Holland America Line

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Received By
Division of Water

AUG 21 2008

Department of
Environmental Conservation

August 18, 2008

Ms. Denise Koch
Program Manager,
ADEC/Division of Water CPVEC
410 Willoughby Avenue, Suite 303
P.O. Box 11800
Juneau, AK 99811-1800

RE: Revised Source Reduction Evaluation – August 18, 2008

Dear Ms. Koch:

Attached is the updated Source Reduction Evaluation Plan for Holland America Line Vessels submitted pursuant to Condition 1.9 of Large Commercial Passenger Vessel Wastewater Discharge General Permit No. 2007DB0002. This plan applies to our entire fleet of vessels discharging under the permit.

The plan includes deadlines establishing a schedule for bringing Holland America Line vessels into compliance with long-term limits for ammonia, copper, nickel and zinc. We believe the plan satisfies the issues raised in your letter of July 25th, 2008, and look forward to any feedback you may wish to offer.

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining that information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information.

Sincerely,

William J. Morani, Jr.
Vice President, Environmental Management Systems

WJM/jg

Holland America Line

Source Reduction Evaluation Plan

August 18, 2008

Submitted per Section 1.9

of the

Large Commercial Passenger Vessel

Wastewater Discharge General Permit

No. 2007DB0002

Holland America Line
Source Reduction Evaluation Plan

I. Source Reduction Evaluation Overview

In submitting the Notices of Intent for the discharge of sewage, graywater or other waste waters (as defined) under the Alaska Department of Environmental Conservation Large Commercial Passenger Vessel Wastewater Discharge Permit No. 2007DB0002 from the vessels identified in the table below (figure 3), Holland America Line has requested to discharge under the interim discharge limits for the identified constituents.

Pursuant to section 1.9.1 in the General Permit No. 2007DB0002, Holland America is submitting this Source Reduction Evaluation (SRE) to identify methods to reduce the presence of these constituents in the discharges authorized by this permit.

It should be recognized that this Source Reduction Evaluation plan has been developed in response to the General Permit issued March 25, 2008. As such, it is anticipated that this plan will be updated and amended as further information is gathered in the process of completing this evaluation.

While this SRE has been developed to be specific to Holland America Line vessels and operations, we may endeavor to undertake cooperative efforts in the development of technology or processes with other members of the Carnival Corporation family of cruise lines, as well as other members of the Northwest Cruise Ship Association (NWCA). No specific cooperative efforts are described in this document although they may include joint pilot projects and other measures designed to leverage resources, share learning and best practices, or otherwise improve our efforts to come into compliance with the long term limits of the permit.

Approach to Source Reduction:

As a general description, Holland America Line's source reduction efforts will be implemented in four phases, which together are designed to bring Holland America Line's vessels into compliance with the long term effluent limits for ammonia, copper, nickel, and zinc by the start of the 2010 Alaska cruise season. The four principal components of Holland America Line's source reduction strategy are summarized below:

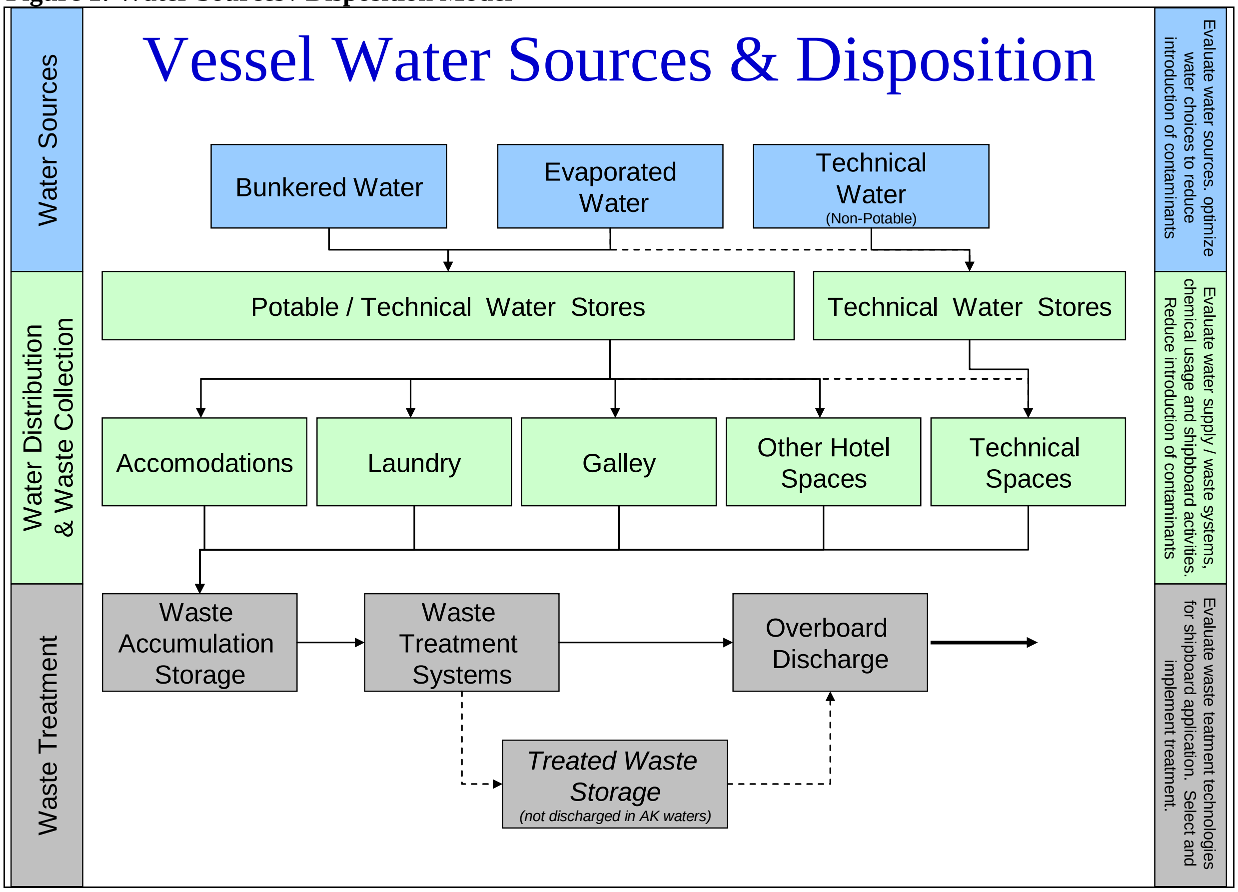
Source Reduction Effort		Mitigation Strategy
I. Influent Source Reduction		
1.	***Source Water Evaluation***: Identification of potential contaminants in source water(s)	Selection of source waters least likely to contribute to increased concentrations of contaminants.
2.	***Chemical Use / Processes Evaluation:*** Identification of on-board chemical use or activities that may contribute contaminants to the waste stream	Product substitution and/or process changes to eliminate or reduce contaminants of concern.

3.	***Water Supply & Waste Collection Evaluation***: Evaluation and Identification of water supply & infrastructure (principally water supply/drainage plumbing) that may contribute contaminants to the waste stream	Implement operational or infrastructure modifications as appropriate to eliminate or reduce contaminants of concern.
II. Treatment Technology Evaluation & Implementation		
4.	**Identification of treatment technologies** to reduce contaminant levels	Evaluation, selection and installation of treatment technology to achieve long term limits by 2010.

As influent reduction opportunities are identified and implemented, this information will feed into and inform development of potential down stream treatment technologies. Therefore source influent changes will in all likelihood precede technology changes or implementation, as reflected in the description above and the milestone schedule provided in Section V of this SRE. Inasmuch as ADEC has recognized that there are presently no technologies available for installation aboard cruise ships that would enable large cruise ships to meet the long term effluent limits set forth in the General Permit, technological changes will be dependent upon development of new systems that are both capable of meeting the General Permit's effluent limits, can gain approval from the appropriate regulatory bodies governing vessel and environmental requirements, and can be adapted for use aboard large cruise ships.

A basic model of this approach for HAL vessel water supply / drainage / treatment / discharge system is provided in figure 1 below:

Figure 1: Water Sources / Disposition Model



Activities under each of these categories are described in this plan.

General Discussion

The four contaminants of interest in this Source Reduction Evaluation are ammonia, and three metals: copper, nickel and zinc.

Preliminary investigation, as well as shore side experience, indicates a likelihood that metals contamination can come from potable water sources, leaching from plumbing systems, such as copper or galvanized pipe, or introduction of contaminants via product usage on board the vessel. Other ship-board activities will also be investigated to evaluate the possibility for contributions of these contaminants as introduced to the gray or black water treatments systems.

Individual metal reduction treatment options will generally apply to all three of these metals. While some technologies may favor one metal over the others, generally speaking a treatment system for copper will positively impact concentrations of nickel and zinc.

With respect to ammonia, it is common knowledge that ammonia is a break-down product of urea, found in both human urine and feces. Studies have shown ammonia nitrogen levels of approximately 190 mg/L in human urine, a concentration that has been shown to rise in storage due to ongoing decomposition processes[1]. Historically, ammonia levels from cruise ships with AWWPS systems have averaged approximately 28-35 mg/L as compared to approximately 15-20 mg/L encountered with shore-based treatment facilities. Cruise ship concentrations are no doubt elevated, in part, due to the use of vacuum flush toilet systems that typically use 0.3 liters per flush as opposed to 1.3 liters per flush used in shore-based low-flush toilets. This is acknowledged in EPA's summary of sampling taken on board Veendam in 2004.

> *"Wastewater conservation practices used onboard, such as use of vacuum toilets, result in highly concentrated wastewater."*[2]

Calculations have shown the per-person mass (as opposed to concentration) contribution of ammonia to discharges from cruise ships is comparable to that of shore based waste water treatment plants; regardless, the focus of this plan is to reduce ammonia concentrations to long term limits established in the Alaska Cruise Ship General Permit by 2010.

In 2004, the US EPA conducted extensive ship board sampling to evaluate cruise ship discharges in Alaska. Four vessels participated – two of which were Holland America Line vessels (Veendam and Oosterdam)[3]. This effort included some source water testing, as well as testing of waste water quality at various stages of the supply/drainage/treatment cycle prior to discharge. The EPA reports, while not sufficiently complete to satisfy requirements for a source reduction evaluation, established a good framework around which to base this plan. In following the EPA model, we can build on the existing data set while refining the analysis.

Wastewater Characterization:

The installation of Advanced Waste Water Purification Systems (AWWPS) on board cruise ships has lead to outstanding improvements in reduction of 'classical' pollutants such as fecal coliform, biological oxygen demand (BOD) and suspended solids. These systems, however, are not designed to meet the stringent long term effluent limitations for ammonia, copper, nickel and zinc in the Alaska Cruise Ship General Permit. ADEC has acknowledged that cruise ship operators will need time to develop and implement measures to reduce concentrations, and have therefore implemented interim permit limits, for these constituents. The interim and long term limits are summarized below:

Analyte	Long Term Limit	Interim Limit
Ammonia	2.9 mg/L	80.4 mg/L
Copper	0.0031 mg/L	0.066 mg/L
Nickel	0.0082 mg/L	0.18 mg/L
Zinc	.081 mg/L	0.23 mg/L

Notices of intent submitted for discharge authorization under the Alaska General permit listed the system capacity and gray water / black water mixture ratio for each vessel discharging permitted

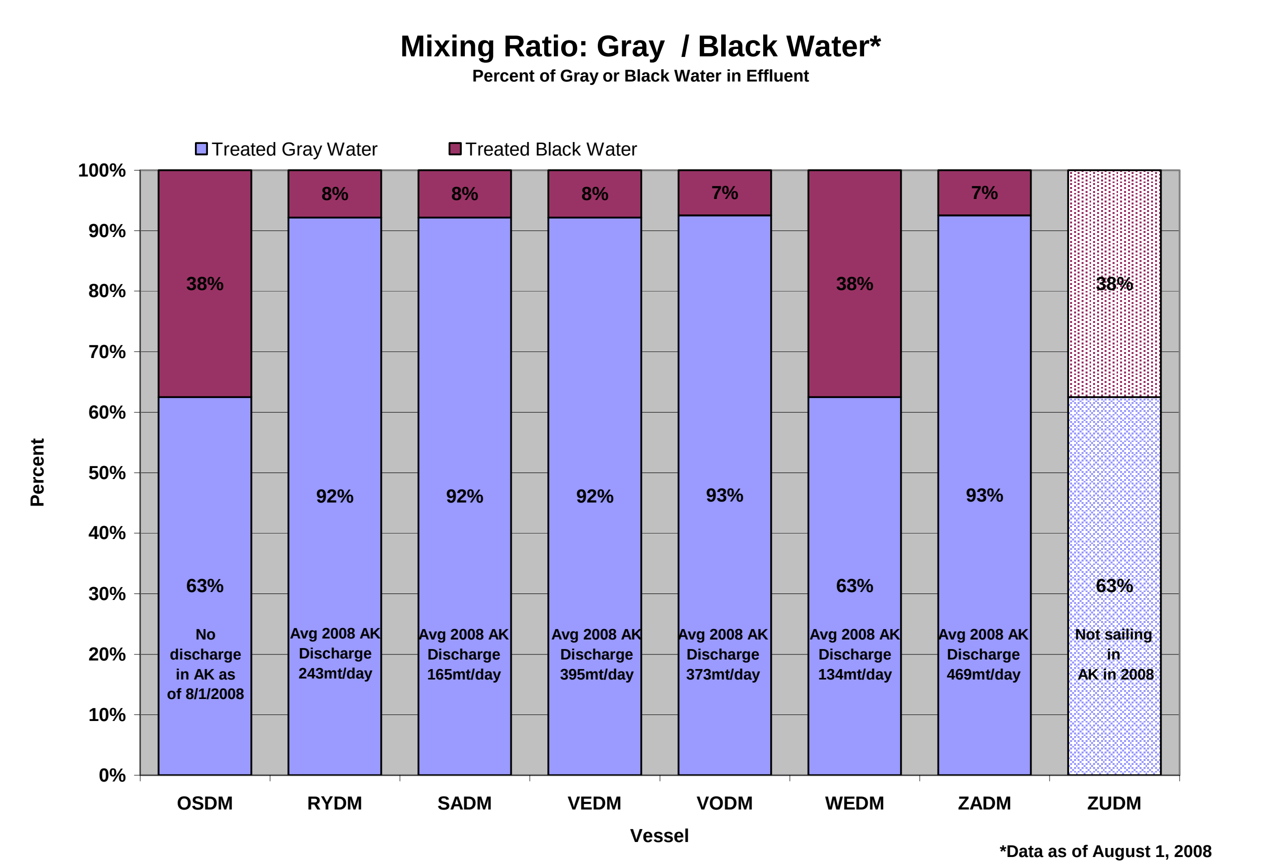
[1] See "Phosphorous Recovery from Human Urine, Gethke, Herbst, Druszies and Pinnekamp, Water Practice 7 Technology, Vol 1, Nox 4 @ IWA Publishing, 2006 http://www.iwaponline.com/wpt/001/0070/0010070.pdf

[2] See EPA Holland America Veendam Sampling Episode Report, March 2006 ll, p. 44, http://www.epa.gov/owow/oceans/cruise_ships/Veendam/VeendamSER.pdf

[3] See EPA Cruise Ship Sampling Reports, http://www.epa.gov/owow/oceans/cruise_ships/results.html

effluent in Alaska waters. The discharge volumes and ratios per vessel are displayed in figure 2 below. Within these estimates, actual discharge volumes and ratios may vary, depending on itinerary, generation and treatment rates, etc. as the vessels sail into and out of Alaska waters.

Figure 2: Gray / Black water Ratios for Alaska Discharges by Vessel



With respect to ammonia, copper, nickel and zinc, analytical results generated during 2008 show some variation. Water bunkering activities, gray/black water ratios, installed systems and other operating variables however, preclude drawing conclusions at this time. It is the focus of this SRE to control for such variables and to investigate and identify targets for source reduction.

Holland America Line Vessel Specific Information

Figures 3, 4 and 5 below provide certain vessel specific information relative to the HAL fleet sailing in Alaska. Zuiderdam is not scheduled for deployment in Alaska until 2009, and therefore some information is either estimated on the basis of similar class vessels, or not provided.

Figure 3: Holland America Line Vessel Information

Vessel	Delivery Year	Vessel Class	Discharging Under Interim Limits	Gray / Black Water Treatment System
Oosterdam	2003	Vista Class	Ammonia, copper, nickel, zinc	Rochem
Ryndam	1994	“S” Class	Ammonia, copper, nickel, zinc	Zenon
Statendam	1993	“S” Class	Ammonia, copper, nickel	Zenon
Veendam	1996	“S” Class	Ammonia, copper, nickel, zinc	Zenon
Volendam	1999	“R” Class	Ammonia, copper, nickel, zinc	Zenon

Westerdam	2005	Vista Class	Ammonia, copper, nickel, zinc	Rochem
Zaandam	2000	"R" Class	Ammonia, copper, nickel, zinc	Zenon
Zuiderdam[4]	2002	Vista Class	To be determined	Rochem

II. Influent Source Reduction Evaluation

This phase of the SRE is designed to investigate the possible introduction of contaminants of concern at water sources, in distribution through the potable water supply, and in collection through the drainage system prior to entering the wastewater treatment system.

Potable/Technical Water Systems Description

Potable and technical water entering the drainage system to the gray and black water systems is either bunkered in ports, or manufactured on board with seawater. In some circumstances, technical (non-potable) water may be used in some cleaning and maintenance activities and has the potential to enter the gray water system. The accompanying figures 4 and 5, based on data from the first half of the 2008 season, provide data on water sourcing employed by the HAL fleet in Alaska. Each of these source streams is described in further detail below:

> ***Bunkered water:*** During Alaska season, water is bunkered in Seattle, Vancouver, Ketchikan, Juneau, Skagway, Haines and Seward. Bunkering decisions depend on both water usage and itinerary, and may vary from voyage to voyage, or vessel to vessel, even on the same itinerary. Variables may include: number of sea days, daily water usage, price/availability in port, etc.

[4] Zuiderdam is not sailing in Alaska in 2008 but is scheduled to do so in 2009.

Figure 4: Bunkered Water Volumes by Port

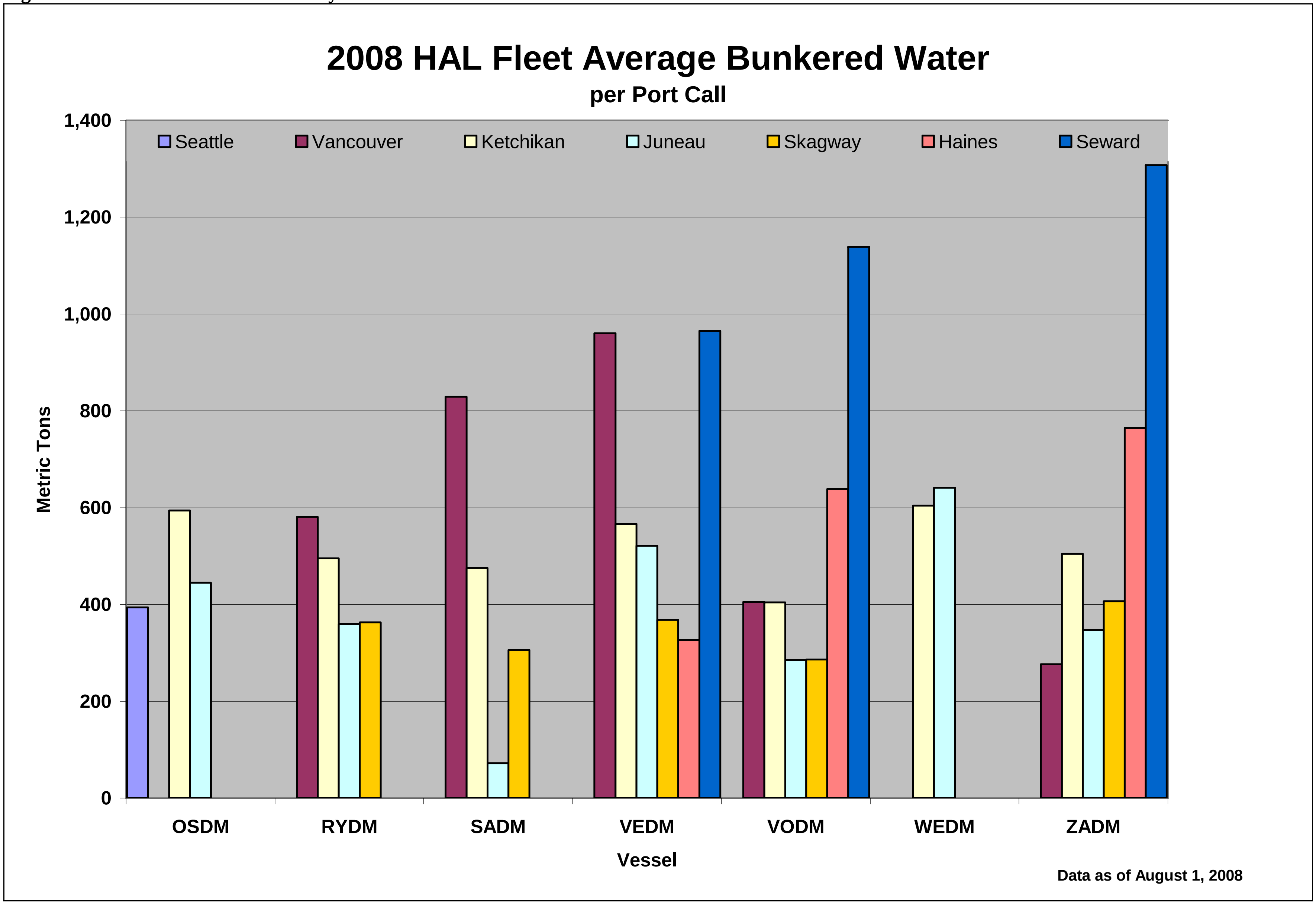
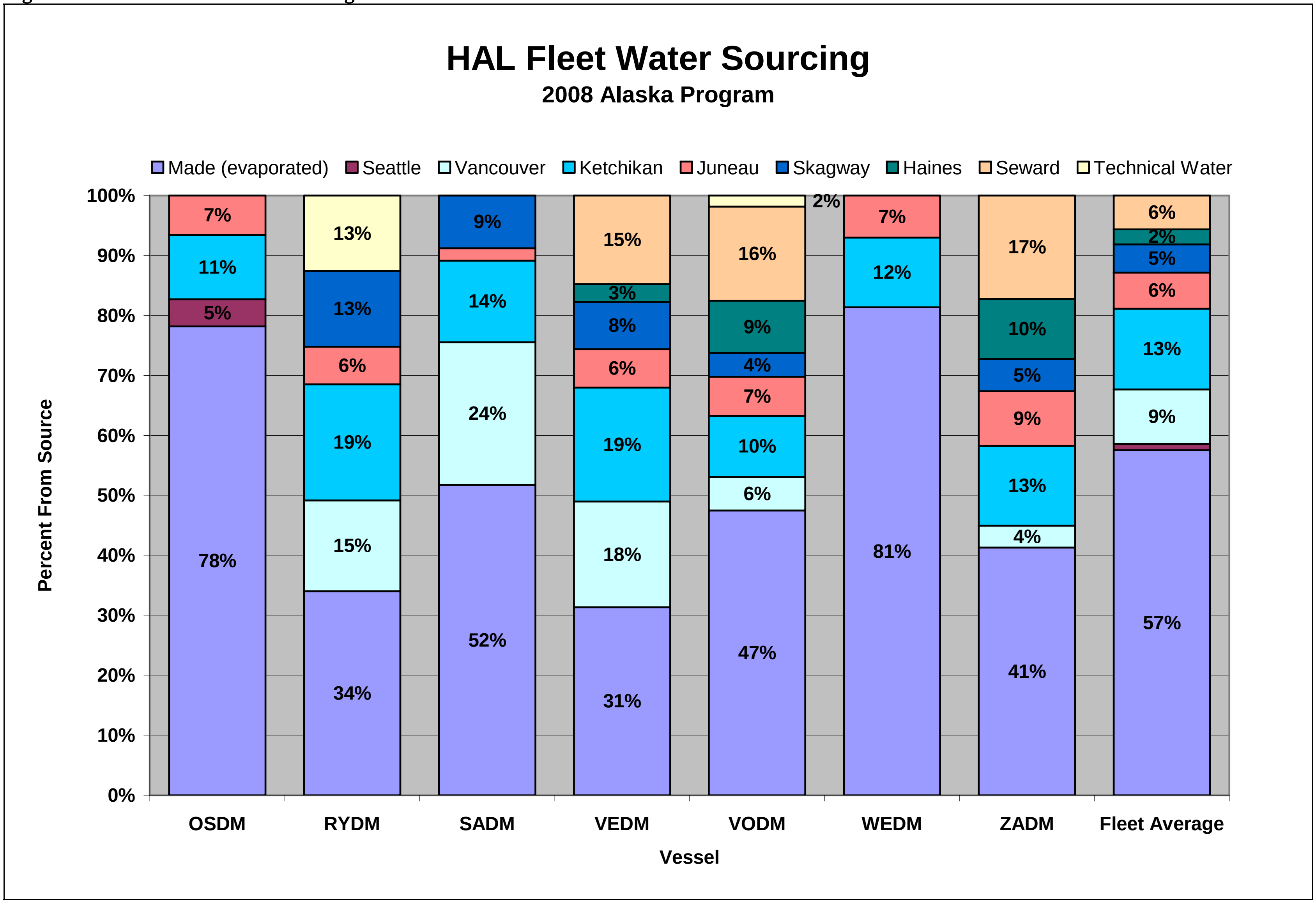


Figure 5: Water Sources as a Percentage



Evaporated Water: Holland America Line ships are equipped with evaporators that produce potable water, evaporating and condensing seawater when en route. The following descriptions are class specific.

"S" and "R" Class Vessels: Evaporators are four-stage distillation units drawing sea water when under way and outside of harbor limits. Intake water is pre-heated in a heat-exchanger served by non-contact high temperature engine cooling water. Both R and S class vessels have two such evaporators; R class vessels have an additional steam heated evaporator as well. The water is then flash-evaporated in the first stage of the evaporator. Three additional vacuum-assisted evaporation stages ensue, followed by re-condensation in a tubular copper alloy, sea water cooled (non-contact) condenser.

Potable water travels from the evaporator to the potable water or technical water storage tanks for distribution via "cunifer" (copper, nickel) pipe. Evaporated water is adjusted for pH in a Culligan water treatment system, calibrated to adjust pH to approximately 7.3. The Culligan neutralizing bed (trade name "Cullneu"®) is a blend of calcium carbonate and magnesium oxide that also provides a corollary benefit of water hardening – although that is not the treatment objective of this system. Water that is already of acceptable pH does not receive pH adjustment and in those cases is not treated with this system.

Per USPH requirements, potable water is chlorinated to between 2.2 and 2.5 ppm chlorine by an automated dosing system prior to entering the potable water storage tanks. [5] Potable water storage tanks are coated with International Paints Epoxy Interline White two-part epoxy system, THA125-127. This coating has been verified to meet the 21 CFR 175.300 requirements for Resinous and Polymeric coatings.

As free chlorine is not stable in the stored water, automated systems verify and supplement chlorination before distribution, when necessary, to maintain free residual chlorine content above 0.2 ppm at the furthest point in the potable water distribution system. From the storage tanks water is transported to each deck in cunifer pipe risers from which water is distributed laterally via polypropylene plumbing to spigots, faucets, showers, etc.

On S and R Class vessels, below the water tight bulk-head deck, all drainage pipes are galvanized carbon steel. Above this level, all drains are "LORO-X" galvanized carbon steel pipe, which is internally coated with synthetic resins.

"Vista" Class Vessels: Evaporators are multi-stage distillation units drawing sea water when under way and outside of harbor limits. Intake water is pre-heated in a heat-exchanger served by non-contact high temperature engine cooling water. Afterwards, the water is vacuum assisted / flash evaporated in a titanium plate

[5] Chlorine used is Ecolab XY-12 8% chlorine solution, supplied in plastic drums by Ecolab®

evaporator. Three additional titanium plate vacuum-assisted evaporation stages ensue, followed by re-condensation in tubular copper alloy, non-contact, sea water condenser.

As with R and S class vessels, potable water travels from the evaporator to the potable water or technical water storage tanks for distribution via cunifer pipe. Evaporated water is also treated in Culligan water treatment system as per above.

Per USPH requirements, potable water is chlorinated to between 2.2 and 2.5 ppm chlorine by an automated dosing system prior to entering the potable water storage tanks. The following potable water storage tank coatings are employed:

1. Zuiderdam & Oosterdam - Phenguard (phenolic epoxy) System; Sigma Coatings
2. Westerdam & Noordam - Hempadure 8567 Phenolic Epoxy; Hempel Coatings

These coatings have been verified to meet the 21 CFR 175.300 requirements for resinous and polymeric coatings.

Before distribution, automated systems verify chlorination and supplement when necessary, to maintain free residual chlorine content above 0.2 ppm at the furthest point in the potable water distribution system. Water is distributed in stainless steel riser pipe to each deck, from which lateral distribution is achieved via polypropylene plumbing to spigots, faucets, showers, etc.

On Vista Class vessels, below the water tight bulk-head deck, all drainage pipes are galvanized carbon steel. Above this level, all drains are "LORO-X" galvanized carbon steel pipe which is internally coated with synthetic resin.

Technical Water: Some non-potable water is used on board some vessels in engineering spaces and deck washing and may enter the gray water system via floor drains in some cleaning applications. Technical water sources include bunkered water, evaporated water (as described above) and, on some vessels, air conditioning condensate. Such water is not chlorinated on board, although bunkered water may be chlorinated at the source. Technical water is not managed for pH or hardness, although bunkered water may be managed at the source. This is not a significant volume of water for most vessels, but it will be evaluated for possible contaminant contributions.

The 2004 EPA sampling activity evaluated source water at the furthest distribution point in the water delivery system – i.e. potable water in one of the cabins. EPA did not evaluate potable water at the source – either at the evaporator or the bunkered water as brought on board. EPA did not evaluate technical water.

The principal means of evaluating these sources will be to sample and analyze for each isolated water source, focusing on concentrations of contaminants of concern as well as water quality characteristics such as chlorine, hardness and/or pH to evaluate the potential for pipe-leaching in the system. For water bunkered from shore supplies, the Alaska Cruise Ship Association (ACA) is completing commissioned a sampling program for the benefit of member lines. This sampling plan includes multiple samples drawn from most cruise water bunkering facilities from San Francisco to Seward, and is scheduled to conclude by September, 2008. Data will be shared among the member lines as laboratory reports are delivered to ACA.

Concurrent with ACA sampling, Holland America Line is conducting source water sampling from evaporator and technical water supplies on board HAL vessels. Samples will be collected not only at the point of generation or accumulation, but also at distributed points in the water supply and waste collection system, including accommodations, galleys, laundry facilities and waste accumulation tanks, in an attempt to isolate possible contributions from disparate uses of the waters supply and drainage system. Data reported in the USEPA Draft Cruise Ship Discharge Assessment Report will also be used in evaluating possible contaminant sources.

Ship-board sampling will be conducted in August and September of 2008, with analytical reports expected 2-3 weeks following the sampling date. The last date on which a Holland America Line ship sails in Alaska this season is September 26th, 2008, when Westerdam calls on Ketchikan.

Recommendations for strategic sourcing of potable water to minimize potential sources of copper, nickel and zinc will be contained in the Annual Progress Report to be submitted to ADEC by January 14th, 2009.

Chemical Uses / Processes Evaluation

HAL is also working to identify cleaning products, rodenticides, pesticides, or other industrial products that may be contributing to metals or ammonia loading of the waste stream(s), either by their composition or their interaction with plumbing supply and/or waste systems. This includes chlorine or other halogenated products that may accelerate pipe corrosion.

This evaluation will incorporate ship-specific knowledge regarding the chemical usage as possible sources of contaminants. Opportunities will be identified and implemented as appropriate for product substitution and/or operational changes that may result in reduction of ammonia, copper, nickel or zinc concentrations. Included in this evaluation will be the potential for products or processes to accelerate pipe leaching or corrosion as may affect influent to the wastewater treatment systems.

As part of this evaluation, we will be reviewing maintenance and hotel procedures, as well as surveying the ships, to determine whether intermittent activities that could contribute to the source of metals or ammonia.

A summary of this evaluation, with recommendations for source reduction actions, will be contained in the January 14th 2009 Annual Progress Report to be submitted to ADEC.

Water Supply & Waste Collection System Evaluation

On a vessel-class specific basis, water storage, supply and waste collection systems are being evaluated for their potential to contribute metals contaminants to the overboard discharge. Emphasis will be placed on the prospect of leachability of metals from plumbing supply and waste systems, principally as a function of water hardness, pH, plumbing materials, or other related factors as may be identified. Water/waste storage tank coatings are also being evaluated as potential sources of contaminants.

Piping materials are not, of course, a source of ammonia. Sampling of strategic points in the water distribution and waste collection system will be similar to those chosen by EPA in their 2004 sampling efforts. This will allow us to build on the existing data set, as well as validate previous sampling efforts.

This body of data from product usages, water sources as well as various points in the supply and waste systems, including that from the EPA draft assessment and previous studies, will be used to analyze and determine at what point contaminants are entering the system. HAL will document this analysis in the Annual Progress Report to be submitted to ADEC by January 14^{th}, 2009.

HAL will identify and implement changes as may be indicated by the data. Such improvements may include, but not be limited to:

1. strategic sourcing of bunkered water
2. optimization of bunkered vs. evaporated water sourcing
3. management of water pH and/or hardness to minimize leaching from pipes
4. chemical substitution for products identified as contributing to contaminants of concern or leaching potential in the drainage systems
5. substitution of non-chemical methods for processes that involve chemicals

Implementation of the (to be) identified improvements will be dependent on the specific measures selected. For example, strategic bunkering will be implemented upon return to Alaska at the start of the 2009 cruise season, while chemical substitution schedules would depend on availability of suitable alternatives, delivery schedules and existing inventories. Phase in of substitute materials that are determined to be appropriate and beneficial will occur throughout 2009. A description of these opportunities will be included in the Annual Progress Report to be submitted to ADEC by January 14^{th}, 2009.

III. Treatment Technology Evaluation & Implementation

Identification of potential treatment technologies for addressing the target constituents is both more complex than, and yet will be considerably informed by, the influent source reduction evaluation described above. It is logical to prioritize and implement source reduction measures upstream of the treatment system to capture achievable source reductions in that way, thus lowering the treatment burden to be born by subsequent treatment technologies.

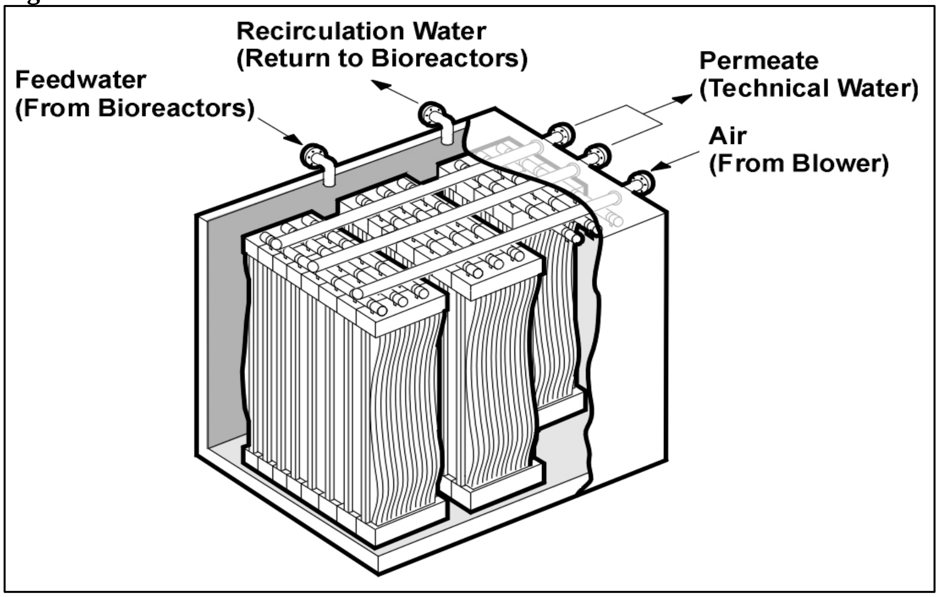
Current Treatment Systems Description

Holland America Line ships discharging treated sewage and gray water in Alaska waters operate one of two systems: Rochem or Zenon. Each of these systems is described below:

Zenon Systems: the Zenon system treats both gray water and black water in combination. The treatment sequence is as follows:

1. collection in equalization tank(s)
2. pre-screening for solids in Masko-zoll® filter stage
3. biodegestion via microbial digestion
4. ultrafiltration with "Zeeweed"® membranes for bacterial and/or suspended solids screening

Figure 6: Zenon "Zeeweed" filters



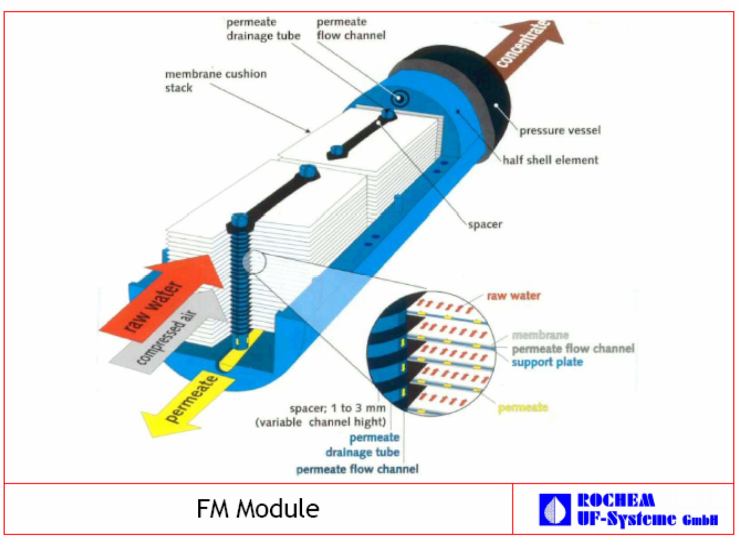
5. The effluent from this stage is referred to as "permeate"
6. Ultraviolet disinfection for 'polishing' of permeate
7. Overboard discharge

Rochem Systems: Vista class vessels equipped with Rochem systems treat all black water and a portion of the graywater generated on board. No untreated gray water is discharged in Alaska.

The treatment sequence is as follows:

1. collection in equalization tank(s)
2. pre-screening for solids in Zweco® filter
3. organic reduction via microbial digestion
4. ultra-filtration via membrane filtrations cartridges

Figure 7: Rochem membrane filters



5. Ultraviolet disinfection for 'polishing' of permeate

6. Overboard discharge.

Both systems have been certified for 24/7 discharge in Alaska under Murkowski requirements, yet do not meet the long-term limits o the Cruise Ship General Permit. The EPA Draft Cruise Ship Discharge Assessment Report provides a broad overview of potential treatment technologies that may address these contaminants of concern. EPA describes these technologies generally in saying:

> *Use of these technologies onboard large cruise ships would require engineering studies to adapt existing designs and materials selection (e.g., metallurgy, membrane and resin selection, loading rates, reliability, space constraints), operating parameters (e.g., pressures, temperatures, service and maintenance cycles), and training for operating personnel to ensure effective and consistent performance and minimize operating costs.*[6]

Therefore between now and the 2010 Alaska season, Holland America Line will engage with our current Advanced Waste Water Purification System (AWWPS) vendors as well as additional suppliers to evaluate, research and develop additional treatment technologies as may be appropriate for reduction of these pollutants. Approval from appropriate regulatory bodies will also be an element of this design and installation process.

Treatment Technology Overview

Treatment technologies for ammonia and metals are distinctly different in their chemical engineering processes, and thus it is unlikely that a single treatment process that will address both. Consequently technology research and development will most likely involve two separate yet parallel paths. This Source Reduction Evaluation describes several of the potential treatment technologies below, followed by a description of the process, criteria and schedule by which HAL will evaluate, research, develop and install treatment technology.

Ammonia Treatment Technologies

Potable water used on board is, of course, quite low in ammonia. While there is the potential that ammonia will be found in chemical products used on board, in all likelihood the majority of ammonia contributions to the waste discharge will be in the form of urea from human urine or feces entering the gray/black water systems. As this is likely to be an unrewarding target for source reduction per se, treatment technology is the most promising strategy for reductions in discharge concentrations.

Treatment systems for ammonia reduction do not generally provide corollary benefits of metals reduction, thus this technology is likely to be in addition to that which may be selected for metals reduction.

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[6] See Draft Cruise Ship Discharge Assessment Report, US EPA, December 2007, EPA842-R-07-005, p. 2-36

The EPA Draft Assessment identifies two treatment technologies as having the potential to improve effluent quality for ammonia: biological nitrification and ion exchange.

> ***Ammonia Removal by Biological Nitrification:*** The process of ammonia nitrification is accomplished by ammonia oxidizing bacteria such as *nitrosomonas and nitrobacter* (sometimes referred to as nitritifiers or AOB's) that digest ammonia into nitrite. These microbes are distinctly different than the predominant biota cultured on board for biodigestion of organic carbon. AWWPS systems installed on HAL vessels, have nitrifying bacteria present, although not in numbers comparable to the microorganisms currently employed to reduce organic carbon.
>
> Management of the treatment processes for these two different microorganisms may require modifications to ship equipment or operations, such as segregated digestion tanks, increased hydraulic retention time and additional aeration equipment. Operational changes may include additional management of sludge retention times, temperatures, pH and other impacts on the microbial health of the systems. The nitrification step would by necessity be inserted into the treatment process after initial screening and before the membrane filtration stage.
>
> While nitrification converts ammonia to nitrate, it does not reduce total nitrogen. Thus, while reducing potential aquatic toxicity in the undiluted effluent, total nutrient loading would not be affected significantly, if at all.
>
> ***Nitrogen Removal by Ion Exchange:*** Ion exchange is a process in which waste effluent is circulated through a tank containing a weak-acid ion exchange resin media. Under proper conditions, such as neutral pH, positively charged Ammonia ions (NH_4^+) bond to the resin due to the negative charge on the resin. By necessity this process would be installed after the membrane filtering process to prevent fouling of the resin media.
>
> Ammonia removal is effective until the resin is fully saturated with ammonia ions, at which point it could be either regenerated onboard or exchanged for a new, regenerated, resin containing canister provided by a shore side by a waste management company. While ship board regeneration of the resin media is possible, the process would raise additional waste management requirements, operational complexity and associated discharge management requirements. Therefore shore-side regeneration would appear preferable at this time.

Metals Treatment Technologies:

On cruise ships, metals concentrations are more likely than ammonia to be positively impacted by source reduction efforts upstream of the waste treatment process. Regardless, it is likely that additional treatment will be necessary to meet 2010 limits of the Cruise Ship General Permit. Precipitation and flocculation metal treatment processes are discounted as impractical on board ships due to their reliance on additional treatment tanks, use of aggressive acids / alkalines and the further issues associated with management of waste from such processes. The EPA draft assessment identifies two treatment technologies for removal of metals: ion exchange and reverse osmosis.

Metals Removal by Ion Exchange**:** In an ion exchange process, metals-containing effluent is passed through a vessel containing a chelating resin. Metal ions bond to the resin and thus are removed from the effluent. By necessity this process would be installed after the membrane filtering process to prevent fouling of the resin media. As these resins are not the same as those that would be employed for ion exchange of ammonia, this treatment step would be in addition to ammonia treatment systems described above.

As with ammonia ion exchange systems, metals removal is effective until the resin is fully saturated with metal ions, at which point it must be either regenerated or replaced with unsaturated resins. While regeneration on board is conceivable, the resulting regeneration solution would be strongly acidic, rendering this option unattractive for ship-board operations.

As with ammonia ion exchange options, the resin canister could be regenerated shore side by a waste management company. The costs and potential environmental concerns associated with management of these wastes would need to be considered as part of the assessment of this technology.

Metals Removal by Reverse Osmosis: Reverse osmosis is a process in which pressure is used to force water through a semi permeable membrane while dissolved concentrations of metal ions are retained. The retained solution containing concentrated metal ions, estimated by EPA to be as much as 15% of the total influent flow, would require further management. By necessity this process would be installed after the membrane filtering process to prevent fouling of the resin media.[7] Membrane maintenance, cleaning and maintenance requirements are an additional consideration for this technology.

Research / Consultation with Vendors

It is logical to initiate discussions with our current vendors, Zenon and Rochem, regarding the above described or other treatment technologies, particularly given their experience in shipboard operations. Initial discussions commenced in the second quarter of 2008, and continue. It is expected that consultation with vendors will continue throughout the term of this SRE and beyond.

HAL will also reach out to other vendors identified during the third and fourth quarter of 2008 to explore additional options. Discussions will focus on general engineering requirements regarding treatment technologies, required capacity, treatment and storage requirements and other system needs will be explored.

While technology solutions will almost certainly be a part of the formula for achieving 2010 limits, it is equally logical to inform vendor discussions with facts and data gathered during the Influent Source Evaluation and other upstream reduction efforts described above. The progress of this research will be summarized in the Annual Progress Report to be submitted by January 14th, 2009, as well as subsequent updates indicated elsewhere in this plan.

Treatment Technology Evaluation

A steering committee will be formed by January 30, 2009 to assess data gathered in both the Influent Source Reduction Evaluation and Treatment Technology Evaluation phases. This

[7] See Draft Cruise Ship Discharge Assessment Report, US EPA, December 2007, EPA842-R-07-005, p. 2-38

committee will evaluate treatment options in consideration of source reduction opportunities as well as other operational needs of the vessel, such as laundry, galley or other operations. Representatives from the Technical, Nautical Compliance, Marine Hotel and Environmental Management Departments will participate in this evaluation for selection of the preferred pilot technology. This steering committee will convene by January 30, 2009.

A ship engineering project lead will be identified by January 30, 2009 to coordinate the technology evaluation, gather data, and manage the treatment technology selection and installation phase of this project.

At a minimum, potential treatment technologies will be evaluated by the following criteria:

1. **Safety to crew, guests or ship –** maintenance and operation of the treatment technology must not place unacceptable risk to the safety of those on board.
2. **Effectiveness in achieving treatment objectives**. The ability of the treatment technology to reduce concentrations of contaminants.
3. **Compatibility with existing systems –** technologies must be compatible with existing treatment systems as well as power and other infrastructural requirements
4. **Installed 'footprint' –** Treatment technologies must fit within confined engine spaces or other areas for which guest access is restricted.
5. **Complexity in operations and maintenance –** additional treatment technologies must be amenable for operations and maintenance by existing work force pool of trained maritime engineers with reasonable training.
6. **Treatment capacity –** additional treatment steps must be capable of matching flux of existing systems. A treatment capacity less than current systems would result in additional stored permeate, which would detract from the 24/7 discharge benefits of the AWWPS systems employed in South East Alaska.
7. **Economics –** selection and installation of treatment technologies must meet the test of comparison with other compliant treatment and/or discharge options.
8. **Approval –** depending on the technology and/or modifications to existing systems, regulatory approval from flag state and/or classification society, as well as the US Coast Guard may impact technology choices.

The technology evaluation will be completed, with selection of the ship for the pilot study, and ordering of equipment necessary for installation, by April 30, 2009. A Technology Evaluation Report will be submitted to ADEC by April 30, 2009.

Pilot Study

Installation of enhancements to the wastewater purification system is likely to incur significant capital investment, and may involve speculative technologies that have not been adapted for shipboard use. Therefore, it is wise to conduct a pilot study using a prototype rather than commit to whole-scale fleet installation without prior operational experience. Additionally, depending on the treatment technology selected and its integration into existing systems, IMO, flag state Class Society and U.S. Coast Guard certifications may be necessary.

The Pilot Study to evaluate selected treatment technologies in anticipated to commence in the second quarter of 2009. The following milestones are projected for this phase of the project:

Pilot Study Milestone	**Estimated Completion Date**
Work with vendors, select pilot option	In progress, to be completed by April 30, 2009
Selection and procurement of equipment for pilot study	April- June 15th, 2009
Installation and commissioning of pilot treatment equipment	July 14th, 2009
Operation and data gathering in Alaska	July- September 2009
Pilot Study Evaluation Report	November 15th, 2009

Delivery and Installation on 2010 Alaska Dischargers

Based on the results of the pilot study, treatment technology options will be selected. Ordering and purchasing for installation in 2010 Alaska dischargers will be incorporated into the budgeting and planning cycles for FY 2010, with installation to be scheduled for commissioning prior to discharge in Alaska season in 2010. The status of installation and implementation will be reported to ADEC in the Pre-2010 Alaska Season Status Report to be submitted by April 20, 2010.

Ongoing monitoring and evaluation will continue on the pilot study vessel, as well as additional vessels as equipment is installed.

IV. Influent Source Reduction Evaluation Milestones:

Influent Source Reduction	
Task	**Estimated Date of Completion**
1. **Water Source Evaluation**: Drawing on existing data and additional sampling, isolate potential sources of contaminants including: a. Bunkered water b. Evaporated water c. Potable water storage tanks d. Water supply plumbing distribution system e. Waste water collection plumbing system f. Waste water storage tanks The approach will be to use analytical data and other information such as published reports to attempt to isolate possible contributors of contaminants.	In Progress, field sampling completed by September 30th, 2008
2. **Annual Progress Report to include Influent Reduction Evaluation:** This report, to be submitted to ADEC, will contain: g. Source water sampling results & analysis h. chemical usage / process analysis to identify source reductions i. Water supply / drainage system evaluation, summarizing potential for leaching / corrosion sources for contaminants j. Action plan for product substitution / process modifications or plumbing upgrades per data.	January 14, 2009
3. **Product Substitution Implementation**: Per conclusions of Influent Source Reduction Evaluation, k. Identify product substitutes and sources for use in Alaska. Draw down existing inventories and replace with substitute products. l. Strategic water bunkering implemented.	2nd through 4th Quarter, 2009 Beginning 2009 Alaska season
4. **Pre-Alaska Season Status Report**: progress and implementation summary on Influent Source Reduction Activities.	April 30, 2009
5. **Annual Progress Report:** Report on source reduction / product substitution efforts on waste stream concentrations of ammonia, nickel, copper, zinc.	January 14, 2010

V. Treatment Technology Evaluation & Pilot Study Milestones

Treatment Technology Evaluation and Pilot Study	
Task	**Estimated Date of Completion**
1. Consult with current vendors regarding current system capabilities and possible add-ons.	In progress, ongoing through selection and installation of equipment
2. Identification of potential treatment technologies for evaluation: research focused on treatment technologies most appropriate for installation and operation on board cruise ships. These activities will be summarized in the Annual Progress Report due January 14th, 2009.	In progress, ongoing through installation of equipment 2nd qtr, 2009 To be reported in Annual Progress Report January, 14, 2009 & 2010
3. Convene Technology Evaluation Steering Committee composed of Technical, Nautical Compliance, Marine Hotel and Environmental representatives. – The purpose of this committee will be to ensure that technology solutions considered will serve vessel needs while working to achieve long-term permit limits.	January 30, 2009
4. Assign ship engineering project lead to coordinate technology evaluations, gather data, installation of equipment, manage project.	January 30, 2009
5. Technology evaluation to determine most promising treatment technology. Report to ADEC summarizing technology evaluation considerations, describing course of action for technology selection and installation.	January - April 30th, 2009 Report to ADEC April 30, 2009
6. Selection and procurement of equipment for pilot study.	April – June 15th 2009
7. Installation and commissioning of pilot treatment technology.	To be completed July 14th, 2009
8. Operation and data gathering in Alaska from pilot treatment technology	July-September 2009
9. Pilot study evaluation report – documentation of data and conclusions from technology pilot study.	November 15th, 2009
10. Selection and ordering of Treatment Technology, Procurement and Delivery. Status to be reported in January 2010 Annual Progress Report.	December 31st, 2009

11. Delivery, installation and commissioning of treatment technology on board.	January – April 2010
12. Pre-2010 Alaska Season Status Report to ADEC, summarizing source reduction, equipment installation status	April 30, 2010
13. First 2010 HAL Ship in Alaska	May 10, 2009
14. Ongoing Monitoring & Evaluation – per AK Cruise Ship General Permit	2010 Alaska Cruise Season

VI. Schedule of Reports

Report	Due Date
Annual Progress report / Source Reduction	January 14, 2009
Pre 2009 Alaska Season Status Report	April 30th, 2009
Pilot Study Evaluation Report	November 15th, 2009
Annual Progress Report	January 14, 2010
Pre-2010 Alaska Season Status Report	April 21, 2010

Appendix A. Water Sampling Plan

This sampling strategy is modeled on the EPA sampling conducted in 2004 on board Oosterdam and Veendam. Some deviations from the EPA strategy are warranted to obtain data with further granularity with respect to sources and potential contributors

On board sampling will be conducted per vessel category, which also corresponds roughly to vessel age. The following vessels have been selected:

Vessel	Vessel Class	Treatment System	Year of Delivery
RyndamStatendam	"S" Class	Zenon	1993
Zaandam	"R" Class	Zenon	2000
Westerdam	Vista Class	Rochem	2005

Sample Locations

Water will be collected at the following sample locations to inform the source reduction evaluation:

Source Water: The Alaska Cruise Association has been conducting sampling of water bunkered in the ports of Alaska, British Columbia, Washington State and California.

On-board sampling will be taken of evaporated water prior to entering the potable water storage tank, but after the chlorination stage, to determine water quality characteristics from this source. Technical water will be sampled from the technical water pump, prior to distribution through the plumbing system.

Potable water at distribution point: Similar to the EPA methods, samples will be taken in a cabin at the furthest reach from the potable water storage tanks. This will build on EPA's data set, while providing a "worst case" data point with respect to possible metals leaching in supply plumbing.

Wastewater**:** Wastewater prior to treatment will be sampled at various locations in an effort to isolate sources contributing to the overall waste stream. As EPA did in 2004, galley and laundry waste will be sampled prior to mixing with other waste streams. Galley wastes will be sampled at the galley drain tank(s) after grease traps, rather than before as was the case with EPA sampling in 2004. This choice was made to evaluate the effect of grease trap treatment practices.

Accomodations gray water will be sampled at a representative gray water collection tank such as the AC compressor room gray water collection tank.

Should analytical results indicate exceptional values at this point, additional sampling upstream from this tank may be conducted.

As in the EPA study, Food pulper waste water will be sampled at the pulper collection tank for those vessels in the sample set that treat and discharge pulper water in Alaska.

Combined Pre- Treatment Wastewater: Combined influent to the treatment plant (gray and black water) will be sampled at the buffer or feed tanks supplying waste to the treatment plant.

Table of Sample Descriptions and Locations

Sample No.	Description	Sampling Location
1	Evaporator Water	Chlorination sampling point prior to tank storage
2	Technical Water	Discharge from Technical water pump
3	Potable Water (distributed)	Accommodation far from potable water stores (Forward, Navigation Deck)
4	Galley gray water	Galley drain tank
5.	Laundry gray water	Laundry drain tank
6	Accommodations gray water	AC compressor room gray water collection tank
7	Combined pre-treatment wastewater	Buffer/feed tank supplying bioreactor

Post treatment wastewater: Given the frequency of wastewater monitoring under the Alaska General Permit. No additional wastewater monitoring will be conducted as part of this effort. Sampling of wastewaters will be conducted as previously planned per requirements of the Alaska General permit.

Analytes

Samples will be analyzed for the following constituents pursuant to this plan:

1. Ammonia
2. Copper
3. Nickel
4. Zinc
5. pH
6. Hardness ($CaCO_3$)
7. Bromine
8. Free Chlorine
9. Total Residual Chlorine

Sampling Schedule

Samples will be collected from each of the listed vessels when alongside in Juneau, Alaska during the 2008 Alaska season per the following schedule:

Vessel	Sample Date
Statendam	August 25, 2009
Zaandam	August 27, 2009
Westerdam	August 28, 2009

It is anticipated that only one round of sampling will be conducted, however anomalous results could trigger additional sampling. Schedules will be coordinated with previously planned wastewater monitoring conducted under the general permit.

It is expected that analytical results will be provided by the contracted laboratory within 2-3 weeks of the sampling events, and in no case later than October 21st, 2008. Data analysis and reduction will be conducted and reported in the Annual Progress Report due to ADEC no later than January 14, 2009.