Appendix A: 2010 Ocean Ranger Verification Project

During the 2010 cruise season Ocean Rangers received additional assignments besides their daily reporting duties. These additional verification projects were assigned to confirm compliance with environmental laws and to obtain additional information regarding the vessel's systems and operations in relation to the environment. The Ocean Rangers received questionnaires to verify the items. The average time spent on each verification project by Ocean Ranger was approximately 2-4 hours. The project set up was similar to 2009, and was designed to minimize the time impacts with the crews.

According to the Ocean Rangers this project was generally well received by on-board crews, who in some cases assisted the Ocean Rangers in completing the projects. In most cases, the cooperation from the on-board officers was also good. The findings of the verification projects were discussed with the crew and officers. In general the Verification Project was very successful. DEC obtained significant recent up-to-date "vessel system intelligence" that was not previously made available to DEC. The obtained 2009 and 2010 information is extremely helpful to better understand the vessels environmental operations.
This specific vessel system understanding will be useful for future training of the Ocean Rangers and communication with the Ocean Rangers on board.

The following verification projects were conducted in 2010 by the Ocean Rangers:

- Large Cruise Vessels Verification Project Fuel Systems and Related Operations;
- Large Cruise Vessels Verification Project Propulsion / Power Systems;
- Large Cruise Vessels Verification Project Potable Water BW & GW Flows;
- Large Cruise Vessels Verification Project Waste Handling and Food Dewatering Operations;
- Large Cruise Vessels current status / progress on AWTS Technologies and Operations to reduce Ammonia on Alaska trade vessels;
- Large Cruise Vessel Experimental Pilot Project Exhaust Gas Scrubber;

Large Cruise Vessels 2010 Verification Project Fuel Systems and Related Operations:

This project included verification of the on-board information with regard to fuel treatment, used fuel type, fuel / oil sludge handling and fuel consumption. A total of twenty five large cruise ships were surveyed. This project included a specific checklist. A summary of the Ocean Ranger findings is summarized in Table 2.

Cruise ships with a relatively short duration in Alaska (the *Pacific Venus, Nippon Maru, and* the *Asuka II)* were not included in this project.

Ocean Ranger reporting included the following findings:

- All vessels had fuel tank plans and detailed information available regarding tank location, tank identification, tank volumes and fuel oil sludge storage strategies.
- Oily water, bilge waters, etc. are treated by advanced Oil Water Separation Systems (OWS)before overboard discharges are conducted (if permitted);
- All oily water, bilge water etc. operations are recorded in the Oil Discharge Logs.
- Sludges from fuel oil and spent lubrication oil is collected and is offloaded to shore facilities;

- Some vessels do have combustion equipment (e.g. Oil Fired Boilers) that is capable of burning fuel sludge blends (mixes). It appears that in 2009 some vessels did use sludge / fuel blends (mix) to fire in the oil fired boilers.
- Most vessels have automated tank sounding equipment to determine fuel tank volumes and tank status.
- All vessels have fuel monitoring systems to monitor and record fuel conditions and fuel consumption.
- All vessels that have diesel engines for direct propulsion, diesel electric propulsion use residual fuels (e.g. Heavy Fuel Oil (HFO) and or Intermediate Heavy Fuel (IFO)) as primary fuel, the distillate fuel (e.g. Marine Diesel Fuel (MDO) and or Marine Gas Oil (MGO)) are used in Gas Turbines, emergency diesel equipment, tender /lifeboats and often as pilot burner fuel at incinerators and oil fired boilers.
- When fuel switches for the diesel engines are made in certain areas, the vessels switch from HFO fuel type to a more clean burning MDO fuel type.
- Ocean Rangers reported that some vessels switched over form HFO fuels to more clean burning diesel fuels (MDO / MGO) while approaching port or while in Port, in particular Juneau and Skagway.

All vessels provide fuel treatment to their fuel. The major bunker ports are Vancouver and Seattle WA. During the fuel bunkering process the fuel will be sampled for fuel quality, and samples will be stored on board. The fuel treatment onboard consists of the following processes: 1) fuel settling, 2) separation of water and particles from fuel (centrifuges), and 3) fuel filter process (strainers) after these processes are completed is ready for use fuel used in the combustion sources. The sludge, water and other contaminants that are removed from the fuel by the treatment process is separately treated by settling in settling tanks processed by the oil water separator (OWS), and/or off loaded to shore processing facilities (e.g. fuel sludges). Oily waters and fuel sludges are not found by the Ocean Rangers to be comingled in the treated waste water stream, or comingled with waste water for discharges outside of Alaska. The storage tanks for used lubrication oil, sludges, and water / sludge removed by the fuel separation processes are stored in dedicated tank systems. The volume of sludge produced by the vessels is a function of the type and quality of the fuel that is treated (HFO MDO), the majority of the sludge is "produced" by the separation (centrifuges) process. Table 2 includes average sludge production volumes per day for the average sludge production from fuel treatment and lubrication oil treatment (separation process).

During the fuel treatment process the fuel is heated to obtain the fuel viscosity for optimum fuel treatment, this is particularly the case with HFO treatment. Before the fuel is combusted (used) HFO fuels need to be brought up to and maintained at correct temperature to achieve a viscosity of the fuel to achieve proper combustion. Fuel treatment and fuel temperature (viscosity) control are two main components to achieve proper and clean combustion of these fuels. Whereas improper HFO and MDO fuel treatment will lead to deterioration of fuel combustion equipment (injection equipment) and affect the opacity performance on the long term, the HFO fuel temperature control will affect immediately opacity performance of the combustion equipment.

With regard to fuel switching, from HFO fuel to more clean burning MDO fuels, it was observed that when the vessels perform fuel switches, these switches were predominately done in the Port of Juneau. Fuel switches were also observed in the Port of Skagway. It should be noticed that regardless of whether "clean burn fuels" are used or not, good operating practices still needs to be exercised to reduce the potential risk of exceeding the State standards for visible emissions. Some vessels did not use / or limited their use of their

diesel engines operated on HFO fuels, but instead operated their Gas Turbine Generator(s) (MGO fuel) while docked. It should be noted that there is no State regulatory requirement to perform in Alaska fuel switches while in Port or at sea. Ocean Ranger were informed by the vessels that did fuel switches, that these fuel switches to MDO / MGO were performed, to reduce, to minimize the visible emissions from the vessel exhaust while docked.

Unitor® Fuel Homogenizer System (UFH) was used on the *Rotterdam* to reduce emissions from the diesel electric generators (main engines). The UFH equipment injects water, up to 10%, into the HFO fuel stream to the engine (after the day tank which contains treated fuel). According to the crew this system will reduce the NOx emission and reduce soot and particles. It appears that there has been no additional maintenance items related to this water injection, but proof will be in the long term results. According the Ocean Ranger reporting there was to date no additional pump, injector or main engine component failure attributed to this water injection system.

TABLE 2
Summary Fuel and Related Operations

Large Cruise Vessels involved in this project	25
Large Cruise Vessels fuel treatment on board (settling /separation/ filtration)	25
Total Large Vessels fuel switch from HFO to MDO in Alaskan Port 1)	8
Total Large Vessels operated Gas Turbines MDO in Alaskan Port	4
Range *Average* Fuel sludge production originated from fuel treatment m3/day 2)	1 - 5
Range *Average* Lubrication Oil sludge production originated from Lubrication Oil treatment m3/day 3)	0.5-1

Note:
1. Fuel switch from HFO fuel to MDO while docked, was predominately done in the Port of Juneau on vessels that performed fuel switches;
2. Sludge Production is indentified as volume Range. Average number dependant on fuel type / quality and treated fuel volume. The most surveyed vessel does produce fuel sludge volumes in the 1-3 m3/day range. Note some vessels included their lubrication Oil treatment originated sludge into the fuel treatment sludge volume.
3. Some vessels include the sludge volumes from lubrication oil treatment in the fuel sludge production volume. On one particular vessel was a high daily volume of lubrication oil treatment sludge reported, potentially caused by vessel transfer operations to new owners / operators.

Large Cruise Vessels 2010 Verification Project Propulsion / Power Systems:

This project included verification of the on-board information with regard to propulsion and power systems. A total of twenty four vessels were surveyed. One vessel did not provide detailed information, so complete surveys are obtained from twenty three vessels.

This project included a specific checklist. A summary of the Ocean Ranger findings is summarized in Table 3 on the next page.

Cruise ships with a relatively short duration in Alaska: the *Pacific Venus, Nippon Maru, and* the *Asuka II* were not included in this project.

The surveyed vessels all have some sort of combustion equipment installed for power generation, propulsion and auxiliary equipment. In 2010 there were no primary steam powered (steam turbine) cruise vessels operated in Alaska. In general the power needed for the "Hotel Power" and propulsion power is often generated by the same power plant. The power plant may consist of five distinctive main groups with regard the primary source of equipment used to generate power (simplified).

The Ocean Rangers identified the following (per main group) combustion sources on board of the vessels:

- Diesel engines;
- Gas turbines:
- Oil fuel fired steam boilers;
- Incinerators; and
- Emergency combustion equipment for power generation.

Ocean Rangers also identified also certain "power categories", the large cruise vessel power needs can be categorized into:

1) Propulsion power: power electric or mechanical power to turn the propellers, to move the vessel. Therefore propulsion power is only needed to make the vessel "move". Note that the propulsion power is not a 'constant" power need it depends how fast the vessel sails and if docked (propulsion off).

2) Power needed for the passengers / quests and crew. This is identified as "Hotel Power". While "Hotel Power" is more or less a 'constant' power demand (kW) as it does not generally vary to a large degree between the at sea operations and port operations (docked). However Ocean Rangers observed differences in hotel power while docked or underway. This difference may lay in the fact that certain functions (e.g. air-conditioning and ventilation, lights, etc) are utilized differently when people are off vessel while it is docked. Hotel power can be identified as the power needed to provide power (for lights, air conditioning, etc.) for the passengers and crew.
A major "Hotel power" consumer on board on the large cruise vessels are the Heat Ventilation Air Conditioning (HVAC) systems and lights.

Table 3 include an overview of the average power needs of the vessels while at sea or docked.

With regard to the propulsion power and power generation on large vessels we can identify the following power generation arrangements (simplified):

- <u>Group I Diesel electric power generation power plant</u>: Primary electric power is generated by diesel engines (generators (DG)). Electric power can be used for propulsion power (electro motor drives the propeller) and electric power for the hotel power needs. This power arrangement set up is the most commonly used power generation arrangement in the Alaska trade vessels;
- <u>Group II Diesel electric power generation with Gas Turbine electric power generation power plant</u>: Primary Electric power generated by diesel engines (generators (DG)) and may used for propulsion power and hotel power. The Gas Turbines electric generators (GTG) can also be used for propulsion power and hotel power as a "secondary" power generator. In most cases the Gas Turbine is used to augment the propulsion and hotel power. This vessel power arrangement is also used in cruise ships that visit Alaska, albeit not so common.
- <u>Group III Diesel direct propeller drive with diesel electric power generation power plant:</u> Diesel mechanical power drives direct (through gearbox) propeller. Diesel electric generators (DG) provide electric power to the (electric) Hotel power needs. This vessel power arrangement is used on a few vessels in the Alaska trade[1].

[1] One vessel had installed electric driven boost motor on propulsion system to "boost power". The electric power for the boost motors are provided by the diesel electric generators.

- Group IV Gas Turbine electric power generation with Diesel electric power generation power plant: Primary Gas Turbines electric generators provide electric power to the propulsion motors (electro motors drive the propeller), and for the hotel power needs. Recent developments in fuel costs, lead to installation of more fuel efficient diesel electric generators which can be used as a "secondary" power generator. This vessel power arrangement is used on a few vessels in the Alaska trade, to minimize the gas turbine use and related high fuel costs in partial load operations.

The Ocean Ranger included fuel consumption rates. It should be noted that the total fuel consumption of the vessel is largely dependent on the vessels speed, particular power needs and the sea conditions. Therefore these fuel consumptions should be seen as "rough ballpark" values, in relation to the vessel operations. It was also identified that most vessels provided their daily (24 hrs) fuel consumption averaged over the time the vessel was sailing in Alaska waters. The in port fuel consumption is not easy to quantify, because the fuel consumption is also dependant on the duration the vessel is in port. The average fuel consumptions cannot be pinpointed solely to the diesel electric generators and gas turbines, although compared relatively small volumes some fuel is also use in the oil fired boilers, incinerators etc. Table 3 include a few examples of vessels fuel consumptions under sea and dock (port) conditions, typical for the Alaska trade.

The Ocean Ranger reporting included the following findings:

- Most vessels have diesel electric power generation power plant arrangements for propulsion and hotel power
- Vessel actively fine tune their operations to reduce fuel consumption and thus related fuel costs. In particular vessel speed and vessel route can lead to large fuel consumption savings. Even relatively minor vessel speed reductions will significantly reduce the fuel consumption compared to the higher vessel speed;
- The largest hotel power consumer is the HVAC systems;
- One vessel (Oosterdam) had a Gas Turbine installed on board, but did not operate it in the 2010 season.

TABLE 3
Summary Verification Project Propulsion Power Systems 2010

Large Cruise Vessels participated in this project [1)]	24
Vessel Power Generation Categories Overview	
Group I Diesel electric power generation power plant total vessels	13
Group II Diesel electric power generation with Gas Turbine electric power generation power plant total vessels	7
Group III Diesel direct propeller drive with diesel electric power generation power plant total vessels	3
Group IV Gas Turbine electric power generation with Diesel electric power generation power plant total vessels	2
Hotel Power Generation Average in MW	
Large Vessel Small class vessel 250-499 pax range In Port Hotel Power Range MW At Sea Hotel Power Range MW	 0.55 – 1.3 0.7 -1.5
Large Vessel Medium class vessel 1200-1500 pax range [2)] In Port Hotel Power Range MW	 4.0 -5.9

At Sea Hotel Power Range MW	4.0 -5.9
Large Vessel Large class vessel 1501-2250 pax range [3)] In Port Hotel Power Range MW At Sea Hotel Power Range MW	 5.4-7.8 5.0-7.2
Large Vessel Titan class vessel 2251-2650 pax range [4)] In Port Hotel Power Range MW At Sea Hotel Power Range MW	 6.5-12.7 7.0-14.5
Typical Fuel Consumption [5)]	
Large Vessel Silver Shadow 250-499 pax range In Port fuel use HFO MT Range MT/day [6)] At Sea fuel use HFO MT day @ 19 kts speed MT /day	 Not provided 85
Large Vessel Zuiderdam 1200-1500 pax range In Port fuel use HFO MT Range MT/day At Sea fuel use HFO MT day AK voyage MT /day	 20-43 165
Large Vessel Island Princess 1501-2250 pax range In Port fuel use HFO / MGO MT Range MT/day At Sea fuel use HFO MT day AK voyage MT /day	 28 / 35 [7)] 150
Large Vessel Celebrity Infinity 2251-2650 pax range In Port fuel use MGO MT Range MT/day [8)] At Sea fuel use MGO / HFO MT day AK voyage MT /day [9)]	 23 85/50

Note:

1) Total 25 vessels surveyed one vessel was non-responsive.
2) One vessel in the Medium Class range reported to Ocean Ranger that the Port and Sea Hotel power was in the 9.0–10.0 MW range. This appeared high, and was not included in the table.
3) One vessel reported relatively low power demands at sea /docked (Celebrity Mercury). Ocean Ranger could not provide the Hotel Power ranges from the Oosterdam, Zuiderdam.
4) Hotel Power data was not provided by the Ocean Ranger on the Sapphire Princess
5) Fuel consumption is based on "ball park" numbers and is for rough identification purposes only. Fuel consumption depends and typical vessel speeds, sea conditions, among other factors.
6) Fuel units in Metric Tons MT (2,204 lbs).
7) When Gas Turbine is operated an additional 35 MT MGO-fuel is used.
8) Celebrity Infinity gas turbines generators using MGO and diesel electric generators using HFO. In Port is MGO fuel consumption identified.
9) Fuel consumption at sea 85 MT for the Gas Turbine (MGO) and 50 MT for the diesel electric generator (HFO).

Large Cruise Vessels Verification Project Potable Water Blackwater (BW) Graywater(GW) Flows:

This verification project consisted of two separate subjects related to water operations and discharges:

- Potable water operations and consumption; and
- AWTS Process wastewater (WW) handling.

For this project was a questionnaire developed. A total of twenty five vessels were surveyed. One vessel (*Rotterdam*) did not co-operate so it was not possible to obtain a completed survey.

The cruise ships with a relatively short duration in Alaska (the *Pacific Venus, Nippon Maru, and* the *Asuka II)* were not included in this project.

All of the large cruise vessels operated in the 2010 season had potable water systems and waste water treatment systems installed on board. Some of the vessels did have Advance Wastewater Treatment Systems on board but decided not to utilize these installations in the 2010.

<u>Potable water Consumption Project:</u>

Vessel Specific Sampling Plans (VSSP) include an estimate of the waste water volumes produced and processed. The VSSP document is only required for vessels that seek authorization to discharge in Alaskan waters. This verification project surveyed the water consumption on board and how produced and consumed water flows are handled. In general potable water on board is used from three possible sources:

- Potable water from evaporator systems: Overboard water (sea water) is desalinated to make "distillate" water for potable water use. This is done in evaporator units on board. Waste heat and/or steam is used to provide the heating energy to the evaporator for this process
- Potable water from Reverse Osmosis Units: Overboard water is desalinated by a reverse osmosis process to make potable water. This system uses selective membranes which allow water to pass through.
- Potable water from shore based sources (bunker water): Water from trusted sources such as city utilities are bunkered (loaded) from the city water system into the vessel potable storage water tanks. These operations are done when the vessel is docked.

There is on some vessels another source of water, although this source is not used for potable water purposes. Technical water (TG)is water that is captured from air conditioning process and/or treated water from wastewater processes. It is used on some vessels in laundry and toilet flush operations. This project did not include technical water items. ADEC may include this item in future verification projects.

Ocean Rangers reporting included the following findings:

- All vessels had potable water savings regimes in place;
- Potable water quality / volumes / consumption rates are meticulously kept and monitoring records are available on board. Most vessels have these records in electronic format;
- The average drinking water use (tons/day) reported on board is compared to what the vessels included in their VSSP document;
- The potable water use depends on the passenger load. It appears that the vessels are on average close to their maximum passengers load and thus the average potable water consumption stated in the VSSP appears to be representative for the Alaska season.
- Some vessels use Technical Water in dedicated systems operations, but it is not used as potable water.

Table 4 includes a concise summary of the vessels including the Potable Water volumes and Monitoring operations. Note that the passenger potable water use, include also the use by the crew, although this is not separately identified. Some vessels did not include in their reporting documentation the crew volumes; in these cases ADEC estimated the crew volume. For the 2011 Alaska cruise season ADEC intend to obtain the volume of crew members; this for the specific vessels that have not reported their volume of crew members in the 2010 season.

TABLE 4
Summary Verification Project-Potable water and BW GW Flows-

Potable Water Consumption 1)	
Total Vessels participated	24
Large Vessel Small class vessel 250-750 pax range Average use ton/day range Average use per passenger ltr/day range Water used monitored recorded	 262.5-330 242-390 2) Yes
Large Vessel Medium class vessel 1200-1500 pax range2) Average use ton/day range Average use per passenger ltr/day range Water used monitored recorded	 400-483 3) 191-260 3) Yes 3)

Large Vessel Large class vessel 1501-2250 pax range Average use ton/day range Average use per passenger ltr/day range Water used monitored recorded	 695-945 230-287 Yes
Large Vessel Titan class vessel 2251-2700 pax range Average use ton/day range Average use per passenger ltr/day range Water used monitored recorded	 552-1010 [4)] 160–297 [4)]

Notes:

1. Based on vessel average volumes ranges over long term data (Alaska trade). On vessel in the 550-750 pax class, the Royal Princess (710 pax) reported water consumption on average 262 ton /day range, 242 ltr/ day range per passenger water use.
2. Note: Volume per passenger includes ADEC estimated crew volume.
3. Note: Rotterdam data was not included / available.
4. Potable water consumption volume (low range) (Celebrity Millennium) appears low. Rhapsody of the Seas did not report the potable water consumption.

Waste water treatment BW and GW Flow and Operations:

Vessel Specific Sampling Plans (VSSP) include an estimate of the waste water volumes they produce, and the hydraulic waste water treatment capacity of their AWTS systems. Cruise ships permitted for discharge provide the VSSP every cruise season to ADEC for review and approval. Besides the sample location and discharge point location the VSSP include a general description of the used Advanced Wastewater Treatment Systems (AWTS) and information with regard to the waste water tanks location and capacity used on board.

This survey included three main elements:

- Identification which GW and BW are processed / or not processed;
- The actual average volume of waste water (BW/GW) that is treated by the AWTS system and in relation to the AWTS "name plate" capacity (utilization factor);
- Process AWTS data in particular the BW GW ratio influent; and
- Handling of the biosludge and food dewatering waste waters.

For this project we divided the waste water stream in three major flows / streams:

- I Black Water (BW): Originated from toilets and urinals. This volume is a relatively small waste water volume compared to other waste water streams, but contains a high volume of nutrients and solids.
- II Graywater (GW): Originated from showers, baths, sinks, galleys, laundry operations, etc. Because the GW composition is related to the origin for this project we divided the generated GW streams in three general volume flows:
    - GW Accommodations: GW generated by the guests sinks, showers, bathes, the "Hotel" part of the waste water stream;
    - GW Galley: GW generated by the vessels food operations, food preparations, food handling etc. from the galleys.
    - GW Laundry: GW generated by the laundries for guests and crew.
- III Waste water flows / streams / de-water operations: Other waste water streams. For example pulper operations, pulper circulation water, pools spas, and Jacuzzi's. The pulper operations and dewatering operations are discussed in more detail in "Verification Project waste handling and food waste dewatering."

The Ocean Ranger survey included a questionnaire including detailed questions of the waste water treatment operations.

Ocean Ranger worked closely with the vessel to obtain representative volume data on the waste water streams. The gathered information was reviewed by the vessel and the results were subsequently discussed with the Ocean Ranger. On some vessels was it difficult to obtain specific waste water treatment and handling information. One vessel (a non discharger) did not cooperate in providing any information on their waste water operations.

Most vessels comingle their waste water blackwater (BW) and graywater (GW) and process this mix in their AWTS system. Most vessels do not have accurate volume data available of the GW or BW other than the volume in the influent GW BW mix tank. However, the Ocean Rangers and vessels were able to gather some relatively accurate field volume data that was in line with the reported VSSP BW and GW generated volumes. On most vessels it is still difficult to measure accurately the exact volumes of BW and GW generated as the flows are not metered individually.

Ocean Rangers reported that some vessel AWTS systems were equipped with influent volume monitoring systems, so GW and BW volumes could be accurately tracked (AWTS system use (gallons per day treated)), and the AWTS treatment process is more closely monitored.

In 2009 Ocean Rangers identified that some vessels comingled pool water with the influent of the AWTS. In this survey it was not identified if vessels continue these practices.

Tank gauging / tank level reading automation and recordings assisted the Ocean Rangers in identifying the GW and BW volumes. Discharged waste water volumes logged in the Discharge Log are derived from the tank readings, or the volumes from tanks (intake) of the AWTS process. There are also vessels that do not comingle the BW GW waste water in their treatment process (such as the Carnival Spirit).

In the Source Reduction Evaluation (SRE) reporting in 2008 and 2009, it was identified by AWTS manufactures and the vessels (operators) that the main factor in the ammonia exceedances in the effluent was caused by a unfavorable BW GW ratio (process setting of "mixing" the AWTS influent volumes). The Ocean Rangers found that the majority of vessels did not have process controls or actively controlled the BW/GW ratios. Most vessels had a "fix set" of the influent flow of BW and GW and are not actively controlled to optimize the AWTS treatment process to improve performance on ammonia in effluent. The BW/GW ratio is extremely important to maintain a satisfactory effluent performance, in particular for ammonia.

The Ocean Ranger reporting included the following findings:

- All discharged treated waste water stream mixed GW and BW except for the AWTS system of the *Carnival Spirit*.
- The estimation of the produced / generated volumes of GW and BW is done in most cases by using tank gauging and tank monitoring data over a long periods of time. If volumetric meters are used these readings /recordings were used.
- A few large vessels appear to treat through AWTS system almost all of their generated BW/GW.
- Not all vessels meter their volumes processed by the AWTS systems in a consistent way. Some meter the effluent volumes, but these metered volumes may not include re-circulated volumes or different influent sources.
- Some vessels have "advanced" GW BW volumetric meter system installed on the AWTS system. This system monitored and recorded influent volumes into the AWTS systems. All other vessels did not have volumetric metering on the intake of the AWTS system.
- It appears that all vessels do not treat their entire waste water streams; in fact most vessels do GW stream segregation. Some vessels do not treat GW galley water / GW laundry water / GW Pulper water / and other waste water flows like food dewatering water.
- The Ocean Rangers identified that most vessels that did discharge in Alaska water did not utilize 100% of the available hydraulic capacity of the AWTS system. In other words on most of the vessels

the entire WW stream is not treated in Alaska. Only relatively a small volume of the produced waste water (GW and BW) is processed by the AWTS on some ships

- The BW and GW ratio before waste water processing in the AWTS was by a majority of the operators *not* (actively) controlled or even known. A few vessels did have BW GW ratio process controls and could provide information regarding this item. It should be noted that the vessels / and AWTS manufacturers identified in the SRE reporting in 2008 2009 that the AWTS effluent performances is largely affected by the GW/ BW ratio.
- Some vessels collected the biosolids for incineration, off loading or discharging outside the waters of the State of Alaska (distance > 12 nm).
- Not all vessels provided information with regard to their average biosludge volumes generated.

<u>Discussion Items GW BW items [See Table 5]:</u>

Table 5 includes a summary of the GW and BW Flow /Operations project, this summary provide an overview of the results the Ocean Rangers obtained on board on an "average Alaska Cruising day".

Waste water production is largely dependent on the number of passengers and crew; a lower passenger load could reduce the generated BW and GW volumes. However, the impression was that in 2010 the vessels were (or close to) fully booked. As a result the volumes appear to reflect a "high" passenger load, and reflect in most cases the BW and GW volumes that were reported in the VSSP documents.

Ocean Rangers tried to identify which volumes from which operations of the BW and GW waste streams were not processed in the AWTS system(s). This was more difficult than initially was thought, some vessels and corresponding VSSP documents identified waste streams which are not processed. In particular the GW galley and laundry water waste streams and some dewatering (although a small volume) are in most cases not processed.

In some cases it appears that time pressure was present and the Ocean Ranger could not always obtain a clear picture with regard to the WW volumes which were generated and which part of the total generated WW volumes were volumes were processed by the AWTS system. Most vessels do not meter (volumetric) influent of the AWTS system, nor could identify accurately the technical water volumes.

It is extremely difficult to establish the real / actual volumes waste water that is processed by the AWTS. However, in the 2008 Source Reduction Evaluations (SRE), one operator provide detailed volumes of GW and BW processed by the AWTS. Table 5A includes a concise overview of this 2008 information.

Not processed waste water means that the waste water flow is not treated by and AWTS systems to meet the effluent requirements as set out in the State of Alaska General Permit (GP). For discharge outside Alaska the waste water –may be treated to meet IMO regulations, which are significantly less stringent than the Alaska's requirements. Based on what the Ocean Ranger found on board, the VSSP estimated generated GW and BW volumes appears correct in most cases.

Some vessels, especially the non dischargers (discharge outside the State of Alaska waters) did not cooperate or provided incomplete waste water (volume) information. Table 5 includes the "average Generated BW / GW for AWTS", this is waste water volume that is processed in the AWTS. Please note that BW and GW is comingled in most systems, so when the BW component of this volumes is not identified (NI); it is included in the reported GW influent volume. The Carnival Spirit treated only a part of their generated GW volumes through their AWTS system In Alaska, although it was the entire volume that was discharged in Alaska.

Some discharging vessels, especially in the "Large Vessel Medium Class 1200-1500 pax range" estimated in their 2010 VSSP documents "average and maximum" BW and GW volumes. There are the volumetric

differences between the average and maximum estimated volumes large as of 60 m3/day (e.g. Statendam 2010 VSSP BW).

For the purpose of this particular project; the vessels are divided into "classes" based on the number of passengers carried; please note that this is done for this project (clarification purposes) only.

TABLE 5
GW BW Flow Project 2010
Preliminary Overview

GW and BW Flow / Operations Project [1]				
Total Vessels selected for participation				25
Total Responsive Vessels				18
Large Vessel Small class vessel 250-750 pax range				
Vessel / Discharge Status	**2010 VSSP**	**OR 2010 Verification** [2]	**AWTS**	**AWTS** [3]
	Average Estimated BW / GW [m3/day]	**Average. Generated BW / GW for AWTS [m3/day]**	**Treated Total Volume [m3/day] / AWTS capacity [m3/day]**	**Total Volume GW BW treated volume %/ AWTS capacity %**
Royal Princess / D	**30/ 310**	**NI/ 230**	**230/ 240**	[9] **/ 96**
Seven Seas Navigator / D	**20/ 230**	**20/ 200**	**220/ 360**	**88 / 61**
Silver Shadow / ND	**25/ 225**	**NI/ 288**	**Not used**	**Not used**
Large Vessel Medium class vessel 1200-1500 pax range [3]				
Vessel / Discharge Status	**2010 VSSP**	**OR 2010 Verification** [2]	**AWTS**	**AWTS** [3]
	Average Estimated BW / GW [m3/day]	**Average. Generated BW / GW for AWTS [m3/day]**	**Treated Total Volume [m3/day] / AWTS capacity [m3/day]**	**Total Volume GW BW treated volume % / AWTS capacity %**
Amsterdam / ND [4]	-	-	-	-
Oosterdam / ND [4]	-	-	-	-
Rotterdam / ND [4]	-	-	-	-
Ryndam / D	**60/550** [5]	**NP**	**NP**	**NP**
Statendam / D	**100/ 550**	**NI /478**	**478 / 660**	**73 / 72** [6]
Volendam / D	**60/ 575**	**68 / 343**	**411 /660**	**65 / 62**
Zaandam / D	**40/ 495**	**NI / 400**	**400 /710**	**74 /56**
Large Vessel Large class vessel 1501-2250 pax range				
Vessel / Discharge Status	**2010 VSSP**	**OR 2010 Verification** [2]	**AWTS**	**AWTS** [3]
	Average Estimated BW / GW [m3/day]	**Average. Generated BW / GW for AWTS [m3/day]**	**Treated Total Volume [m3/day] / AWTS capacity [m3/day]**	**Total Volume GW BW treated volume %/ AWTS capacity %**
Carnival Spirit / D	**90/980**	**85 / 980**	**202 / 740** [7]	**20 / 27**
Zuiderdam / ND	-	-	-	-
Sea Princess / D	**80/ 720**	**NI / 429** [8]	**429 / 452**	**60 / 95**
Mercury / ND	-	**800 /NI**	-	-
Large Vessel Titan class vessel 2251-2700 pax range				
Vessel / Discharge Status	**2010 VSSP**	**OR 2010** [2]	**AWTS**	**AWTS** [3]
	Average Estimated	**Average. Generated**	**Treated Total Volume [m3/day]**	**Total Volume GW BW treated**

	BW / GW [m3/day]	BW / GW for AWTS [m3/day]	/ AWTS capacity [m3/day]	volume % / AWTS capacity %
Coral Princess / D	**200 / 910**	**NI / 446**	**446 / 640 8)**	**48 / 70**
Golden Princess / D	**240/1125**	**122 / 756**	**878 / 960 8)**	**78 / 91**
Island Princes / D	**200 / 910**	**NI / NI**	**NI / 640 8)**	**NI /NI**
Celebrity Infinity / ND	**-**	**110 / 690**	**-**	**-**
Celebrity Millennium / ND	**-**	**-**	**-**	**-**
Radiance of the Seas / ND	**-**	**-**	**-**	**-**
Rhapsody of the Seas / ND	**-**	**-**	**-**	**-**
Norwegian Pearl / D	**100/ 1000**	**100/ 1000**	**915/ 1780**	**83/ 51**
Norwegian Star / D	**60/ 1035**	**60/ 1035**	**1035/ 1400**	**100 / 74**
Diamond Princess / D	**220/ 1010**	**NI / 1010**	**724 / 960**	**58 / 78**
Sapphire Princess / D	**220/ 1010**	**NI / 287**	**287 / 960**	**23 / 30**

Notes:

Abbreviations: D=Discharging Vessel ND=Non Discharging Vessel NI=Not identified NP=Not provided by vessel.

1) ADEC assumption is that the vessels that did not include their crew volume, these volumesare included in the total reported GW volumes or separately in the BW and GW volumes (if applicable). For discharge in Alaska waters the AWTS systems must be used (to meet GP WQ limits). Royal Princess (710 pax), average GW generation (includes) BW 230 ton
2) Ocean Ranger surveyed the average GW and BW volumes daily on board. In most cases the average GW BW volumes are in line with the estimated reported volumes in the 2010 VSSP documents.
3) AWTS treated means AWTS used to meet the GP standards, discharge in AK waters. Most vessels comingle BW and GW in AWTS process. Total discharged flow include GW and BW mix. Vessels that did report reported the total flow GW.
4) Note: Rotterdam data was not included / available. The GW and BW volumes for the Amsterdam, Oosterdam, Rotterdam, and Ryndam, were not available for OR to check onboard.
5) 2010 VSSP include min. and max. volumes, max. 2010 VSSP volumes listed.
6) AWTS percentage % calculated by using max BW volume 2010 VSSP.
7) Carnival Spirit treated GW only, selected stream (accommodation).
8) GW flow separation, GW flow of laundry galley not treated discharge > 12 nm or off load. BW include in GW flow.
9) Royal Princess total BW and GW generation (2010 VSSP) is > the maximum reported AWTS capacity. (e.g. BW GW generation total 340 m3/day / AWTS max. capacity of 240 m3/day).

TABLE 5A
2008 SRE Fleet Reported
GW BW Flows 2008
Overview

2008 SRE Fleet Reported				
Total Vessels included SRE Evaluation				6
Large Vessel Medium class vessel 1200-1500 pax range				
Vessel / Discharge Status	**2008 VSSP**	**2008 VSSP**	**AWTS Volumes SRE Reporting**	**AWTS**
	Average Estimated BW / GW [m3/day] 2)	**Total Average BW / GW for AWTS [m3/day]**	**Treated Total Volume [m3/day] / AWTS capacity [m3/day]**	**Total treated Volume GW BW % / AWTS capacity %**
Ryndam	60 / 550 1)	610	243 / 700	39.8 % / 34.7 %
Statendam	40 / 470	510	165 / 660	32.3 % / 25.0 %
Veendam 3)	40 / 470	510	395 / 710	77.5 % / 55.6 %
Volendam	40 / 495	535	373 / 710	69.7 % / 52.5 %
Zaandam	40 / 495	535	469 / 710	87.6 % / 66.0 %

Large Vessel Large class vessel 1501-2250 pax range				
Vessel / Discharge Status	**2008 VSSP**	**2008 VSSP**	**AWTS Volumes SRE Reporting**	**AWTS**
	Average Estimated BW / GW [m3/day] 2)	**Total Average BW / GW for AWTS [m3/day]**	**Treated Total Volume [m3/day] / AWTS capacity [m3/day]**	**Total treated Volume GW BW % / AWTS capacity %**
Westerdam 4)	60 / 660	720	134 / 650	18.6 % / 20.6 %
Typical Average WW volume % treated by vessel AWTS 5)				54.3 %

Notes:

1) Ryndam VSSP 2008 Revision: 2.
2) VSSP Reported in average Volume estimate (m3/day).
3) Veendam was not in AK waters 2010 season.
4) Westerdam was not in AK waters 2010 season.
5) For the 2008 SRE reported HAL Fleet (conservative volume).

The Ocean Ranger reporting included the following findings:

- It is very difficult to obtain accurate, in depth information with regard the GW BW and technical water operations on board. Most volumes are calculated from tank records or discharge logs.
- In general the Ocean Ranger found that the BW and GW volumes as listed in the VSSP were close to the generated volumes observed on board.
- Most vessels do not monitor and or record their GW BW volumes treated / processed by their AWTS systems.
- It appears that some vessels did have influent volume monitoring systems but did not use them or were not in operable condition.
- Some vessels do have detailed records / reports on the WW volumes generated and off loaded include the associated operation costs.
- The vessel that are authorized to discharge are not processing their 100% generated BW and GW volumes through the AWTS, it appears that the WW volumes that are processed (treated) by the AWTS is significant lower.

It is recommended to include this verification project in future cruise seasons, in order to obtain more up to date volume and volume treated information to understand waste water operations better.

Large Cruise Vessels Waste Handling and Food Waste Dewatering verification Project

This verification project consisted of three subjects related to water operations and discharges:

- Solid waste handling related to the overboard waste chute system;
- Chemicals use in dry cleaning (laundry) operations; and
- De-watering process operations of food waste.

For this project a questionnaire was developed. A total of twenty five vessels were surveyed.

The cruise ships with a relatively short duration in Alaska: the *Pacific Venus, Nippon Maru,* and the *Asuka II* were not included in this project.

Garbage Waste Handling Overboard chute system: All of the large vessels operated in the 2010 season had Garbage Management Plans and conducted their garbage management operations according to this plan. Large vessels reported their off loading actions of non hazardous and hazardous wastes.
The chutes for the vessels that have them are used to dispose of non hazardous materials (food wastes, bones etc.) outside Alaska waters (e.g. > 12 nm). In Alaska waters these chutes are not used and a chute locking regime is in place. When these chutes were operated the actions and specifics about the operation and volumes disposed (volumes, time / date / location) are recorded. Some operators do have chutes installed, but decided not to use them or to use in the "Alaska trade", in these particular cases the chute covers were sealed and/or welded shut. Table 6 provide an overview of the solid waste handling in relation to the overboard chutes.
Dry Cleaning / Perc Chemicals (Tetrachloroethylene C_2Cl_4): Most of the large vessels do not use the dry cleaning chemical Perc anymore. A few vessels that to do use Perc chemicals have procedures and plans in place. Spent Perc is collected and kept in dedicated storage areas. The Perc material is included in the Hazardous Waste management Plans and off loading actions are reported to the State. Also observations of the Ocean Rangers identify that spent Perc is off loaded (disposed off) to shore based facilities outside Alaska. Table 6 includes a concise overview of the Perc use on the 2010 season fleet. Some vessels use a "wet cleaning" processes instead the dry cleaning process, the new processes are using more with environmental friendly cleaning products (e.g. Citrus wet cleaning, Smart wet etc.).

Dewatering operations of food wastes: All vessels generate food waste; this food waste has water content that is extracted from the food waste. Food waste is screened and reduced in the pulper (pulped). The slurry is pumped to water extractors (de-watering); the extracted water is re-circulated to the system, and is kept in dedicated tanks. The solids are kept in "food waste silos" and disposed of outside Alaska waters (e.g. > 12 nm). This disposal can be by disposal of the solids through the chute system, or direct pumping the dewatered food waste (slurry) from the dedicated tank / food silo to the overboard piping system. The piping of the food waste system, pulper, piping etc. are on a regular basis cleaned (with hot water). This cleaning water is kept in separate holding tanks for discharge outside Alaska waters (e.g. > 12 nm). Some vessel store this water in the bio solids holding tank. However, some vessels with the Somat system use the water and processes this in the AWTS system. Table 6 provides an overview of the food waste handling operations on board.

Table 6 Overview
Waste handling PERC Dry Cleaning
Food Waste de-watering

Waste handling / Chemical use Dry Cleaners /Food waste Handling	
Waste Handling Chute Installations	
Total Vessels participated	25
No chute system installed	2
Chute system installed but not used	3
Chute system used outside AK /Garbage Management / Records	22
Dry Cleaning / Perc Chemicals used	
Total Vessels participated	25
No Perc chemicals used	16
Perc Chemicals used Dry Cleaning operations	9
Perc chemicals handling / Haz mat handling / off loading regimes	9
Dewatering Operations of food waste	
Total Vessels participated	25
Vessels Food waste system de-watering (solids water) [1]	25
Vessels Dewater water discharged > 12 nm	25
Vessels Dewater water processed through AWTS system	4
Vessels Food waste solids discharged > 12nm [2]	25
Vessels Food waste solids incinerated [3]	6

Notes:

1) Most vessel have a "combination" of handling dewater water operations; pending location and their operations.
2) Vessels discharge solids / slurries from holding tanks overboard / and or use chute operations to discharge the solids.
3) Some vessels use their incinerator to dispose of the food solids; sometimes in combination with the discharge of the solids.

Large Cruise Vessels 2010 season status / progress on AWTS Technologies / Operations to reduce Ammonia

Vessels that operated under the 2008 State of Alaska Large Cruise Ship General Permit (GP) that were granted interim limits were required to submit Source Reduction Evaluation Plans (SRE). The SRE plans included actions taken by the vessels to minimize ammonia and metal concentrations in their effluent. In 2008 and 2009 vessel operators were required to submit SRE plans and updates detailing work and planning on effluent pollutant reductions.

On April 22, 2010 ADEC issued a new State of Alaska Vessel General Permit (GP), this new issued GP did not include an SRE requirement, nor did it include requirements to continue to fine tune, explore operation improvements to reduce the metals and ammonia in the effluent.

<u>Ammonia reduction trial Norwegian Cruise Line [Scanship AWTS]:</u>

Norwegian Cruise Line (NCL) continued (voluntary, as no such permit requirement exist) to work on their AWTS system and operations, as they initially identified in their 2008 SRE reporting.

In 2010 NCL kept actively working on their AWTS systems and operations to improve the effluent (reduce ammonia levels) with tangible results. The Ammonia sample results in 2010 In particular the Norwegian Cruise Lines demonstrated that a combination of AWTS system upgrades and process changes as were identified in their initial SRE report were continued and completed in the 2010 season.

Below is a brief overview of the SRE project continuation in 2010 as reported by the Ocean Rangers on the Norwegian Star:

- NCL made numerous AWTS (Scanship) process changes and operational changes. At the time of this project (September 2010), there were visible equipment fine tunes and Scanship engineers were working with NCL on test runs on the modified / improved AWTS system. Overall impression was that NCL did what they promised to do in their 2008 and 2009 SREs.
- End of season Status: AWTS installation in "test run" mode. Appears that NCL will finish these tests, and the vessel will operate with improved ammonia values in the effluent.
- The installation (AWTS) is complete and appears in good order.
- NCL identified that the WW storage capacity on the vessels are limited, therefore they process almost their entire WW volume trough the AWTS system while in Alaska waters.

It appears that on many of the other cruise vessels not much progress was made. Some work was done, but a structural operational change from the start of the 2010 season, especially in potable water sourcing / control did not appear to be implemented. This was identified in the 2009 season as well. Implementation and on-board efforts are crucial to the continuing success in reducing ammonia and metal levels.

We noted that some operators / vessels, in particular the NCL appeared to continue in the 2010 season to pursuing the SRE goals and promises, and worked to reduce the ammonia and metal loads in the effluent.

Ammonia reduction trial Princess Cruise Lines [Hamworthy AWTS]:

Princess Cruise Line (PCL) continued (voluntary, as no such permit requirement exist) to work in 2010 season on their AWTS system and operations, as they initially identified in their 2008 and 2009 SRE reporting.

According to reporting to the Ocean Ranger, the Golden Princess started ammonia reduction trails after the shipyard visit in 2009. In the 2010 season Princess developed the idea to implement to use the former MSD II and unit MBR No. 5 as pre-treatment unit for mixed and gray water before entering MBR No. 3. This set up was not a success because the MSD II (Trident unit) could not handle the flow (peak times). In 2010, just before the Alaska season it was decided that a new approach was needed. The implementation includes the MBE No. 1 used only to treat black water, and the use of MicroSolv 6001 additive. All of this was developed with close cooperation with the AWTS Vendor Hamworthy. Tank modifications were made on Tank 5, in order to improve the "pre-process" time and to support AWTS process. This Princess project appears solely to be focused on the reduction of ammonia in the effluent. Please note that under the new GP conditions the ammonia limits for the Hamworthy AWTS systems are the highest of all the categorized AWTS systems.

Below is a brief overview of the SRE project continuation in 2010 as reported by the Ocean Rangers on the Golden Princess:

- Princess worked on operational changes and used dedicated MBR units for particular waste stream.
- Until August 28, 2010 was the "additive" MicroClear 207" and "MicroSolv 600L" used. These additives are respectively to handle difficult organic process problems, and support, facilitate the nitrification / denitrification process.
- MicroClear-207 is a high impact grease digester, and can be help full to handle better processing of the waste streams. The MicroSolv 600L is to support the nitrification process.
- Tank 5 modifications were made, including an aeration manifold system, and tank re-coating. The tank blowers were installed and valves and other controls installed. MBR 3 modifications. Improvement that was made to the MBR No. 1 and 2. Also an ammonia measuring tool / instrument was installed.
- During the 2010 cruise season measurement and process fine tunes were made to find the optimum ammonia values in the effluent.

At this time the final results and further developments of the ammonia reduction project are not known. ADEC expects that PCL will provide more detailed up to date information for the upcoming cruise season in 2011.

Large Cruise Vessels Experimental Pilot Project Exhaust Gas Scrubber Project.

In 2006 Holland America Line (HAL) started the "exhaust gas scrubber pilot project". The technology evaluation projects goal is to evaluate the removal of Sulfur Oxides and particulates form the engine exhaust flows (stack emissions). A sea water scrubber was installed on board of cruise ship the Zaandam to treat (scrub) exhaust gas of one of the diesel electric generators (DG 5). The project was partially funded by, and performed in cooperation with, the U.S. EPA, Environment Canada and other local agencies, which formed a technical Advisory Committee (TAC) to oversee the project. In 2008 the Zaandam visited Alaska and scrubber test runs were conducted. In 2009 the Zaandam did not utilize the pilot scrubber in Alaska waters, nor did it appear that the scrubber project continued for that cruise season. In August 2010, the HAL informed ADEC that operation of the scrubber was allowed under the US EPA Vessel General Permit. The remainder of the 2010 season the scrubber was operated and HAL and the scrubber factory representatives obtained operational data including effluent sampling data.

In 2010 the Ocean Ranger reported:

- For the 2010 pilot project test an additional tank (residence tank) was installed, this tank used blue filter media;
- Soot that is separated out the scrubbing process is collected in the cyclone system and pumped into a separate soot holding tank;
- The estimated waste offload is to be expected to be a volume of one approximately 2 m3/per year;
- Hamworthy Krystal technical officials were on board to test the scrubber system;
- HAL performed sampling and monitored the effluent pH values.

HAL completed a season report of the 2010 pilot project results. A copy of the report is on file at ADEC.