DEPARTMENT OF ECOLOGY
State of Washington

State of Washington Department of Ecology

Cruise Ship Memorandum of Understanding, Cruise Operations in Washington State Inspection Report

Northwest Regional Office

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Bellevue, WA 98008

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Inspection Date	Permit Number	County	Receiving Waters	Ecology Inspector
September 8, 2015	NA	King	Marine Waters	Amy Jankowiak

Entry Time 9:47 am	Photos Taken	Samples Taken	Inspection Announced	Discharges to: ☒ Surface Water
Exit Time 11:25 am	☒ Yes ☐ No	☐ Yes ☒ No	☒ Yes ☐ No	☐ Ground Water ☐ Dewater ☐ POTW

Name and Location of Site Inspected:
CARNIVAL LEGEND, Carnival Cruise Line
Pier 91
Seattle, Washington

Additional Participants/Inspectors:

On-Site Representative(s): ***Name/Title/Phone/e-mail***
Anand Bhagat, Environmental & Occupational Safety Officer
E: LEENVOFF@carnival.com

Responsible Official(s): ***Name/Title/Address/Phone/e-mail***
Rabih Boudargham
Director, Environmental Operations
Compliance, Environmental & Occupational Safety – Marine Operation
Carnival Cruise Line
3655 NW 87th Avenue, Miami, FL 33178|
p: 305.599.2600 Ext. 64691
e: rboudargham@carnival.com

Other Facility Data:
Notification made to Rabih Boudargham on September 8, 2015 (07:20)

IMO Number 9224726

Section A: Areas Evaluated

☒ Black/Gray Wastewater System	☒ Residual Solids	☒ Records/Reports	☒ Hazardous Waste/ Solid Waste	☐ Sampling/Monitoring
☒ Discharge Locations	☒ Operation & Maintenance	☒ Sludge Handling/ Disposal	☒ Oily Bilge Water	☒ Other

Section B: For Vessels Discharging ≥ 1nm from Berth and ≥ 6 Knots Only [2.1.3(A)]

☐	Schematics Match Black/Gray Wastewater System
☐	Operations as Described in Submitted Documentation
☐	Daily 24-hour Continuous Monitoring for Turbidity or Equivalent Monitoring
☐	Turbidimeter or Equivalent Monitoring Equipment Functioning Properly
☐	Auto Shut Down or Operational Controls to Insure System Shut Down if High Turbidity Occurs
	Turbidity or Equivalent: Last Calibration: Trigger Level for Early Alarm: A Trigger Level for Shutdown: Recorded Turbidity/Equivalent Levels Above Triggers:
☐	Daily 24-hour Continuous Monitoring for Disinfection Effectiveness
☐	Disinfection Effectiveness Monitoring Equipment Functioning Properly
	Disinfection Effectiveness Monitoring:
☐	Auto Shut Down or Operational Controls to Insure System Shut Down if Disinfection System Upset Occurs

NOT APPLICABLE

☐	Disinfection System Operated and Maintained Properly	
	Disinfection System:	

Section C: For Vessels Discharging Continuously [2.1.3(B)]

☐	Schematics Match Black/Gray Wastewater System	
☐	Operations as Described in Submitted Documentation	
☐	Daily 24-hour Continuous Monitoring for Turbidity or Equivalent Monitoring	
☐	Turbidimeter or Equivalent Monitoring Equipment Functioning Properly	
☐	Auto Shut Down or Operational Controls to Insure System Shut Down if High Turbidity Occurs	
	Turbidity or Equivalent: Last Calibration: Trigger Level for Early Alarm: Trigger Level for Shutdown: Recorded Turbidity/Equivalent Levels Above Triggers:	
☐	Daily 24-hour Continuous Monitoring for Disinfection Effectiveness	
☐	Disinfection Effectiveness Monitoring Equipment Functioning Properly	
	Disinfection Effectiveness Monitoring: NOT APPLICABLE	
☐	Auto Shut Down or Operational Controls to Insure System Shut Down if Disinfection System Upset Occurs	
☐	Disinfection System Operated and Maintained Properly	
	Disinfection System:	

Section D: General (Approved to Discharge)

☐	No Discharges Within ½ Miles From Shellfish Beds/ Protocol (President's Point, Apple Tree Cove, Tyee Shoal, Middle Point (near Pt Townsend))	
☐	Discharges Immediately Stopped When High Turbidity Occurs	
☐	Discharges Immediately Stopped When Disinfection System Upset Occurs	
☐	Immediate Notifications Made to WA Department of Health for Disinfection System Upset	
☐	Sampling Conducted 2/month, 1/month in Seattle (BOD, TSS, Fecal Coliform, pH, Chlorine Residual)	
☐	Whole Effluent Toxicity Testing 1 per 2 Years (Homeported) or 1/40 Calls for Continuous	

Section E: General

☒	Wastewater Discharge Records Review	Discharge records were reviewed (blackwater/graywater/residual solids) and are maintained properly. No discharges appear to be in the OCNMS, MOU waters or Washington state waters (MOU related waters).
☒	Wastewater Discharges protocol per MOU and managed properly	The discharge protocols appear to be consistent with MOU requirements to not occur in MOU related waters.
☒	Residual Solids Managed Properly/Disposal Protocol per MOU	Residual solids appear to be handled per MOU requirements.
☒	Hazardous Waste Managed Properly	Hazardous waste appears to be handled per MOU requirements.

☒	WA Hazardous Waste Guidelines Followed (Appendix vii)	Hazardous waste guidelines appear to be handled per the MOU and guidelines.
☒	Solid Waste Managed Properly (zero garbage discharge)	Solid waste appears to be managed per MOU requirements.
☒	Photo/X-Ray Waste Managed Properly (fluids, cartridges,...) and landed ashore	Photo and x-ray waste appears to be handled per MOU requirements.
☒	Dry-Cleaning Wastes and Byproducts (fluids, sludge, filter materials...) Managed Properly (PERC – haz waste – landed ashore)	No dry cleaning is done on board and therefore dry cleaning waste products are managed per MOU requirements.
☒	Unused/Outdated Pharmaceuticals Managed Properly (safely disposed of)	Unused or outdated pharmaceuticals appear to be managed per MOU requirements.
☒	Fluorescent and Mercury Vapor Lamp Bulbs Managed Properly (prevent release of mercury)	Fluorescent and mercury vapor lamp bulbs appear to be managed per MOU requirements.
☒	Waste Reduction/Reuse/Recycling Opportunities Maximized (glass, cardboard, aluminum & steel cans)	Waste reduction/reuse/recycling opportunities appear to be maximized per MOU requirements.
☒	Batteries Managed Properly (recycled, reclaimed, disposed of properly)	Batteries appear to be managed per MOU requirements.
☒	Incinerator Ash Managed Properly and minimized volume (haz waste segregation and annual testing)	Incinerator ash appears to be managed per MOU requirements.
☒	Oily Bilge Water Managed Properly (<15 ppm, no visible sheen and underway)	Oily bilge water appears to be managed per MOU requirements.
☒	Ballast Water Managed Properly (per Wash regs –reporting, treated or if open sea exchange >200 nm from outside EEZ, 50nm if not EEZ)	Ballast water appears to be managed properly per MOU requirements.
☒	OCNMS rules and regs followed	The discharge protocol appears to be consistent with MOU requirements to not occur in the OCNMS.
Additional General Questions		
☒	How is deck runoff and hull cleaning handled (scuppers...) (non-toxic/phosphate free cleaners, biodegradable)	Deck runoff and hull cleaning appears to be handled per MOU requirements.
☒	How is maintenance performed on the outside of the vessel (paint chipping, painting, etc)	Outside vessel maintenance appears to be handled per MOU requirements.
☒	Sculleries and Galleys – type of detergents and degreasers used (phosphate free and non-toxic)?	Galleys appear to use phosphate free and non-toxic detergents and degreasers.
☒	How are food waste discharges handled (prevention of erroneous materials)?	Food waste appears to be handled per MOU requirements.
☒	Medical sinks/floor drains, chem. stor areas wastes go where (plugged, blackwater, bilge)?	Medical sinks/floor drains appear to be handled per MOU requirements.
☒	Where is pool and spa water discharged? Dechlorinated/debrominated and underway?	Pool and spa water appears to be handled per MOU requirements.
☒	What type of fuel is used and percent sulfur content?	Fuel sulfur content meets requirements.

Other:

Section F: Sampling Results

Parameter	Results
Biochemical Oxygen Demand 5-Day (BOD_5)	
Total Suspended Solids (TSS)	
Fecal Coliform	
Residual Chlorine	
pH	
Ammonia, Nitrogen	

NOT APPLICABLE

Section G: Summary of Findings/Comments

Introduction

Amy Jankowiak, Washington State Department of Ecology (Ecology) Northwest Regional Office, Water Quality Program (NWRO-WQ), conducted the inspection of the Carnival Cruises CARNIVAL LEGEND on September 8, 2015. The main contact on board the CARNIVAL LEGEND was Anand Bhagat, Environmental & Occupational Safety Officer for the CARNIVAL LEGEND. Prior notification of the visit was given earlier in the morning on the day of the inspection for security protocol. The purpose of the inspection was to evaluate compliance with the *Memorandum of Understanding Cruise Operations in Washington State* (MOU), as amended. The CARNIVAL LEGEND is not approved to discharge wastewater in MOU waters.

The CARNIVAL LEGEND was put into service in August of 2002 and is 963 feet long with 12 decks. Passenger capacity is currently about 2200, with about 925 crew.

The CARNIVAL LEGEND is scheduled for16 calls in Seattle between May 26, 2015 and September 8, 2015. The vessel will be en route to Australia after this call with several stops along the way.

Inspection

I arrived and boarded the ship (photo #01) at 9:47 am and first met with Anand Bhagat, Environmental & Occupational Safety Officer for the CARNIVAL LEGEND. We briefly discussed the purpose and plan for the inspection. We first discussed discharge protocols for the various wastestreams and reviewed certain records. We then went to the Engine Control Room (ECR) and went through additional records and discussion. We then viewed the oily water separators, the marine sanitation devices (MSD), discharge ports and the desalination systems. We then did a walk-through of the garbage and recycling room and went to the infirmary to review waste and pharmaceutical management practices. We concluded with discussion and review of protocol and notification documents on the bridge and a brief debriefing with the Captain. I disembarked the vessel at 11:25 am.

Discharge Types and Protocols:

The vessel/line has a policy of no discharge in MOU waters, Washington State waters and the Olympic Coast National Marine Sanctuary (OCNMS) (MOU related waters). Blackwater, pool water, and bilge water are discharged >12 nautical miles (nm), graywater, food waste and incinerators are > 4 nm, and for all of these discharge types, even if beyond 4 or 12 nm, the discharges do not occur in MOU related waters. In addition, no discharges occur in bordering Canadian waters. Standards and protocols for discharges are posted on the bridge (photos #21 and #22) and in the office. If a discharge is to occur, there is an established process in place for communications between the bridge and the ECR to assure that discharges only occur outside of MOU related waters. Discharge ports are padlocked (photo #10) and the keys are only used by the engineers and are logged in and out with a detailed signed checklist in the ECR. For black water and gray water, the latitude and longitude coordinates are recorded in the *Sewage and Graywater Discharge Record Book*. The date, time and location of both the start and the stop of the discharges are recorded, along with port location, effluent type, and volumes. The wastewater discharge records for this cruise season to date showed no discharges in MOU related waters based on a visual review of coordinates.

Discharge Types:

The MSD systems do not produce much if any biomass due to its type of biological treatment. The tanks are cleaned about twice a year.

Oily bilge water is treated with a Norddeutche Filter oily water separator (OWS) process. There are two OWS (photos #02 and #05) with one of the two in standby and rotated use. The oily content meter (photo #04) measures oil content and discharges occur at less than 15 parts per million (ppm), typically closer to 10 ppm and outside of MOU related waters. A white box (photo #03) is used for secure discharges and the discharge port is padlocked. Oil sludge is offloaded as non-hazardous waste.

The CARNIVAL LEGEND has 4 fresh water Jacuzzis and 3 saltwater pools. The pools are discharged >12nm and outside of MOU related waters and the Jacuzzi water is sent to the graywater collection tanks for discharge outside of MOU related waters.

The CARNIVAL LEGEND uses graywater in various tanks and the dedicated blackwater tank for ballast and therefore does not do ballast water exchanges. Stability has not been an issue.

Food waste is sorted at the source with 11 pulpers throughout the galleys. Food waste goes to 2 food waste tanks is then pulped food waste is discharged outside of MOU related waters. Water from the pulpers goes to the graywater tanks. Solid food waste that cannot be pulped such as bones, egg shells, coffee grounds and rinds is either incinerated or sent ashore. Grease collected from the grease traps is offloaded as food waste. Used cooking oil (photo #20) is sent ashore for recycling.

Any deck runoff is collected by the scuppers, goes directly overboard and any waste is sent to garbage and ashore. No cleanings/washings of open decks are done in MOU related waters. Only phosphate free, non-toxic products are used. A chart was posted that listed to the approved and used cleaning products. Vessel maintenance such as paint chipping and painting is technically allowed with local approval in Seattle, but is not done. If any paint chipping or painting is to be done, there are best management practices for use including magnetic tarps. Only fresh water is used for washing.

Laundry water is sent to the graywater collection tanks and Ecolab phosphate free and non-toxic detergents and degreasers are used. Dry cleaning is sent ashore and not done on the vessel. Therefore, no chemical such as perchloroethylene (Perc) are used on the vessel.

Hazardous waste is offloaded in Seattle including items such as oily rags, photo waste, fluorescent bulbs, pesticides, solvents and paints. Stericycle/Waste Management is used for the offloads and RCRA requirements with state codes were well documented in the reviewed paperwork. Incinerator ash and oil sludge are offloaded as non-hazardous waste.

X-rays are done digitally and therefore do not have a waste product. Photo waste is collected and offloaded as hazardous waste. Fluorescent bulbs along with other bulbs are collected and offloaded ashore without crushing as hazardous waste. Bio-hazardous waste and medical waste is collected and sent ashore or incinerated (no plastics). Hazardous waste is stored until offloaded.

Unused or outdated pharmaceuticals and narcotics go back to the vender or are sent to the blackwater system. The vessel prefers not to incinerate for safety reasons. Receipts are kept for vendor returns. Logs are kept in the infirmary. Drains in the medical facility go to the blackwater tanks.

Solid waste (garbage, recyclables, etc) is sorted at the source and is collected and sorted (photos #16 and #17) in the garbage and recycling room and is either reused, recycled, incinerated or offloaded to shore as appropriate. Paper, cardboard, plastics, metals, glass (photo #19) and aluminum are compacted and crushed and recycled. Toners are recycled and batteries are sent ashore. Food contaminated cardboard is sent ashore in Victoria separately. Garbage records were reviewed and appear to be in compliance with the MOU.

Paper, certain plastics and garbage are incinerated (photo #18). Incinerator ash is offloaded as non-hazardous waste as is tested regularly. Recent test reports were reviewed and in compliance.

The CARNIVAL LEGEND uses fuel with a sulfur content of 0.0003% MGO in MOU related waters and can use approximately 3% sulfur content in other areas. The vessel has 3 scrubbers for continual compliance. The vessel was bunkering fuel (photo #24) at this port call. Fresh water was also being bunkered and can be produced on board with either a reverse osmosis system (photo #13) and chlorine (photo #14) or evaporators (photo #15). The vessel does not use shore power.

Notifications for MOU non-compliance is done by contacting the main environmental office in Miami who then makes notifications. Oil spill notification numbers and procedures were posted on the bridge.

Black water System:
Blackwater, which includes toilet waste is treated by one of four USCG certified traditional Triton-Format MSDs (photos #06 and #08). All four are typically in use at the same time. Discharges take place outside of MOU related waters. The Black/ Gray Water Discharge Record book was reviewed and there were no discharges in MOU related waters observed.

Black water is collected by vacuum to one of the 91.0 m3/day capacity MSDs. Description paraphrased from the schematic (photo #07) on the MSD system: Black water enters from the inlet into the aeration tank where the bacteria present in this section decomposes the blackwater in the presence of oxygen which is supplied by the aeration nozzles. A continuous supply of oxygen is necessary. The blackwater then enters into the settling section where settling takes place and flocs of activated sludge settles down along with other settleable matter. Sludge is returned back to the aeration section. The settled blackwater then enters into the disinfection section where chlorine is added (photo #09). Flow then goes to dedicated holding tanks if not in an area of discharge (photo #12).

The schematic outlines daily, monthly and yearly maintenance as well as a flow diagram, trouble shooting and recommended routine analysis. The vessel monitors chlorine content and percent suspended solids approximately weekly. Maintenance is completed on each treatment system to the pumps, motors, and blowers on a regular basis. Recent maintenance logs, analysis results, sampling protocols, and sewage system information was provided by request after the inspection. Graywater is discharged (photo #11) untreated outside of MOU related waters.

Conclusions and Recommendations

The protocols and procedures for discharge are clear and inclusive of verification.

The records were very organized, easy to read, and complete with detail. There was a great attention to detail including amendments to data being done properly with crossing out and initials.

The staff was very knowledgeable of the systems and procedures related to compliance with the MOU.

Attachments:
Follow-up information the MSDs
Photographs

Copies to:
Anand Bhagat, CARNIVAL LEGEND
Captain, CARNIVAL LEGEND
Mark Toy, Health
Greg Wirtz, CLIA-NWC
Stephanie Jones Stebbins, Port of Seattle
Kevin Fitzpatrick, Ecology
Mark Henley, Ecology
Amy Jankowiak, Ecology
Central Files: Carnival Cruise Line – CARNIVAL LEGEND; WQ 6.1

Name and Signature of Inspector:	Agency/Office/Telephone:	Date
Amy Jankowiak 	Department of Ecology Northwest Regional Office Water Quality Program Municipal Compliance Specialist 425-649-7195	9/14/15
Name and Signature of Reviewer:	Agency/Office/Telephone:	Date
Mark Henley 	Department of Ecology Northwest Regional Office Municipal Unit Supervisor 425-649-7103	9/16/15

APPENDIX 6

SEWAGE EFFLUENT CHEMICAL ANALYSIS (ALL VESSELS)

DATE	JUL-26-15	AUG-5-15	AUG-12-15	AUG-19-15	AUG-26-15	SEP-5-15	VALUES
SEWAGE PLANT No. 1 CHLORINE CONTENT	2	2	2	2	2,5	2	2-5 ppm
SEWAGE PLANT No. 1 OXYGEN CONTENT	4	4	8	4	5,6	4	4-8 mg/l
SEWAGE PLANT No. 1 SUSPENDED SOLID %	0.2	0.2	0.2	0.2	0,3	0,25	0.1-0.3 mg/l
SEWAGE PLANT No. 1 COLIFORM %	/	/	/	/	/	/	
SEWAGE PLANT No. 2 CHLORINE CONTENT	2,1	2	2	2	2	1,5	2-5 ppm
SEWAGE PLANT No. 2 OXYGEN CONTENT	4.3	4	6	4	3,5	4,5	4-8 mg/l
SEWAGE PLANT No. 2 SUSPENDED SOLID %	0.2	0.2	0.2	0.2	0,2	0,5	0.1-0.3 mg/l
SEWAGE PLANT No. 2 COLIFORM %	/	/	/	/	/	/	
SEWAGE PLANT No. 3 CHLORINE CONTENT	2,1	2.2	2	2	1,8	1,7	2-5 ppm
SEWAGE PLANT No. 3 OXYGEN CONTENT	4	4.2	4.2	0.6	6	7	4-8 mg/l
SEWAGE PLANT No. 3 SUSPENDED SOLID %	0.1	0.1	0.1	0.1	0,35	0,3	0.1-0.3 mg/l
SEWAGE PLANT No. 3 COLIFORM %	/	/	/	/	/	/	
SEWAGE PLANT No. 4 CHLORINE CONTENT	2	2	2	2	2	1,5	2-5 ppm
SEWAGE PLANT No. 4 OXYGEN CONTENT	4	4	4	4	4	4	4-8 mg/l
SEWAGE PLANT No. 4 SUSPENDED SOLID %	0.2	0.2	0.2	0.2	0,3	0,3	0.1-0.3 mg/l
SEWAGE PLANT No. 4 COLIFORM %	/		/	/	/	/	
ENGINEER OFFICER SIGNATURE:							

Filename: **Sewage.xls**

Note : Coliform test to be performed monthly.

WATER-QUALITY-TEST

It is necessary to carry out water quality tests in order of ensure that the plant is operating properly.

WEEKLY DISINFECTION-SECTION

The water quality in the disinfection section must be tested for sufficient chlorine and oxygen to fullfill the BOD requirement.

Chlorine
The content of the chlorine in the water can be tested with test strips which indicate the content **0 - 1 - 3 - 10 - 30**. An indication between **1 - 3** shows that there is sufficient chlorine.

Oxygen
The Methylen-Blue-Test shows wether the water sample has suffcient oxygen. A 50 ml glass bottle with a polished stopper must be filled and to this must be added 5 drops of Methylen-Blue. The stopper must be closed ensuring that there is no air inside. The water sample should then be stored at an ambient temperatur of 20 deg. C.. The sample will now be blue. When the water sample stays blue as least five days it shows that the water is of good quality with sufficient oxygen.

WEEKLY AERATION-SECTION

A test of the sludge volume must be carried out to ensure that the correct biological matter is available in the plant.

One litre must be placed in a 1.000 ml glass cylinder. The sample must then rest for 30 minutes. If the sludge volume is higher than 600 ml, dilution water from the disinfection-section must be added 1:1 or 1:2 or 1:3. The result must be multiplied by 2, 3 or 4.

Settling volume	=	150 - 500 ml/l	the plant is O.K., there is enough biological matter
Settling volume	≤	100 ml/l	the plant is not O. K., dumping should not be carried out
Settling volume	≥	600 ml/l	the plant is O. K., but there is too much biological matter, dumping in small quantities should be carried out until the volume is 150 - 500 ml/l

WEEKLY SETTLING-SECTION

Suspended Matter

A sample of 1 - 2 litres must be taken from the highest level. The sample must then be placed in a 1.000 ml IMHOFF-CONE and left to rest for 120 minutes. If suspended matter clings to the cone then it should be rotated and replaced until settling is complete.

Suspended matter	<	0,1 ml/l	the settling is O. K.
Suspended matter	<	0,3 ml/l	the settling is still sufficient
Suspended matter	>	0,3 ml/l	the settling section is not O. K., sludge must be dumped

A sample has to be taken below the surface and the test carried out as above.

Suspended matter	<	0,1 ml/l	the sludge level is sufficiently low and the separation is very good
Suspended matter	<	0,3 ml/l	the sludge level is sufficiently low and the separation is O. K.

Suspended matter	>	0,3 ml/l	the sludge level is too high, contains too much biologocal matter, dump sludge in small charges
Suspended matter	>	1,0 ml/l	the sludge level is much to high dump sludge in greater charges

Sludge Return

To test the sludge return please proceed as for weekly sludge test in aeration-section.

Settling volume	=	600 - 800 ml/l	sludge return is o. K. and viscosity is sufficient
Settling volume	<	600 ml/l	sludge return is not O. K. and viscosity is insufficient no dumping
Settling volume	>	900 ml/l	the sludge return is O. K. but too much biological matter dump in small charges

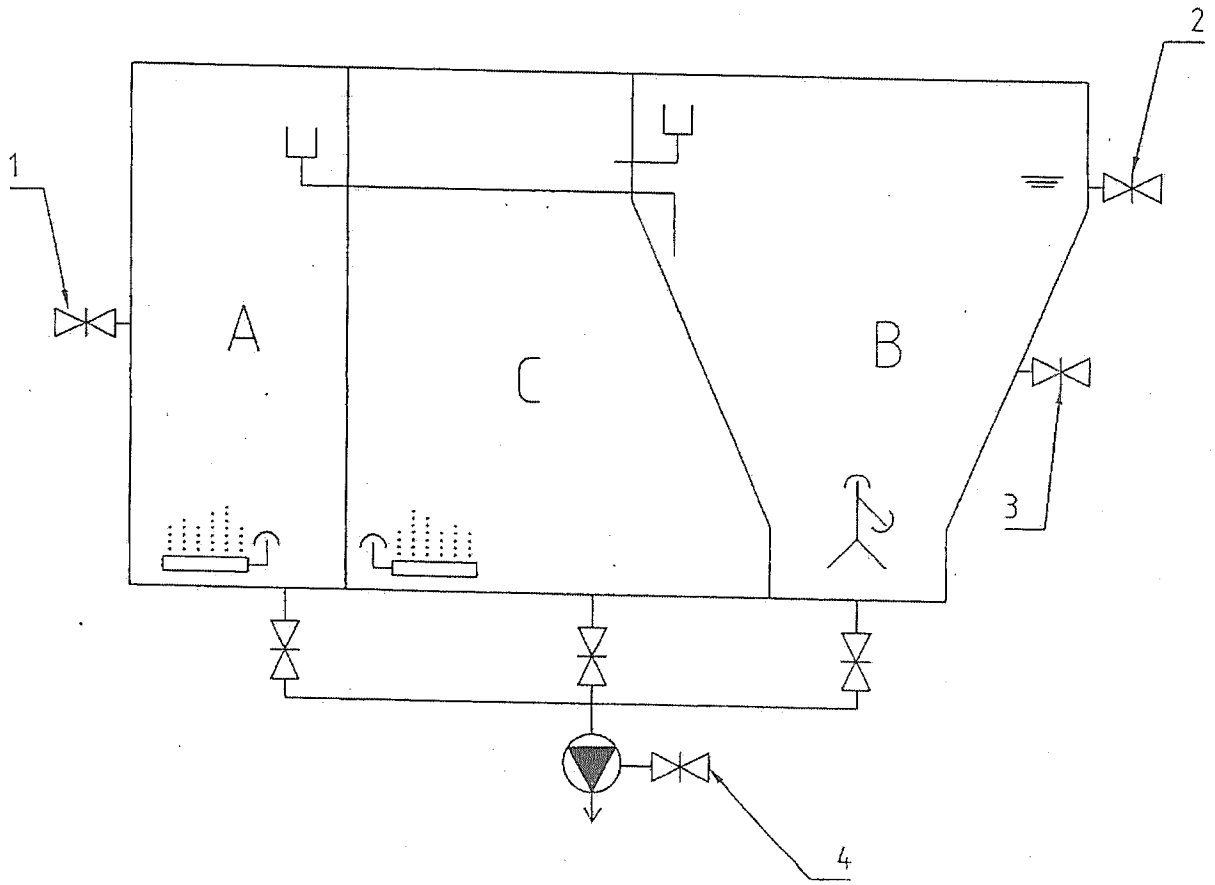
MONTHLY TEST AERATION-SECTION

pH-value

Take a sample of 1 - 2 litres after approx. 5 litres dumping.
The test sample with test strips.

pH-value	=	6 - 9	plant is O. K.
pH-value	<	6	add caustic soda to increase the pH-value
pH-value	>	9	add hydrochlorid acid to decrease the pH-value

Water Quality Test Diagram



A = aeration section,
B = settling section
C = disinfection section

1: sludge volume [ml/l]
pH-value
2: suspended matter [m
methylen blue test
3: suspended matter [m
4: chlorine test [mg/l]

Sewage systems

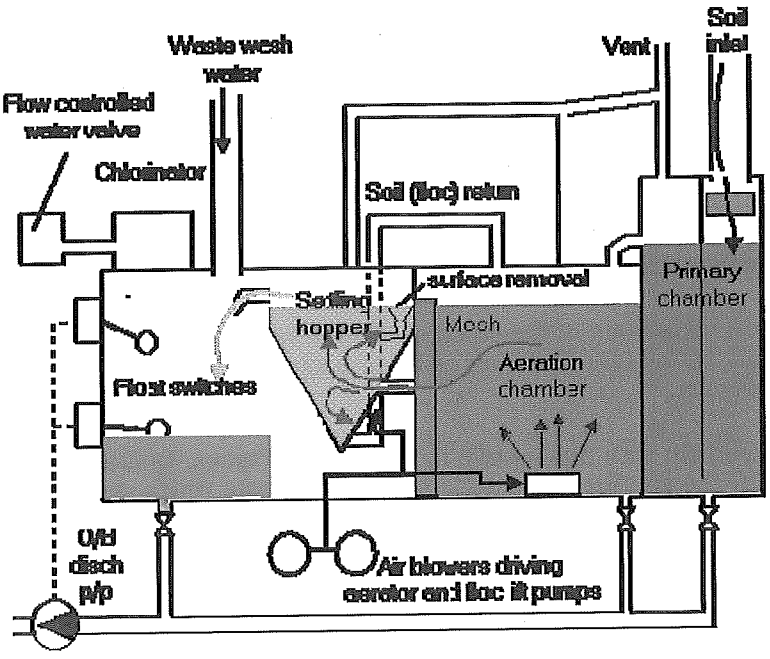
Regulations.

Legislation preventing the discharge of untreated waste overboard has been in place for some time with a requirement that it should be retrofitted where not already in use. American legislation defines three types of sewage treatment units.

Type I	A device capable of discharging effluent having no floating solids and a coliform count of less than 1000 per 100ml of effluent.
Type II	A device capable of discharging effluent with suspended solids not in excess of 150mg/litre and a coliform count of less than 200 per 100ml
Type III	A device to prevent the discharge overboard of treated or untreated waste.

Ventilation systems are to be kept independent of other vents A log is to be kept of any discharge overboard from a holding tank

Aerobic (Biological) Treatment plant (Flow through system)



Principle

Biological system require a steady and relatively constant flow of solid sewage so the bacteria can exist in sufficient quantity to maintain effluent discharge at the correct quality. sludge build up is a possible problem although extended residence in the aeration chamber greatly reduces the amount. For example, sewage with 80% solid waste is reduced to 20% of its original weight after 12 hours in the aeration tank.

The process of aerobicity strips oxygen from the water and creates more water, carbon dioxide and bacteria.

Operation

The Trident sewage treatment unit shown above consists of three chambers.
Sewage enters the **aeration chamber** via a coarse mesh filter where large solids are broken down. The aeration chamber is where the main biological action takes place. Here air blowers mounted on the outside of the unit oxygenate and stir the effluent and bacteria mix via a series of pipes and nozzles. The sewage remains in this aeration tank for some time.

Incoming sewage displaces some effluent of the **settling tank (or hopper)** where under inactive conditions biological floc, activated sludge and bacteria, settle out and is returned to the aeration chamber via air lift pumps also driven by the blowers. A second transfer pipe scum's the surface of the settling tank and returns it back to the aeration chamber. This returned sludge contains the bacteria to digest the incoming sewage. Thus the importance of this floc return can be seen

Authors note:
This is a common question in orals

Effluent passing over from this chamber should be clean and ready for disinfecting in the **chlorinating chamber.** The level in this chamber is controlled by a pump and float switch arrangement. typical chlorine levels at discharge is 5ppm.

Valves are fitted to the aeration and primary chambers to allow them to be pumped out and back flushed as necessary.

The bacteria are susceptible to water conditions including temperature and the presence of toilet cleaning agents. In this way the system is fitted with by-pass valves so passing contaminated water overboard. Should the bacteria be killed it takes some time before a new colony forms. There are special 'feeds' which promote the reestablishment of these colonies.

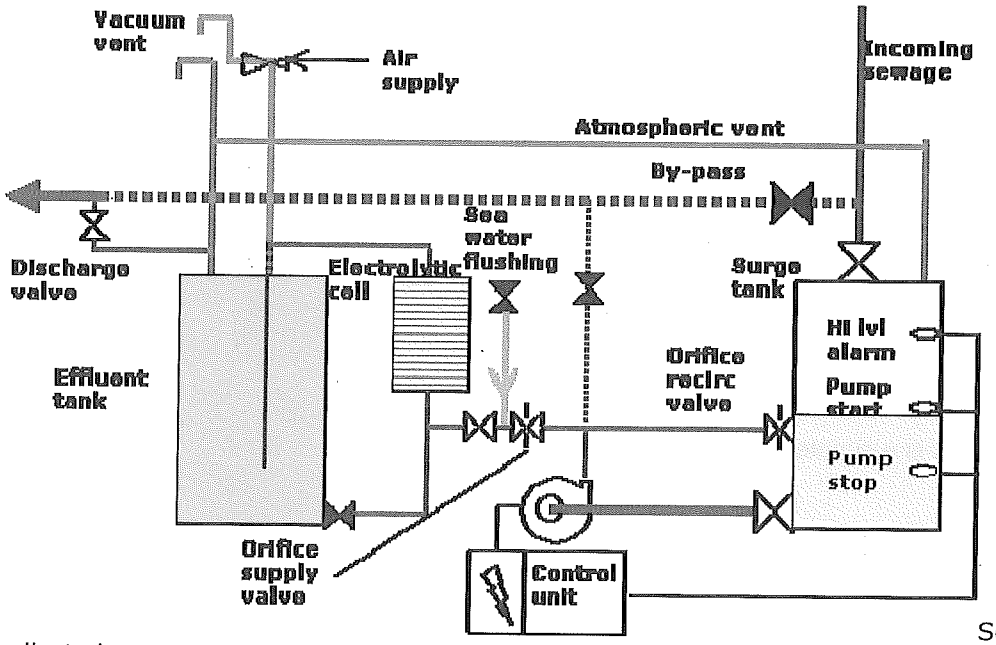
Physical-Chemical Sewage system

This is based on the separation of the liquid element from the sewage flow. This is disinfected in a 5% chlorine for 30 minutes to kill off coliform bacteria and then discharged overboard in full MARPOL compliance.

One problem with this system is the required space, Only a finite amount of space can be set aside for the storage of the solid part of the waste which can only be discharged in port or outside territorial waters when allowed. If these facilities are unavailable the system become inoperative.

There is also the need to carry quantities of Calcium Hypochlorite for conversion to Sodium HypoChlorite for the disinfection of sewage flow. Calcium Hypochlorite requires very careful handling.

Electrocatalytic Oxidation



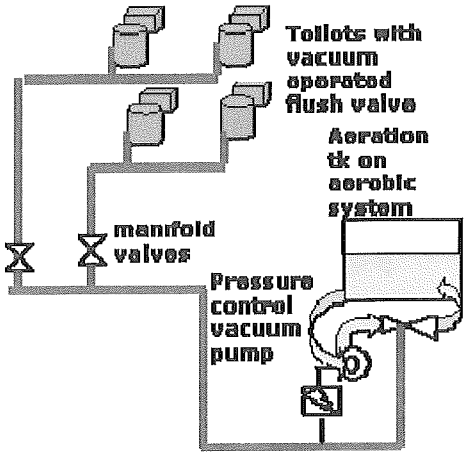
Sewage is collected, macerated and passed through a electrolytic cell.

Electrolysis produces Sodium Hypochlorite which is used to oxidise organic material before discharge. Alternately dosing by chlorine may be used. The effluent passes on through to a settling tank were the oxidation process is completed

These type of plants can be 50% smaller than biological types, this and the fact that pass through times are extremely short-typically 30 minutes compared to the several hours of the biological unit- are the main advantages of this system.The discharge contains no solids and is totally free of coliform bacteria.

A disadvantage of this system is due to the short exposure time in the oxidiser relatively high levels of chlorine are required to ensure destruction of the coliform bacteria. It is possible that this chlorine level can be present to some degree in the discharge. Dechlorination plant may be fitted

Vacuum sewage systems



Shown is a simple layout for a vacuum sewage system.

Operation

Liquid flows from the aeration tank of an aerobic sewage tank to a coarse impeller centrifugal pump. This delivers the liquid under pressure via an eductor and back to the tank. The eductor reduces the pressure in the sewage system pipework to a set point after which the pump is stopped. When the pressure in the pipework rises above a set value it is restarted.

The pipework consists of a network of mainly pvc pipes connected into separate zones- typically by deck- and brought down to a common manifold via isolating valves. These valves allow work on sections of the system whilst still maintaining others in use.

The toilets are connect to the system via a vacuum operated foot valve. Vacuum timers are also fitted which allow measured quantities of flushing water to be applied.

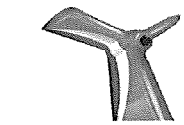
Where toilets are connected in the same zone but exist at different heights non-returning valves may be fitted. In addition filter boxes may be fitted along with additional isolating valves to improve operation.

Advantages and disadvantages

Very little flushing water is required and the volume of sewage dealt with can be much reduced with the downsizing of relevant equipment and cost saving.This has made them very popular for passenger vessels.Lloyds regulations state that the capacity of a sewage system for flushing water with conventional plant is 115 litres/ person/ day and 15 litres for vacuum systems.

The main disadvantage is blockage due to drying and crystalisation of urea. Over a period of time this can be so severe as to completely close the pipes. Chemicals are on the market which can be added in very small doses which help remove and prevent this deposits but there success is not guarenteed.

In the event of vacuum failure a method must be in place to prevent dangerous gasses passing back into the accommodation.



SEWAGE TREATMENT PLANT
Maintenance Date

Updated 28-Aug-15

ID OBJECT	OBJECT NAME	MAINTENANCE DATE
SEWAGE TREATMENT PLANT No.1 CLEANED		**28-Oct-14**
	AIR BLOWER No.1	19-Mar-12
	AIR BLOWER No.2	16-Mar-12
	PUMP, DISCHARGE No.1	13-Nov-12
	MOTOR, ELECTRIC No.1, DISCHARGE PUMP	13-Nov-12
	PUMP, DISCHARGE No.2	25-Apr-14
	MOTOR, ELECTRIC No.2, DISCHARGE PUMP	5-May-13
	PUMP, DISCHARGE No.3	23-Aug-15
	MOTOR, ELECTRIC No.3, DISCHARGE PUMP	23-Aug-15
SEWAGE TREATMENT PLANT No.2 CLEANED		**2-Apr-15**
	AIR BLOWER No.1	9-Mar-15
	AIR BLOWER No.2	10-Mar-15
	PUMP, DISCHARGE No.4	9-Apr-13
	MOTOR, ELECTRIC No.4, DISCHARGE PUMP	9-Apr-13
	PUMP, DISCHARGE No.5	3-Oct-14
	MOTOR, ELECTRIC No.5, DISCHARGE PUMP	3-Oct-14
	PUMP, DISCHARGE No.6	14-Jan-15
	MOTOR, ELECTRIC No.6, DISCHARGE PUMP	14-Jan-15
SEWAGE TREATMENT PLANT No.3 CLEANED		**1-Apr-14**
	AIR BLOWER No.1	28-Oct-14
	AIR BLOWER No.2	28-Dec-13
	PUMP, DISCHARGE No.7	27-Dec-13
	MOTOR, ELECTRIC No.7, DISCHARGE PUMP	27-Dec-13
	PUMP, DISCHARGE No.8	27-Dec-13
	MOTOR, ELECTRIC No.8, DISCHARGE PUMP	27-Dec-13
	PUMP, DISCHARGE No.9	26-Apr-14
	MOTOR, ELECTRIC No.9, DISCHARGE PUMP	27-Dec-13
SEWAGE TREATMENT PLANT No.4 CLEANED		**12-Sep-14**
	AIR BLOWER No.1	25-Jun-14
	AIR BLOWER No.2	25-Jun-14
	PUMP, DISCHARGE No.10	10-Jan-15
	MOTOR, ELECTRIC No.10, DISCHARGE PUMP	10-Jan-15
	PUMP, DISCHARGE No.11	14-Dec-11
	MOTOR, ELECTRIC No.11, DISCHARGE PUMP	14-Dec-11
	PUMP, DISCHARGE No.12	23-Aug-15
	MOTOR, ELECTRIC No.12, DISCHARGE PUMP	23-Aug-15

PHOTO #:01 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010028
DESCRIPTION: CARNIVAL LEGEND VESSEL, PIER 91, SEATTLE

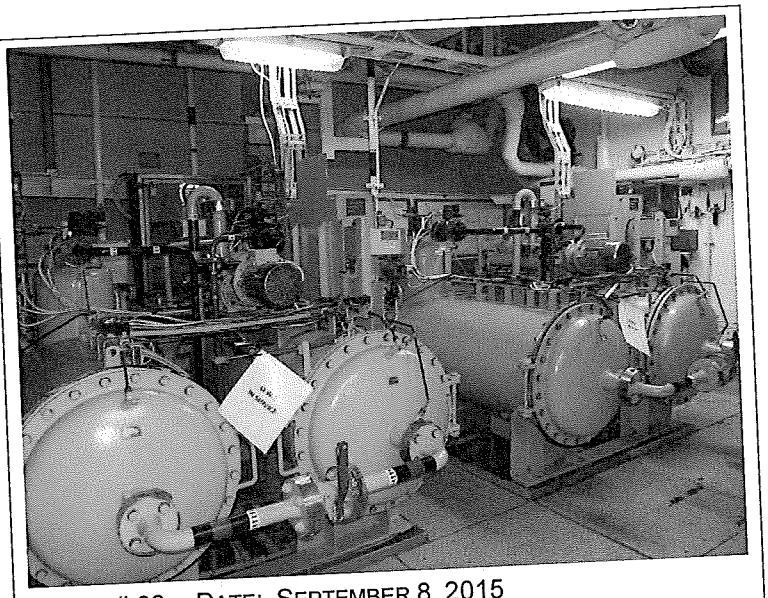


PHOTO #:02 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010002
DESCRIPTION: OILY WATER SEPARATORS (2) (OWS)

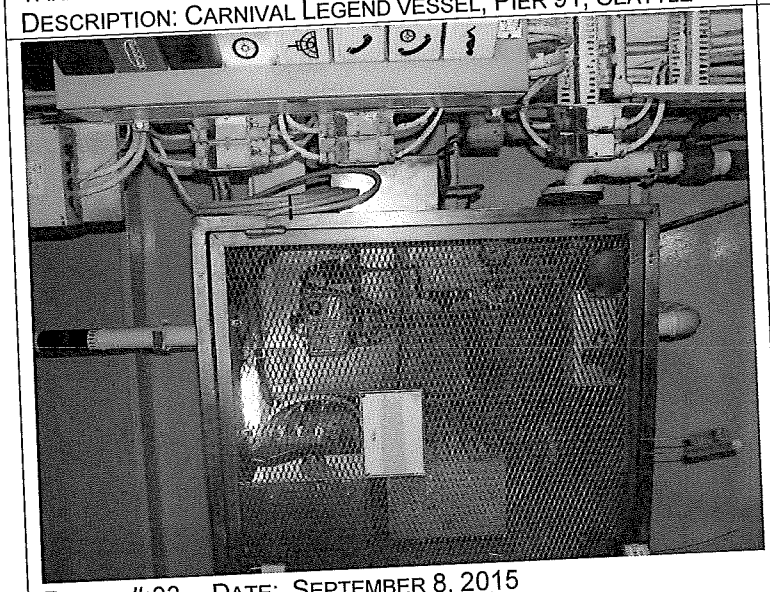


PHOTO #:03 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010004
DESCRIPTION: OWS WHITE BOX

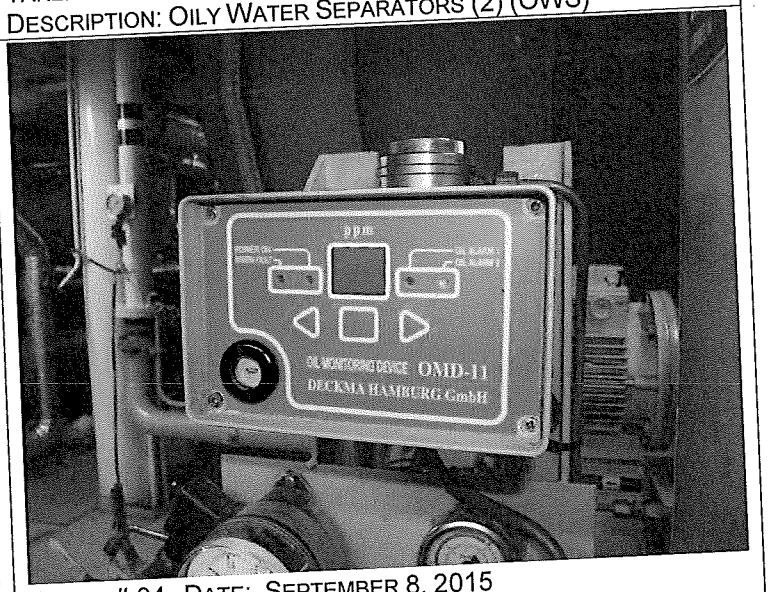


PHOTO #:04 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P10100
DESCRIPTION: OWS OILY CONTENT METER

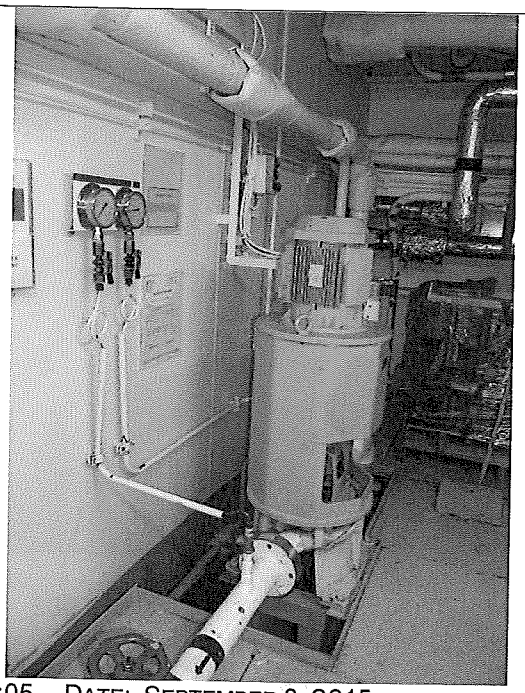


PHOTO #:05 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010006
DESCRIPTION: OWS CLEAN BILGE PUMP

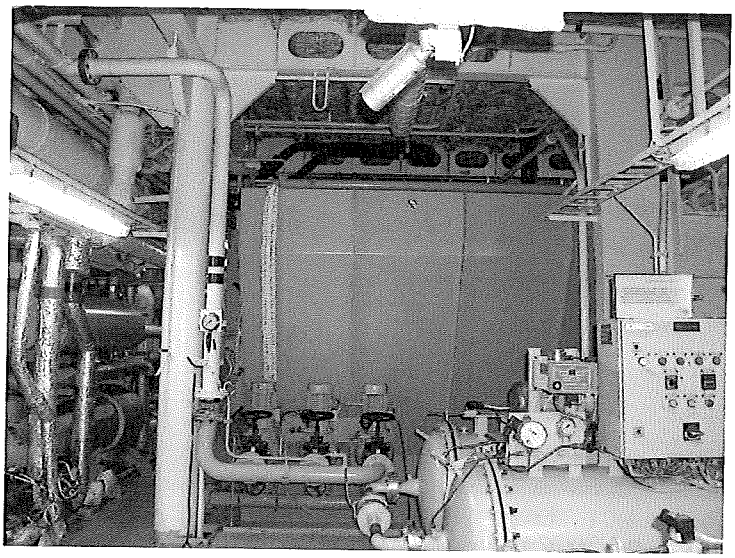


PHOTO #:06 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010008
DESCRIPTION: MARINE SANITATION DEVICE (MSD)

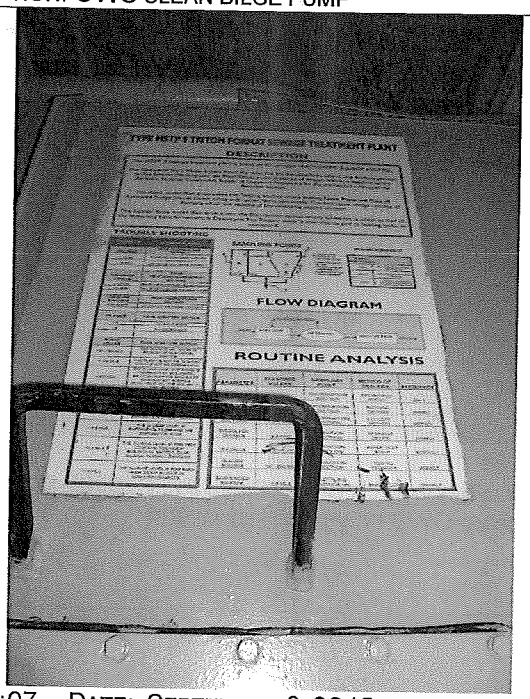


PHOTO #:07 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010010
DESCRIPTION: MSD SCHEMATIC

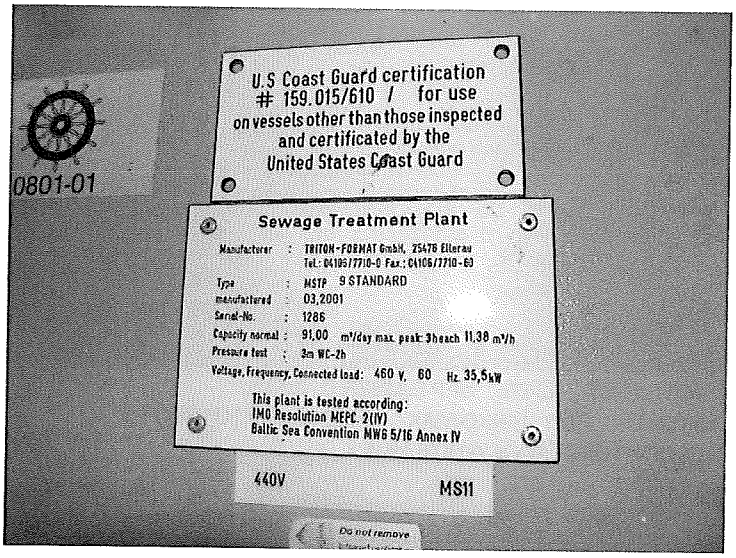


PHOTO #:08 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010011
DESCRIPTION: MSD INFO PLATES

PHOTO #:09 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010012
DESCRIPTION: MSD CHLORINE DOSING SYSTEM

PHOTO #:10 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010013
DESCRIPTION: GRAYWATER DISCHARGE PORT

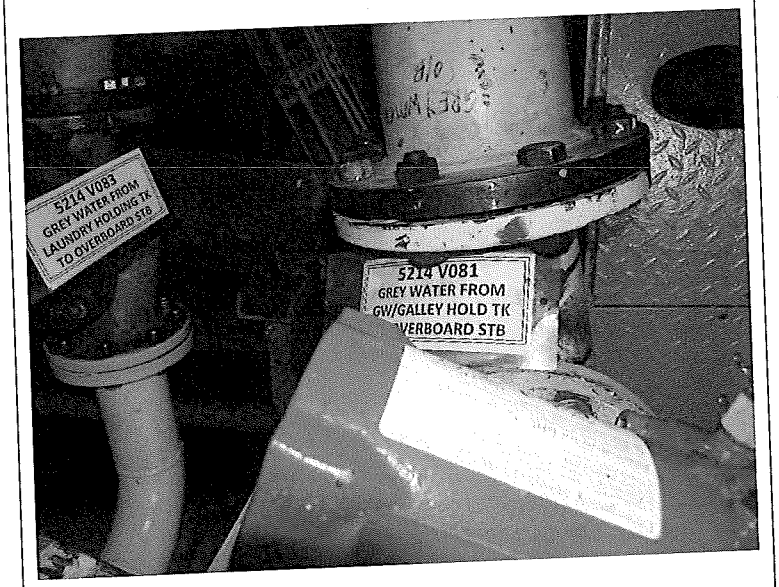


PHOTO #:11 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010014
DESCRIPTION: GRAYWATER DISCHARGE PORT

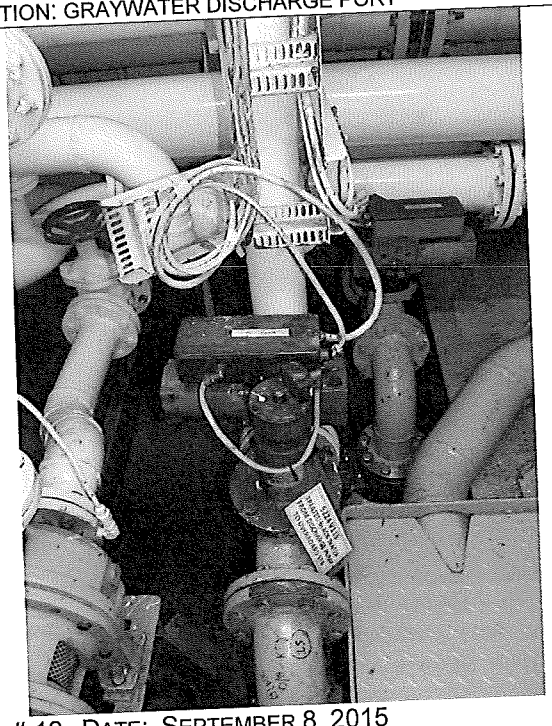


PHOTO #:12 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010015
DESCRIPTION: BLACKWATER DISCHARGE PORT

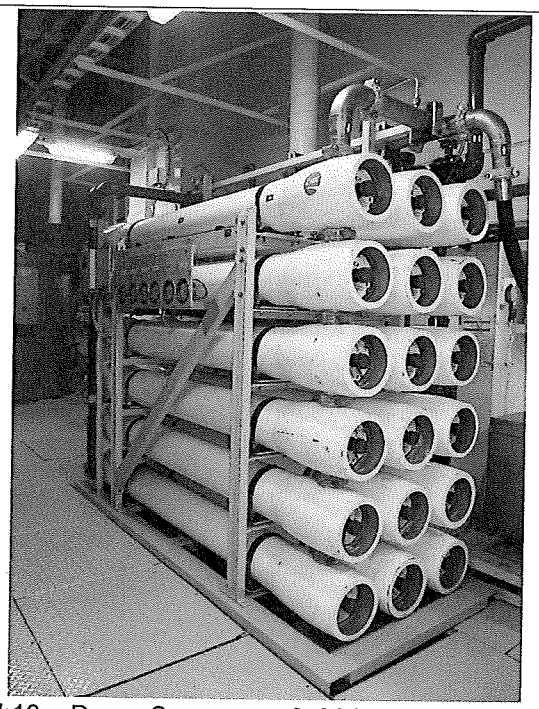


PHOTO #:13 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010016
DESCRIPTION: REVERSE OSMOSIS (RO) DESALINATION

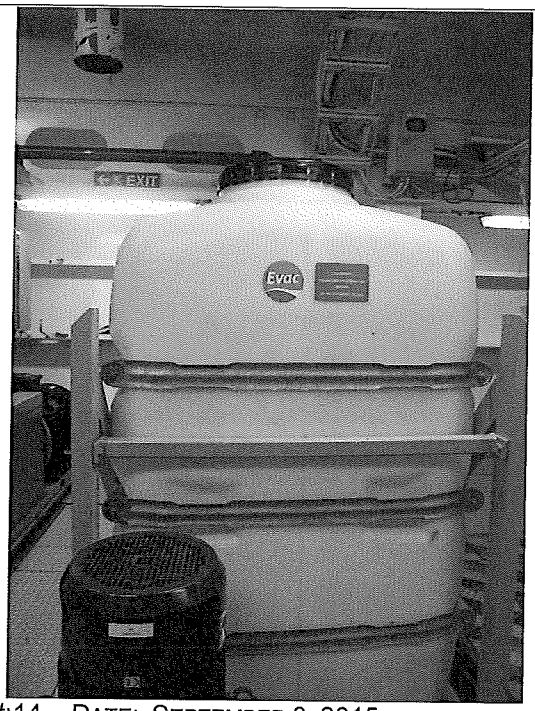


PHOTO #:14 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010017
DESCRIPTION: RO CHLORINATION

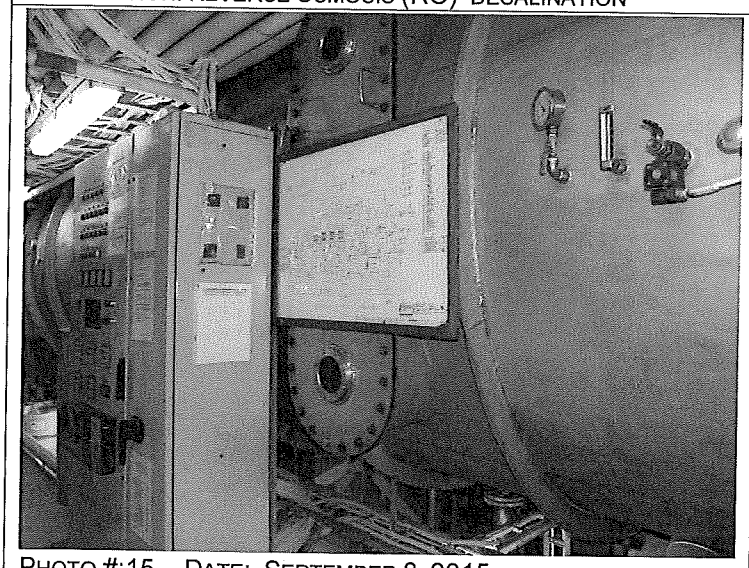


PHOTO #:15 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010018
DESCRIPTION: DESALINATION EVAPORATOR

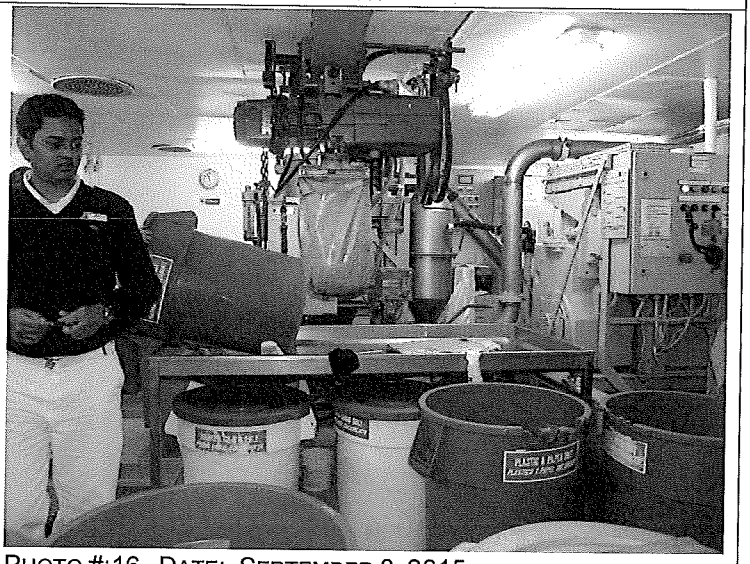


PHOTO #:16 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010019
DESCRIPTION: GARBAGE AND RECYCLING ROOM/SORTING AREA

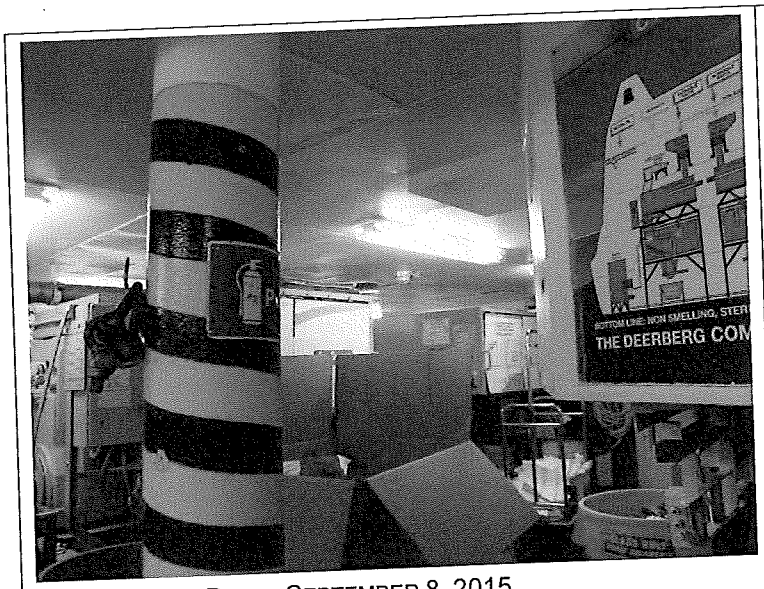


PHOTO #:17 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010020
DESCRIPTION: GARBAGE AND RECYCLING ROOM INCINERATOR (BACK GREEN)

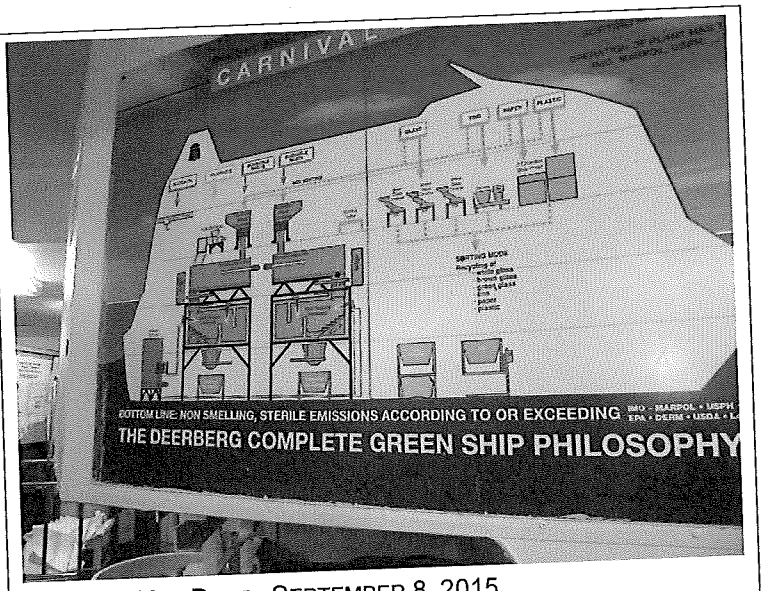


PHOTO #:18 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010021
DESCRIPTION: INCINERATOR SCHEMATIC

PHOTO #:19 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010022
DESCRIPTION: GLASS CRUSHERS

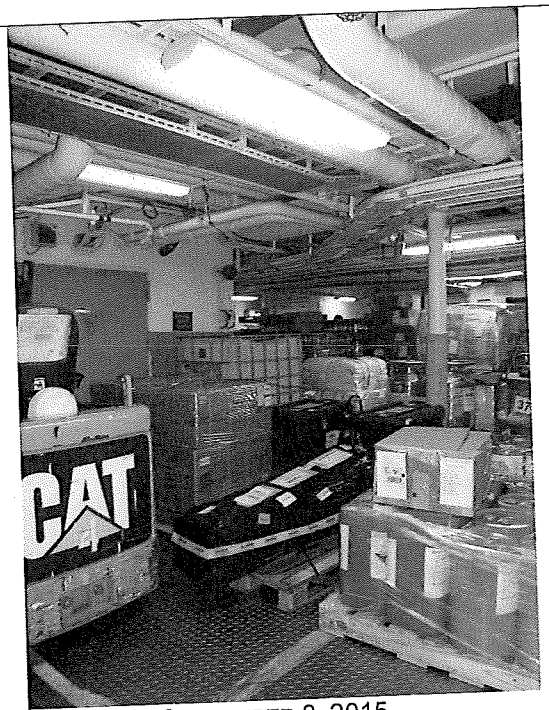


PHOTO #:20 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010023
DESCRIPTION: USED COOKING OIL (LARGE CREAM CONTAINER)

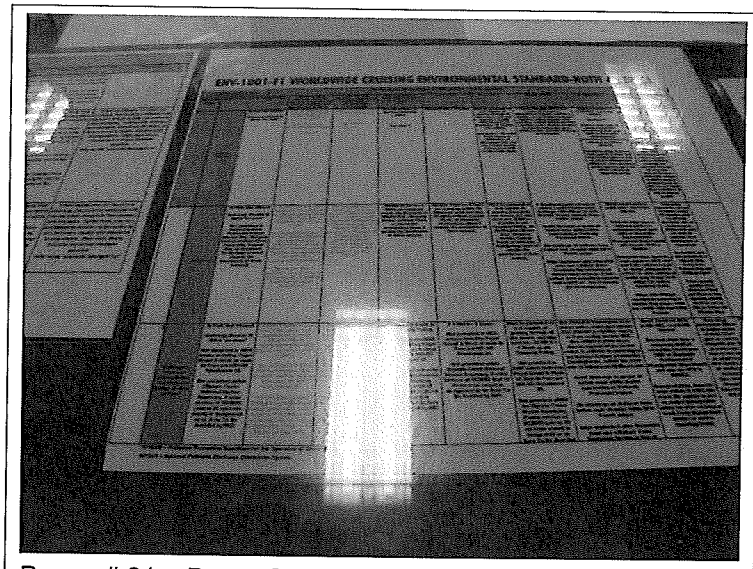


PHOTO #:21 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010024
DESCRIPTION: ENVIRONMENTAL STANDARDS/PROTOCOLS ON BRIDGE

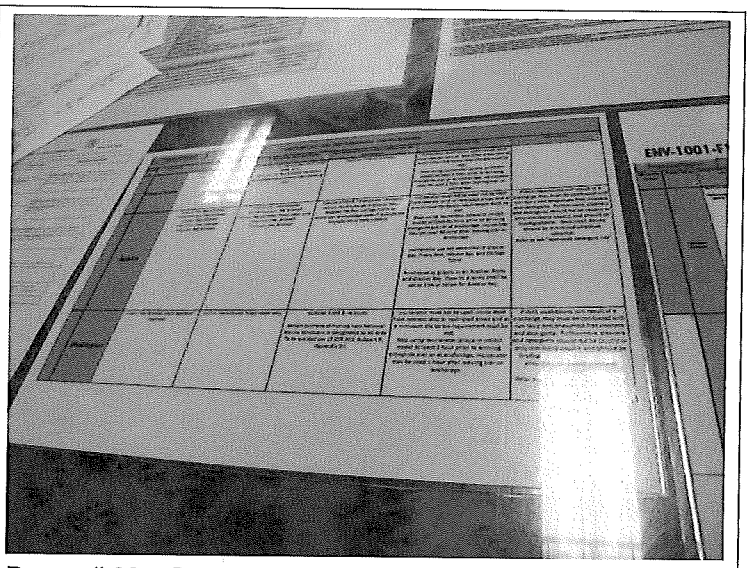


PHOTO #:22 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010025
DESCRIPTION: ENVIRONMENTAL STANDARDS/PROTOCOLS ON BRIDGE

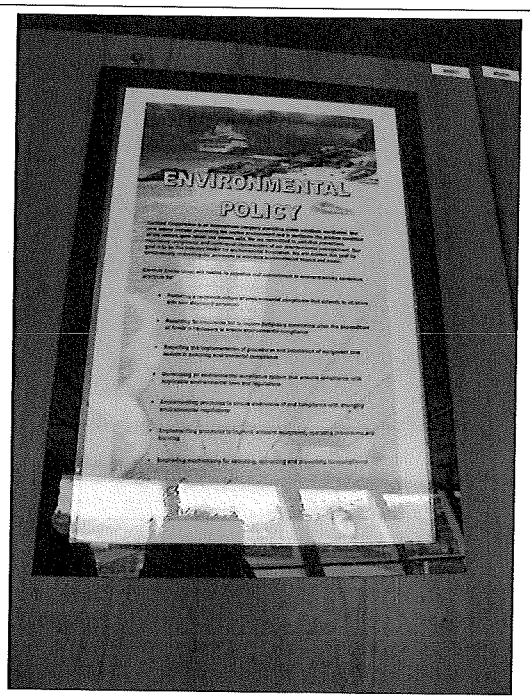


PHOTO #:23 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010026
DESCRIPTION: ENVIRONMENTAL POLICY POSTING ON BRIDGE

PHOTO #:24 DATE: SEPTEMBER 8, 2015
TAKEN BY: AMY JANKOWIAK FILE NO.: P1010027
DESCRIPTION: FUEL BUNKERING