

SEVEN SEAS MARINER -SOURCE REDUCTION EVALUATION
ALASKA –SUMMER 2009

Pursuant to section 1.9.1 in Alaska Department of Environmental Conservation Large Commercial Passenger Vessel Wastewater Discharge Permit No. 2007DB0002, V.Ships Leisure UK Ltd, on behalf of Regent Seven Seas Cruises we have received approval from the Department to discharge the following parameters – ammonia, copper and zinc – at concentrations in compliance with the interim limits for these constituents as identified in the referenced permit (Table 1).

V.Ships Leisure (UK) Ltd 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.

As a minimum the plan will be reviewed by October 30th then by December 15th 2008 and regularly thereafter.

We will strive to meet the long term effluent limits by the beginning of the 2009 cruise ship season and indeed no later than the beginning of 2010 cruise ship season.

Seven Seas Mariner - Machinery Appliances specification and pipelines arrangements:

AWWTS:

The Seven Seas Mariner is fitted with two Advanced Wastewater treatment system made by Hamworthy – Membrane Bio Reactors – Type MBR 240C – USCG Type II approved. Capacity max 180 m³ per day.

The MBR operates as an aerobic biological treatment system. Incoming waste is fed into a high strength biomass within which there is a diverse microbial ecology that breaks and consumes the raw sewage. The by products of consumption are water and carbon dioxide; the water passes through the membrane and is discharged , the carbon dioxide is vented outside along with the air that is used for the aeration of the bio-mass.

The membrane module contains large numbers of ultra-filtration membrane tubes designed to achieve very high permeate production under the cross-flow scouring velocity.

The MBR 240C holds a Certificate of type approval – compliance with IMO MEPC.2 (VI) – and therefore vessel has a valid “Document of Compliance for International Sewage Pollution Prevention” issued by Bureau Veritas (Classification Society) on January 2007.

MBR Certification is attached.

Evaporator Distillate Water:

Vessel is fitted with two fresh water generator made by Serck Como (Germany) – Type MSF 400 –S. Distillate capacity is 400 m3 per day, utilizing steam only or using jacket water only or by means of any combination of both heat sources.

Pipelines:

The vessel systems that deliver influent to the wastewater treatment system area as follow:

- Black water system: toilets/ urinals/hospital- drain, sink
- Grey water system: sink, drain and baths, showers of the cabins/ suite/ accommodations
- Grey water system: sinks and drains of the galleys
- Grey water system: Pulpers
- Grey water system, Laundry sinks and drains
- Grey water system: Jacuzzis

On board pipelines have been made of following materials:

- Grey water – stainless steel
- Sewage – stainless steel
- Potable water system: machinery spaces/ bunkering – galvanized steel/ distribution system – copper
- Technical water – galvanized steel and copper

Source Reduction Evaluation Overview

Efforts under our plan will fall into one of two categories of activities, as a minimum:

1. Source Reduction of inflows to reduce introduction of constituents to the waste water stream
2. Technology Evaluation / Implementation to identify and install (as necessary) technology to reduce effluent concentrations.

It should be noted that technology solutions are not yet commercially available for application on a medium size cruise ship, and therefore at present there remains much uncertainty in the evaluation and potential implementation of such technologies.

Activities under each of these categories is described further below:

Influent Source Reduction Evaluation

A source reduction evaluation does include:

- **Cleaning Products, rodenticides, pesticides, other industrial products:**

Chemicals that are currently in use and may wind up in the wastewater system are as follow:

Chemicals

Description	Maker
Laundry Liquid Soft	Ecolab
Mikro Quat	Ecolab
Rinse Dry Drying - Agent dishwasher	Ecolab
Solid Power Dishwahr	Ecolab
Silver Fusion 3-4 lb	Ecolab
Super Trump	Ecolab

Laundry SL-2000	Ecolab
Laundry Starch	Ecolab
Laundry DeStainer	Ecolab
Laundry Softener	Ecolab
Laundry detergent	Ecolab
Bio Bright	Hepburn
Bio WC	Hepburn
Bio Scale Zapper	Hepburn
Bio ET Digestor	Hepburn
Bio Clean Technical	Hepburn
Solid Fusion 6-6	Ecolab
Metal Fusion 4-6	Ecolab
Mag Fusion	Ecolab
Eco San chlorine sanitizer	Ecolab
Clean and Smooth Hand lotion soap	Ecolab
Balanced Fusion	Ecolab
Crystal Fusion	Ecolab

We are currently evaluating the benefits to reduce the level of ammonia in a stream by replacing the chemicals used in the main laundry as a washing softener. For good order the aforementioned list of chemical does not show tangible traces of heavy metals in the ingredients.

With regards to the group of halogens (fluorine/ chlorine/ Bromine/ Iodine/ Astatine), only chlorine and bromine are containing in the chemicals used on board. Specifically the chlorine(sodium hypochlorite) like the “laundry destainer” used in the main laundry, the “eco san” used in the laundry, galley and housekeeping. Meanwhile the sodium hypochlorite 14% used in the system such as: potable water system, grey & black water systems, swimming pool & Jacuzzi, wastewater system (MBR).

We are maximizing the usage of those chemicals containing halogens on board and latest figures for month of June 2008 went down to:

- Laundry destainer – 600 ltrs approx.
- Eco san – 350 ltrs approx
- Sodium hyp. 14% - 1300 ltrs
- Bromine 20 kg

The degreaser used for internal pipe cleaning are: Bio ET (Hepburn) on regular basis and the Bio Scale Zapper (Hepburn) on quarterly basis.

- **Drinking water supply:**

Vessel will be loading fresh water in Skagway, Juneau, Seward and Ketchikan.
The estimated average volume of fresh water bunkering is:

Skagway= 340 m³
Juneau= 530 m³
Seward= 810 m³
Ketchikan= 710 m³

Vessel carry out 600 m³ circa of potable fresh water embarked in Vancouver.

We are carrying out water analysis for ammonia/metals at the vessel intake with a minimum of one sampling prior the end of this summer season on each port that vessel is bunkering. Results are about to be received by Admiralty Env and they will be part of next SRE review due by October 30th 2008.

As part of this evaluation process, giving consideration that copper may be present in the fresh water bunkered in Alaskan ports, we have increased production of on board fresh water as an alternative

We decreased bunkering in ports, whilst awaiting for the potable water analysis results for level of ammonia and/or heavy metals. The two fresh water generators on board are currently producing 360 m³/ day each (average). The following additives are add to the potable water: Soda ash/ Acid/ Potable water stabilizer and chlorine.

The potable water tanks are internally coated with Jotun “epoxy tankguard 412” paint, which it is known to be a solvent free epoxy product.

- **Alternative cleaning products:**

Alternative chemical products available on the market research is currently ongoing.

- **Adoption of operational practises to reduce pollutant:**

Reducing ammonia by biological reduction, by means of increasing the wastewater retention on board and reduce the load on the MBR treatment as to maximise the wastewater treatment process of the unit have been implemented. This is possible due to the extensive capacity of ship’s ballast tanks.

The current mixing ratio of sewage and grey water influent before it is treated in the wastewater treatment system is – average ratio 5/95, already optimised as to not affect the effluent quality.

The MBR units (x2) are operating at a maximum daily flow rate lesser than 180 m³ per day/ per unit. This is well below the Manufacturer's max capability of 240 m³ each unit. Ship's tank capacity is designed to have a ballast system that could be used to ballast the ship or to hold grey water or treated grey water, for a total capacity of 2,717 m³. The wastewater holding tanks are all coated with Jotun "Epoxy Tankguard 412" paint. The coating is known to be a solvent free epoxy product.

Heavy metals reduction is achieved by continuous monitoring of the corrosion status of on board pipe work. On board the ship the potable water piping system is made of galvanized steel for the bigger diameters in the machinery spaces and copper piping for deck distribution.

In order to minimize the piping corrosion and to control the softness a potable water stabilizer made by UNITOR is dosed in the piping system.

Latest on board assessment by Chief Engineer show that no piping are in need to be replaced. Piping monitoring is already part of vessel planned maintenance system.

- **Substitution of non chemical methods for methods that involve chemicals:**

The purpose will be to identify potential sources of copper, zinc and ammonia as they may enter the waste water stream, and to investigate and implement means to reduce their presence in the influent to the Advanced Waste Water Purification Systems (AWWPS) on board. The major phases of this evaluation will be:

- Document influent to waste streams as potential sources:
 - Most significant cleaning or other chemicals in terms of volume and/or concentration of constituents
 - Source water evaluation
 - Other potential contributors**Ongoing – Further updates by April 2009**
- Evaluation and estimation of potential contributions from cleaning products or source water to copper, zinc, ammonia in the effluent?
Ongoing – Further updates by April 2009.
- Identification of potential product / source water substitution to reduce constituent concentrations or environmental loading.
Ongoing – Further updates by April 2009.

July 25th 2008 SRE Intermediate Review:

After comparing the first DMR Report carried out on May 25th with the second one completed on June 14th, it appears that the implementation on board of the ship of the aforementioned Source Reduction Plan is proceeding towards the 2010 effluent parameters compliance.

The metals detected in the waste-stream are in full compliance with interim G.P. Table 1 limits and specifically:

- Copper dissolved: 9.7 ug/L (7 times below interim table 1)
- Ammonia: 33 mg/L (almost three times less interim parameters)
- Zinc dissolve: 97.3 ug/L (more than twice less interim parameters)

Treatment Technology Evaluation

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. Therefore during the forthcoming months we will work with our AWWPS vendors "Hamworthy" as to evaluate additional treatment technologies as may be appropriate for reduction of these pollutants that are practicable for implementation in a cruise ship environment. Hamworthy will assist us on the refining process of best operational practices on board.

Hamworthy has initiated studies with UK Water Research Centre as to ascertain that the G.P. Table 1 limits can be consistently met in wastewater applications by an environmentally sustainable means and Hamworthy will continue to investigate applicable and proven technologies to satisfy the regulatory requirements.

We will envisage that the initial "treatment technology evaluation" work research by Hamworthy should be available **in the nearest future.**

December 15th 2008 SRE Intermediate Review:

As a result of the end of year review, our development plan as to advance towards the compliance with the G.P. Table 1 limits – 2010 will unfold as follow:

- 2009 On board fresh production will increase to its max production, whenever feasible.
- Fresh water bunkering in Alaskan ports. After reviewing the water analysis for dissolved metals, we will stop the bunkering in Ketchikan and we will evaluate the bunkering in Juneau on a case by case basis.
- On board pipelines for grey water/ sewage/ potable water system/ technical water are continuously checked and replacement carried out whenever was found necessary.
- Ecolab chemicals used in the main laundry appears, to this point and date, to contain the lowest level of ammonia thus far. Therefore further maximizing of the usage of those chemical listed in the SRE will take place on board. We will continue to pursue for alternative chemicals anyhow.
- We will continue to utilize the MBR with a maxing ratio of sewage and grey water influent before it is treated to – average ratio 5/95.
- We will further regulate the operations of the laundry activities on board as to maximize the usage of chemicals.

As far as treatment of Technology Evaluation work research by Hamworthy, no data have been made available thus far.

After comparing all the DMR Report carried out during the summer 2008 aforementioned Source Reduction Plan is proceeding towards the 2010 effluent parameters compliance.

The metals detected in the waste-stream are in full compliance with interim G.P. Table 1 limits and specifically:

- Copper dissolved 4.7 ug/L
- Ammonia: 9.9 mg/L
- Zinc dissolve: 47 ug/L

Overall results are getting very close to achieve the compliance with 2010 and we are constant monitoring the waste stream effluents for further reductions on ammonia and heavy metals levels. In the meantime we are awaiting for any Technical evaluation data by the AWWTS Manufacturer's.

April 15th 2009 SRE Intermediate Review

We have received following updates form the AWTS Maker – Hamworthy – regarding latest attainment and future strategies for the compliance with the GP Table 1 effluents parameters.

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As far as the Heavy Metals toxicity, a few technologies were reviewed, including ultra-pure water technologies such as RO, EDR, an Ion-exchange resin bed. However Maker stand is to address the issue at the source, to its best and practical extend.

For the Ammonia toxicity maker reviewed a few technologies inclusive of:

- Ion exchange – zeolite and resin bed
- Advanced oxidation
- Ammonia stripping
- Bio augmentation to a MBR designed for BOD removal

Hamworhty stand: BNR process is believed to be environmentally friendly and sustainable way forward, although a ship trial is necessary.

Maker’s informed us that investigation of the efficiency and stability of this BNR process is currently on going and trial is scheduled to be completed by year end.

This time frame will allow maker to:

- risk assessment for ship operations
- allowed for on line flow measurement and quality instrumentation including ammonia and nitrate
- allowed for simple yet robust BNR configuration
- allowed for various test scenarios to conclude efficiency and reliability of a BNR process

unquote

From an Operational perspective, the development plan prepared at the end of year 2008 is in place and ready for this forthcoming season.

Constant monitoring of the waste stream effluents for further reduction on ammonia and heavy metals is applied, inclusive of shore-side analysis of the effluents parameters, with satisfactory results. In addition to regular maintenance/ controls carried out by Chief Engineer on board, the MBR Plant is checked and functionality verified by Maker’s technician on regular basis.

Best Management Practices on board includes the reduction of the most significant cleaning or other chemicals in terms of volume and/or concentration of constituents; minimization of environmental loading on board. As far as chemicals used on board, the list mentioned in the SRE can be considered a suitable management practice for this vessel towards the compliance with the GP Table 1 effluents parameters.

Further updates from a technology perspective will follow as soon as they are made available by Hamworthy.