be performed to determine whether of not it is satisfied with 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 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. PSCO shall not delay the movement, operation, and departure of a ship while waiting for results of such detailed analysis that is expected to take several days or more. These guidelines also provide the list of detainable deficiencies which are considered to be of a serious nature that PSCO may warrant the detention of a ship such as 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 etc.

2. The USCG also will assess compliance as part of regular vessel inspection. This compliance approach will follow a similar regime in place for all other equipment inspection such as oily water separator, marine sanitation device etc. As the first phase, a Coast Guard inspector will review document including the type approval certificate, AMS acceptance letter. And as the second phase, the inspector wll verify the crew's knowledge regarding use of the equipment and also verify the equipment's condition. If an 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 shall 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, shall be subject to surveys and the ship shall be issued a Certificate after successful completion of a survey.

1.1.2 This Convention shall 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 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, weather and etc. [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 shall 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 shall 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) only 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 shall remain 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) shall 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 Environment & Piping Team of KR when authorized from the subject flag Administration in the future.

2.2.5 BWMP shall be approved by KR Environment & piping team.

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

2.3.1 Each ship shall have on board a Ballast Water record book that may be an electronic record system, or that 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 shall 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 shall be fully recorded without delay in the Ballast Water record book. Each entry shall be signed by the officer in charge of the operation concerned and each completed page shall be signed by the master. The entries in the Ballast Water record book shall be in a working language of the ship. If that language is not English, French or Spanish the entries shall 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) devided 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, hold ventilation discharge of each place shall be separated with a safety 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]

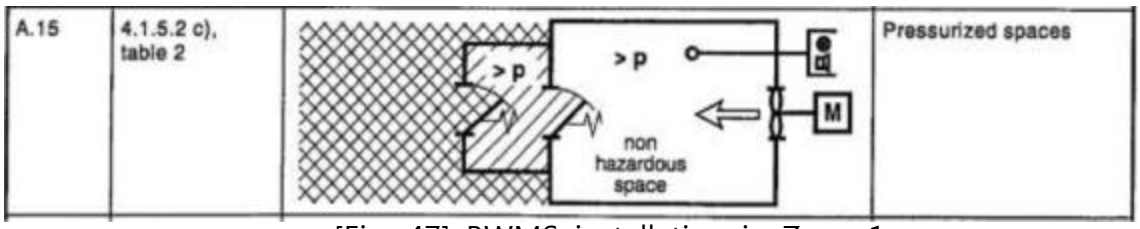
The doors to be installed in entrance shall be of a Self-Closing Gastight Door,

and Holding Back Arrangement shall not be installed. Mechanical ventilation system shall be provided in the protected space, audible and visible alarm shall be activated in the continuously attended space in case of the ventilation system failure.

[Fig. 46] BWMS installation in Zone 2

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

Type of the doors to be installed in 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, audible and visible alarm shall be activated in the continuously attended space, and after a short while, power supply for nonexplosion electric facilities installed in safety space shall automatically be shut off from the outside of 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 safety zone and hazardous zone shall be separated with a minimum safety distance. For example, air inlet of safety space shall maintained with an additional safety distance of 1.5m from dangerous space, and air outlet shall be installed outside of dangerous space.

Section 2. Certificates, guidelines and checklists[18)]

1.1 Issuance of certificates (Rev.47 2018.7.1)

1.1.1 Certificate shall be issued after an initial survey and the surveyor shall 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 shall be used the same 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;
.3 Method of ballast water management used shall be selected among the following items:
ⅰ) Ballast water Management System

18) 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.

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 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 Principal ballast water management method shall 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 an 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 ❑

 2 / 3

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 : _____

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[Figure 48] BWMS installation in KR-CON IBWMZone1

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.