Holland America Line

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November 17, 2009

Ms. Denise Koch
Program Manager,
ADEC/Division of Water CPVEC
410 Willoughby Avenue, Suite 303
P.O. Box 111800
Juneau, AK 99811-1800

RE: 2009 End-of-Season Pilot Study Evaluation Report

Dear Ms. Koch:

This is to transmit our End-of-Season Pilot Study Evaluation Report on the ammonia reduction project conducted jointly with Princess Cruise Lines on the Golden Princess. This is submitted pursuant to our approved Source Reduction Evaluation Plan of August 18, 2008 in which we committed to providing this update by November 15, 2009.

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.

Please feel free to contact me if you have any questions or concerns.

Sincerely,

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

WJM/jg
Attachments:

Attachment A - 2009 End-of-Season Pilot Study Evaluation Report
Attachment B - September 2009 Golden Princess Ammonia Removal Trial: Scenario 1 – Progress Report No. 2

Holland America Line End-of-Season Ammonia Reduction Pilot Study Report

This report provides a summary of the current status of the Ammonia Reduction Pilot Project jointly conducted by Princess Cruise Lines and Holland America Line in the summer of 2009. This report is submitted pursuant to the approved Source Reduction Evaluation plan submitted in August of 2008 and subsequently approved by the Alaska Department of Environmental Conservation. This report is based primarily on input from a review of ship-board operations conducted by HAL personnel on board the Golden Princess in Seattle in September of 2009, as well as an interim report provided by Hamworthy, the vendor, in September 2009 (see Appendix attached, Princess Cruise Line has already provided this report to ADEC as well).

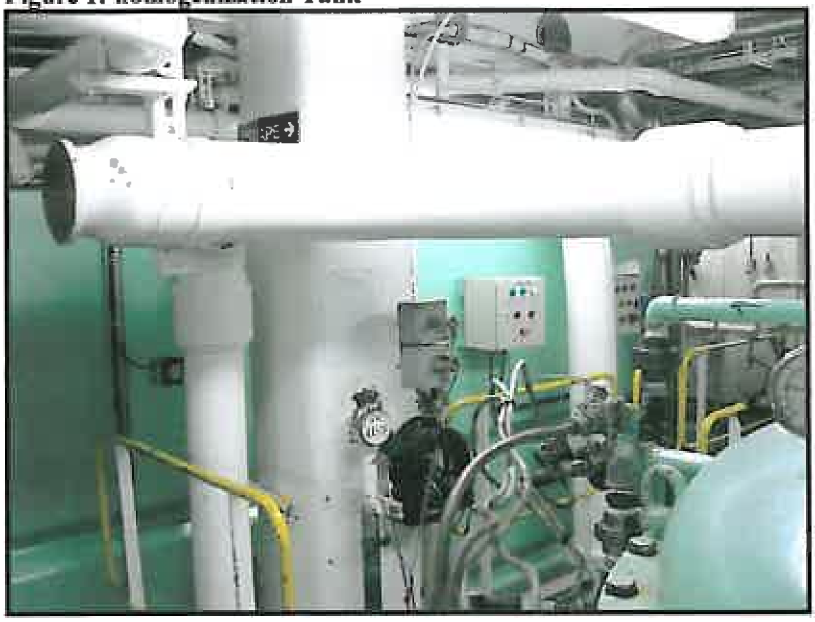
The pilot project equipment is installed on the Golden Princess. The project has been funded by Carnival Corporation, the parent company of both Holland America Line and Princess cruises. Golden Princess is equipped with three separate Hamworthy membrane bio-reactor advanced waste water treatment facilities, each with a designed capacity of approximately 280-300 m^3 per day. Preliminary influent and effluent characterizations were completed during Phase I of this project earlier this year.

The Golden Princess was modified during the May dry dock to allow commissioning of the system in June and July of this year. One of the Hamworthy units was converted for this pilot project. Installation included a homogenization tank, monitoring and control equipment, a two stage nitrifying tank, associated pumps, flow meters, dosing stations, pipes and alarms, visual control displays etc. The capacity of this system has been reduced from the above stated volume to approximately 80-100 m^3 per day. Operations were initially in the vicinity of 100 m^3 per day, with more recent experiments conducted at approximately 80 m^3 per day to evaluate the effect of longer residence time in the treatment unit. This highlights one of the fundamental trade-offs associated with this system: more complete nitrification-denitrification requires a longer residence time in the tank, thereby reducing treatment capacity for a given tank volume.

During the September ship visit, Mr. Wei Chen of Hamworthy described the current status of the system. The first stage of the process is to collect influent in the homogenization tank (referred to as "Tank 5" in the Hamworthy report). This was determined to be necessary during an earlier phase of this pilot project due to the unusual variation in influent throughout the day. In normal, land based applications, this is less critical as municipal systems typically serve a more diverse customer base, plumbing and sewer systems are larger, extending many miles throughout the community. This allows greater mixing and homogenization as the waste travels through the sewer system. Municipal sewage systems are immediately more dilute because they rely on gravity rather than vacuum based conveyance and therefore use more water for transporting the waste. As a result, the Golden Princess (GP) system is designed to manage the influent, targeting approximately a 2:1 gray water : black water ratio. Hamworthy representatives commented that the blending system is not that precise, and that there is some variation in their ability to achieve this idealized blend.

HAL representatives then took an equipment tour which first went to the homogenization tank (Tank 5). This tank is approximately 2.3 meters tall x 3.5 meters wide by 7.3 meters long comprising a volume of 59 m^3.

Figure 1: homogenization Tank



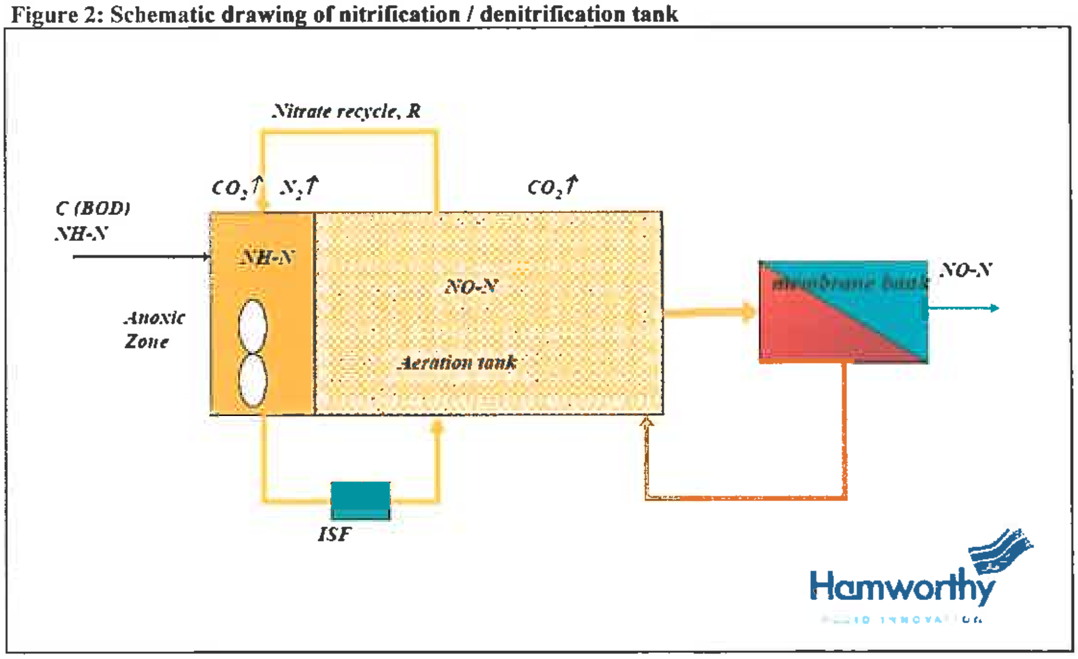
The mixing tank is operated to contain approximately 30 m^3 of mixed gray and black water.

Mixing is achieved with aeration, typically one minute of aeration followed by five minutes of no aeration (constant aeration could lead to foaming and a reduction of carbon source for the denitrification process). Influent has been found to settle at approximately 40° C, somewhat higher than the optimum of 25°C.

This tank is equipped with Membrane BioReactor (MBR) feed pumps, an aeration blower, in line monitoring (to determine influent ammonia content) and other associated equipment.

Once homogenized, mixed liquor is sent to the first stage of the Membrane Bioreactor (MBR) Plant, demonstrated in the graphic below.

Figure 2: Schematic drawing of nitrification / denitrification tank



This tank is partitioned into two stages: an anoxic zone and an aeration zone which manage a two step reaction:

$NH\text{-}N + O_2 \rightarrow NO_2^-$ (nitrite) $+ H_2O + H^+$ (by nitrosomonas)
$NO_2^- + O_2 \rightarrow NO_3^-$ (nitrate) (by nitrobacter)

The anoxic tank (including the "swing zone" which allows mixing between the anoxic and aeration tanks) measures 1.4 m x 3.5 m x 2.6 m ≈ 13m^3 while the aeration zone measures 1.8 m x 3.5 m x 4.7 m ≈ 30m^3. The combined dimensions of this tank are therefore approximately 1.8 m x 3.5 m x 7.2 m ≈ 45 m^3. Thus the combined foot print for the mixing tank and the MBR tank is approximately 50 m^3, not including auxiliary equipment such as pumps, monitoring equipment, etc.

Stage 1 is an anoxic stage (<0.3 mg/L dissolved oxygen) in which de-nitrifying bacteria convert nitrate and nitrite into nitrogen gas. This tank is equipped with a mixing pump to keep solids in circulation without aeration pumps, which supports bacterial digestion while maintaining the anoxic environment.

The second stage of this tank contains nitrosomonas bacteria and nitrobacter bacteria, which oxidize ammonia into nitrite ($N0_2^-$), and then nitrite into nitrate (NO_3^-). Mixed liquor is re-circulated from this section back to the first stage, to enhance nitrate removal. It is believed that if nitrobacter bacteria suffer, the system will 'accumulate' nitrites in the waste water – as has been experienced with Golden Princess. This may require a larger reactor, with longer sludge retention times. Conversely, a reduced flow through capacity would yield a longer sludge retention time with a lower treatment capacity.

Figure 3: pH adjustment chemicals

Both Nitrosomonas and Nitrobacters are slow growing and vulnerable bacteria, particularly when compared to the bacteria typically used to reduce Biological Oxygen Demand (BOD). As a consequence, these bacteria require more active control of their environment and a more stable influent (for example for pH). This requires the ability to monitor and adjust the mixed liquor – particularly for pH, to assure an optimum environment. The slow growing nature of these bacteria requires longer solids retention time to assure an adequate repopulation rate. If flow-thru is too rapid, populations will die-off and be wasted before their replacements can re-grow.

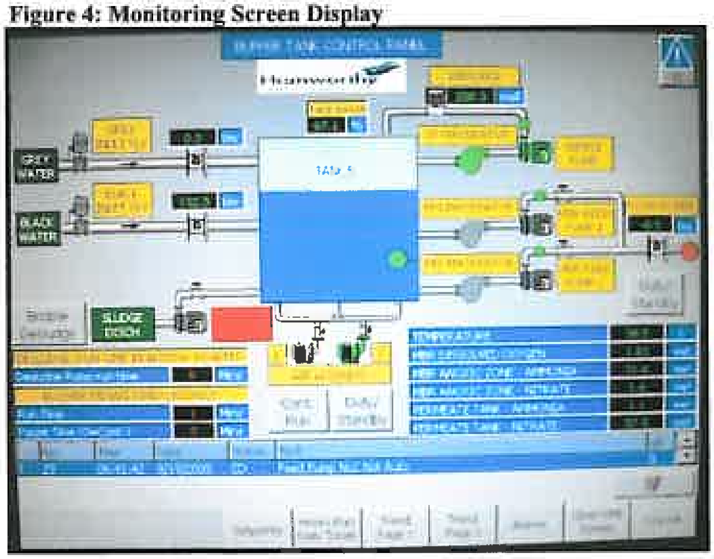
This would indicate that recovery from system upsets will take much longer than has been experienced with currently installed AWWPS systems that have thus far targeted BOD and TSS removal. A target of 15 days solids retention would thereby specify a wasting of approximately 6% solids per day.

Shipboard Monitoring:
Key measurements are:

Temperature (homogenizer and nitrifying tanks)	MBR Anoxic zone – Total Organic Nitrogen
MBR Dissolved Oxygen	Permeate Tank – ammonia, Total Organic Nitrogen
MBR Anoxic zone – ammonia	Permeate Tank – Total Organic Nitrogen

The below photo shows the on-line monitoring capability of the installed system.

Figure 4: Monitoring Screen Display

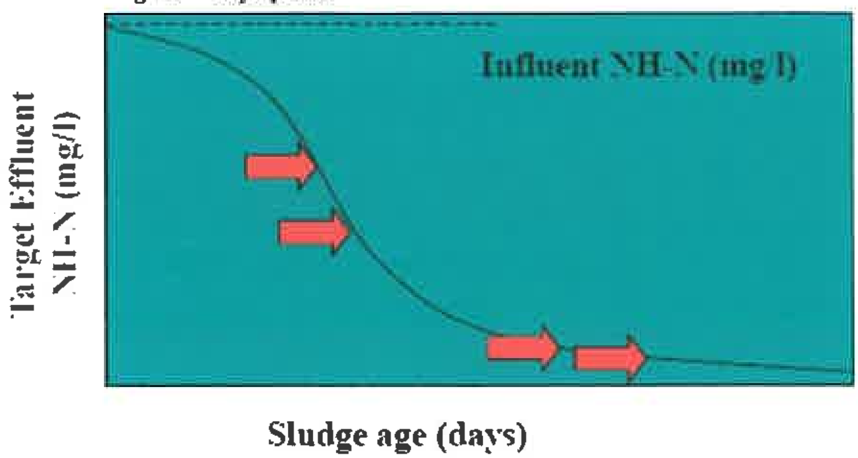


Additionally, shipboard sampling and analysis is conducted in a small field laboratory which uses a Hach-Lange DR2800 equipment to measure for ammonia, nitrate, nitrite, phosphorous, and COD. Ship-board training is required to educate the technicians on the use of this equipment.

Hamworthy Reports of Preliminary results
The consultant's report shares some results indicating significant reduction of ammonia concentrations, tempered by an apparent buildup of nitrites. It is noted that the system was not yet delivering ammonia reductions capable of meeting long-term limits required under the Alaska permit and in fact was yielding results *already* obtained by the Zenon systems installed on several Holland America Line ships. This is largely due to the much higher gray water to black water ratio treated in the Zenon systems.

With respect to influent concentrations, the consultant emphasized that the ammonia reduction process is asymptotic – i.e. reductions from typical influent concentrations experienced in this pilot of 1,000 mg/L to effluent values of less than 100 mg/l, (more than 90%), would not likely be repeated when attempting to reduce ammonia concentrations from, say, 30 mg/L to 2.9 mg/L (long term limit of the Alaska permit).

Figure 5: Asymptotic Ammonia Removal Curve



Next Steps

There will be continued refinement of the treatment process, along with experimentation on the sludge retention time, to determine whether further removal is achievable. Greater operational experience will also determine stability of the system, as well as other considerations. Increasing the ratio of gray water to black water to reduce influent concentrations will be of particular interest relative to HAL operations, as the blended effluent typically treated in HAL's Zenon systems is of much lower ammonia values than that of the Golden Princess.

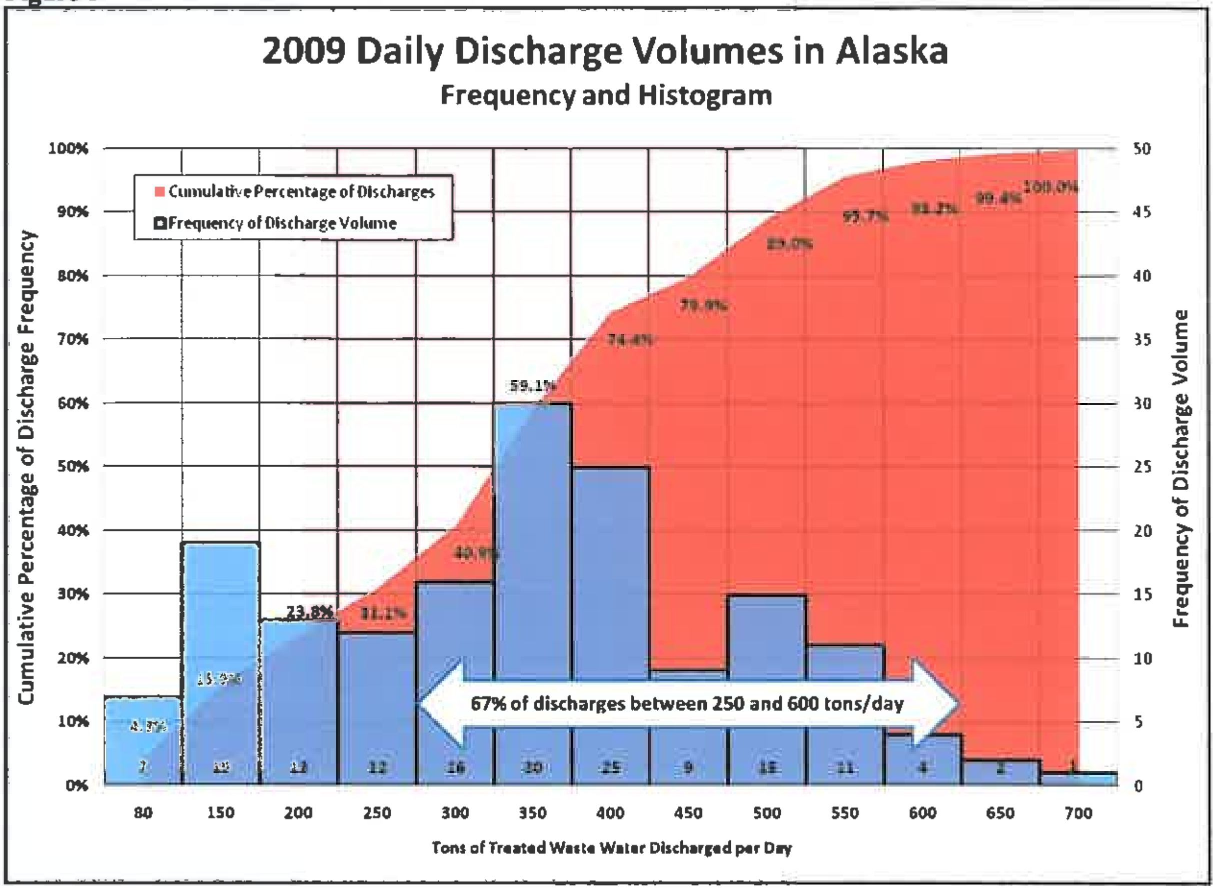
HAL Specific Issues

Required Treatment Capacity

The pilot project on the Golden Princess has treated only a portion of the daily waste stream generated each day. The mixing tank (Tank 5), associated equipment and nitrifying tank are sized to treat approximately 80 tons of waste water per day.

Although HAL ships are smaller, this capacity represents just a fraction of the waste water generated each day on R and S Class vessels. Based on data compiled for the 2009 season, the chart below shows the percentile for discharge volumes averaged between these two classes of vessels.

Figure 6



As indicated, a daily discharge of 80 tons or less of waste water occurred on less than 4.5% of the days in which HAL discharging vessels operated in Alaskan waters in 2009. These data include days in which discharges are restricted, such as in Skagway Harbor and Glacier Bay.

This is significant as most Alaska itineraries involve several consecutive days in Alaska state waters. This would necessitate accumulation of wastewater in tanks for discharge outside of waters subject to the long-term limits, with consequent requirements for increased sailing distance and speed. The result would be a considerable increase in fuel consumption / with associated emissions and expense.

Additionally, since the system has not yet achieved the long term permit limits on a pilot scale, we are unable to predict whether it can be effectively scaled to treat the 250-600 tons typically discharged per day. Continued study under the pilot program will be necessary to determine mixing tank requirements, or what modifications to our membrane bioreactors would be necessary.

Figure 7: Volendam Deck C Plan

Equipment Footprint

The Golden Princess pilot project highlights the need for additional tankage and equipment were this approach to be scaled up to address the full treatment requirement – particularly given the challenges presented by the need to homogenize the treatment influent. The mixing tank occupies a footprint of approximately 25 m^2. If this were to be scaled up linearly to accommodate a typical discharge volume of 400 tons, this could require as much as 200m^2 of tank footprint. Figure 7 provides a general arrangements layout of Deck C on Volendam – an R-class vessel that sails in Alaska. Obviously the required floor space can vary with changes in tank volumes adjusted by height, however mixing and aeration issues would need to be considered as well. Regardless, this gives an idea of the scale of space that must be identified in an already crowded engine room before a full scale implementation could be initiated.

The Golden Princess is a "Post-Panamax" vessel, meaning it will not fit through the Panama Canal. This is because the beam of the vessel is 118 feet and thus wider than the canal.[1] In comparison, All HAL vessels can pass through the Panama Canal with a beam of 106 feet or less. The implications for this are that HAL ships have a smaller foot print than is potentially available on the Golden Princess. Of course larger ships have their own floor space demands in the engineering spaces, and it is not our purpose to conduct a definitive comparison here, but the fundamental differences between the vessel dimensions is an important consideration.

Next Steps

At this writing it is inconclusive as to whether this ammonia reduction process will be capable of meeting the long-term limits of the Alaska permit. Hamworthy is planning to adjust the gray water/black water ratio to manipulate the influent ammonia levels to a lower concentration. As documented in our SRE submittal of January 2009, HAL's measured ammonia concentrations before treatment ranged between 69 and 150 mg/L – a variation believed to be caused by the percentage of graywater in the combined influent. Future work and success in meeting long-term permit limits given a lower influent concentration will dictate whether this technology proves feasible.

[1] The maximum dimensions allowed for a ship in transiting the canal are: Length-965 ft. (294.13m); Beam – 106 ft. (32.31m); Draft - 39.5 ft (12.04).

On Going Source Reduction Activities

In addition to the pilot program on the Golden Princess, HAL has committed to several initiatives under its SRE program including:

1. Strategic source water bunkering
2. Laundry water investigation (including Ozonator installation)
3. Water conservation
4. Enhanced Nitrification using additives to existing waste water treatment systems

These efforts are on-going and will be discussed in detail in the annual SRE report due January 14, 2010.

Attachment 3

Hamworthy

GOLDEN PRINCESS

AMMONIA REMOVAL TRIAL

SCENARIO 1 – PROGRESS REPORT No.3

September 2009

Hamworthy

Golden Princess Ammonia Removal Trial

Summary

Hamworthy carried out a further progress review on board from 12 to 19 September, by W Chen and K Cooksley. The purpose of the visit was to ensure that the trial was continuing with good progress and that all parameters were being maintained. Further adjustments were recognised during the visit, which will be highlighted in this report.

Personnel directly involved in the visit: Pietro Donato (Staff Engineer), Carmine Parisi (Hotel Engineer), Wilfredo Saavedra (1st Plumber), Hector Tapdasan (1st Plumber), Roy Van Acuzar (2nd Plumber) and Jovy Abellonar(Plumber). A review of the progress and the test results was carried out with Chief, Staff and Hotel Engineer, and separately with HAL representatives and Marin (Environmental engineer) on board on 19/09.

No.	Subject	Action
1	General Very good progress has been made, recognising the operational constraints and pressures ship's staff perform under, especially during the Alaska season. Snags and all previous actions in the previous update reports (Appendix B&C) were addressed. The process performance is far more stable than during July and August. Hamworthy appreciate the continued huge support by the ship staffs. There are factors to further lengthen the trial period, such as 1) the need to unblock the anoxic zone mixing pipe; and 2) MBR No.3 aeration diffuser maintenance requirement that will waste the nitrifying biomass, which will have to be re-established. Hamworthy encourages the PCL head office to review the technical progress and the trial results together with Hamworthy and the ship staffs, so that the targets and the outcome of Scenario 0 and Scenario 1 are implemented and understood to the best degree. Hamworthy will explore possible arrangement with PCL.	HWS
2	MBR No.3 Feed System and MBR Capacity The Feed Tank level was further increased to 70% to balance the ammonia fluctuations in the influent. The ratio between grey and black water, controlled by Feed Tank levels, is now deemed acceptable, with resultant ammonia concentration varied between 100 and 200 mgN/l. The attached graphs show the ratio of Grey to Black has been oscillating around the 2:1 from September. The difficulties of maintaining this ratio are also evident. Additional regulating hand valves may be provided to the black water feed line, if so required by any worsening of the ammonia fluctuations. MBR No.3 capacity was running at 90-100 m3/day during Sept., and any excess water was sent to MBR 1 or 2. The target is now 80 m3/day, to improve nitrification efficacy - considering the ammonia achieved so far is still nowhere near the GP limit. There will be no attempt to further reduce the feed flow, because this will render the solution further away from being feasible due to the required tankage. The detrimental impact of the increased flow to MBR No.3 during Mid August, as a result of MBR No. 1 planned maintenance, was all too clear in the graphs. The effluent reflected a significant increase in ammonia. The mixing air provided to Tank 5 was reduced to 1 minute on 5 minutes off, in order to reduce the aerobic biodegradation of carbon source in the wastewater (see note B in P&IDs). Carbon is needed for denitrification process in the Anoxic zone. This will be an interesting element to adjust in the future.	(HWS)

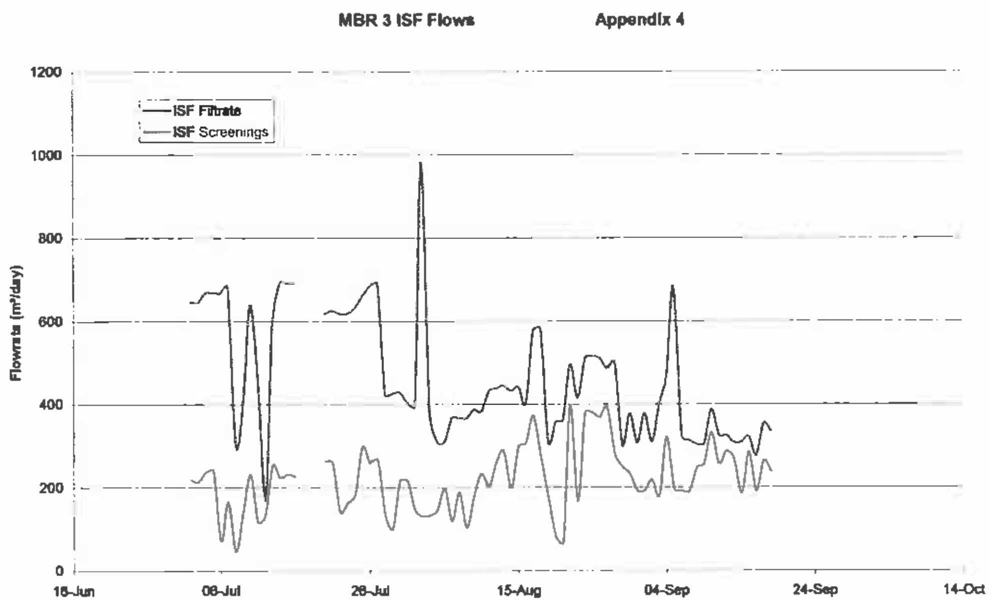
3	Mixing in the Anoxic Zones The mixing pipe in the Anoxic zone was evidently blocked. This renders the anoxic zone ineffective for denitrification process (see note C in P&IDs). Operators were encouraged to visually observed the mixing via the viewing hatch. Anoxic zones need to be emptied and cleaned. Detailed instructions were provided separately to the ship. The task will be done while en-route to LA. There is also a planned maintenance to MBR No.3 aeration diffusers in early Oct. The nitrifying biomass has to be wasted as there is no mean of transferring the biomass back from any holding tank. It will be a lengthy process to re-establish the nitrifying bacteria. Ship staffs may combine this task with the task above, so that the trial system is ready from the first LA cruise.	Ship Ship
4	Dissolved Oxygen (DO) in the aerobic reactor DO has now increased to 1.5-2.0 mg/l which is satisfactory. The spray nozzles to the Anoxic zone were closed during the visit to reduce the amount of entrained air (and the associated DO in the spray water) into this zone (see note A in P&IDs). The nozzles may be turned on if there is evident of foaming or scum build-up in the anoxic zones.	
5	ISF flows The ISF Filtrate flow has been set to 300-350 m3/day. This is acceptable. Screening flow cannot be reduced further. This element is considered less important, and will not be pursued further. The filtrate pump flow may be attenuated in order to improve the nitrate return into the anoxic zone. At present, the filtrate flow (less permeate production) is batched into the anoxic zone. By throttling filtrate pumps, the batch flow into anoxic zone will have less flow rate, but over a longer duration. This shall in theory improve the process. This element may be investigated in the near future when conditions are ready.	(HWS/ Ship)
6	Sludge Age The sludge age is currently maintained at 21 days, by a daily desludge of 6% of the second stage ($2.02m^3$). Although this is in theory sufficient, a longer sludge age may be attempted in the near future aiming to improve process stability.	(HWS/ ship)
7	Preliminary comments on on-line Instrumentation Comparisons between the on-line measurements and the laboratory test results were made, as shown in the attached graphs. During July, the figures showed significant discrepancies in permeate ammonia. The discrepancy reduced after the sensor was calibrated at the end of July. However, the calibration had to be repeated at the end of August. A calibration on ammonia probe takes 1 to 2 hours. Greater uncertainties were found with ammonia probes in Tank 5, and in Anoxic zone. The probe in Tank 5 requires daily cleaning to prevent blockage, the probe in anoxic zone has to be cleaned 3 times per week. The NOx probe in the permeate tank is performing reasonably stable, although there is a level of discrepancy to lab results. The NOx probe in the anoxic zone was proved in-effective. Much effort (and expenses) had been made to this probe in the past 2 months. Hamworthy sourced a second probe with 1mm sensor spacing to replace the previous probe (with 2 mm spacing). The outcome was not positive. For future applications, it may not be recommendable to use NOx probe within a MBR bioreactor.	

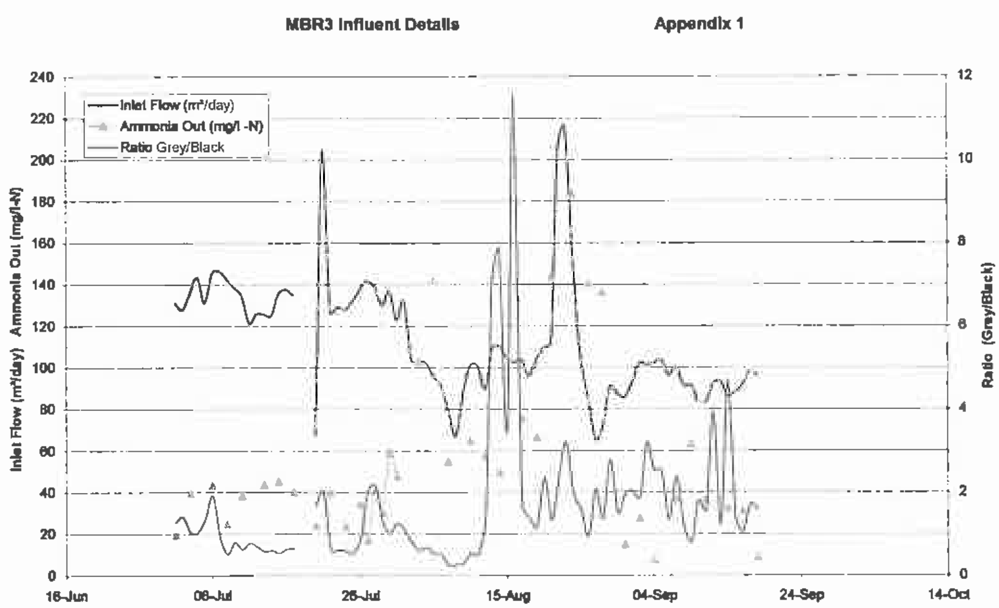
Hamworthy

	It can also be concluded that the reliability of ammonia and NOx probes are reasonably satisfactory for process indication, but may not be reliable enough for compliance purpose.	
8	Resources and training With the support by PCL, Jovy Abellonar will extend his contract to Jan 2010. A new 1st plumber is also allowed to over lap with the existing crew. Hamworthy encouraged the ship staffs to take increased interests in the daily trial results. A set of training material on biological nitrification and denitrification was distributed to Chief, Staff and the Hotel Engineer. Allowance of an additional technical resource on board was considered by Hamworthy. No conclusion is drawn at present. Setting aside the issue on funding of such resource, Hamworthy believes it is useful to continue the trial with realistic resource input that typical to a cruise ship operation. CCP may be consulted on the subject.	HWS
9	Performance analysis It is still early days, as the process is just starting to stablise. The attached graphs clearly indicated the gradual process of improvement, including - the feed flow rate being stablised towards 80-100 m3/day - the grey to black mixing ratio being stablised towards 2 - the DO being increased to 1.5 – 2 mg/l - the mixing tank (Tank 5) level being increased to 70% (not shown in the graph) - the ISF filtrate flow being reduced towards the target set in Scenario 0 - etc., The above improvements were made with great efforts from the ship staffs, in a period longer than we anticipated, but Hamworthy agrees that this is a true reflection of the operational constraints and pressures ship's staff perform under, especially during the Alaska season. Good nitrification and denitrification processes were observed, albeit not yet reliable. Specially, during the running in September, significant nitrification can be seen, along with relatively low effluent ammonia levels. There are signs of uncertainties such as indicated by a high nitrite level. This could be due to unfavourable conditions to certain nitrifying bacteria.	

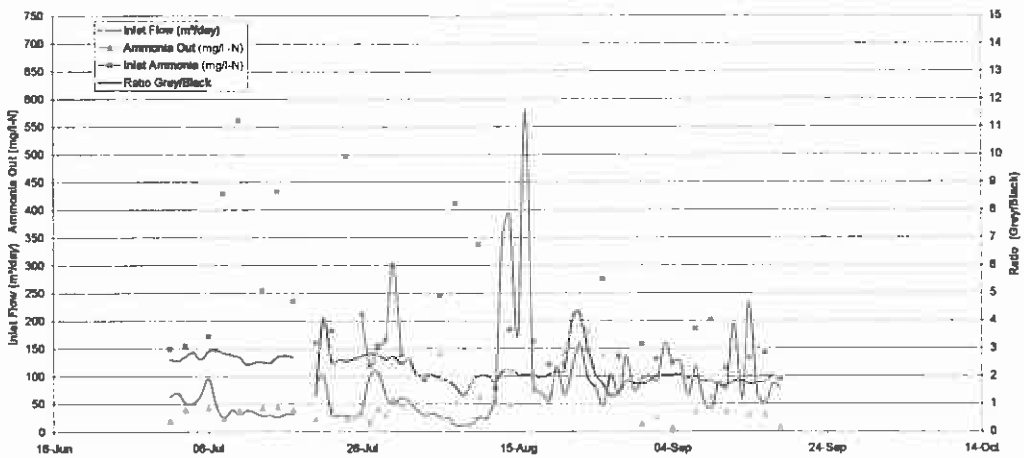
(K Cooksley/W Chen 22-09-09)

Hamworthy

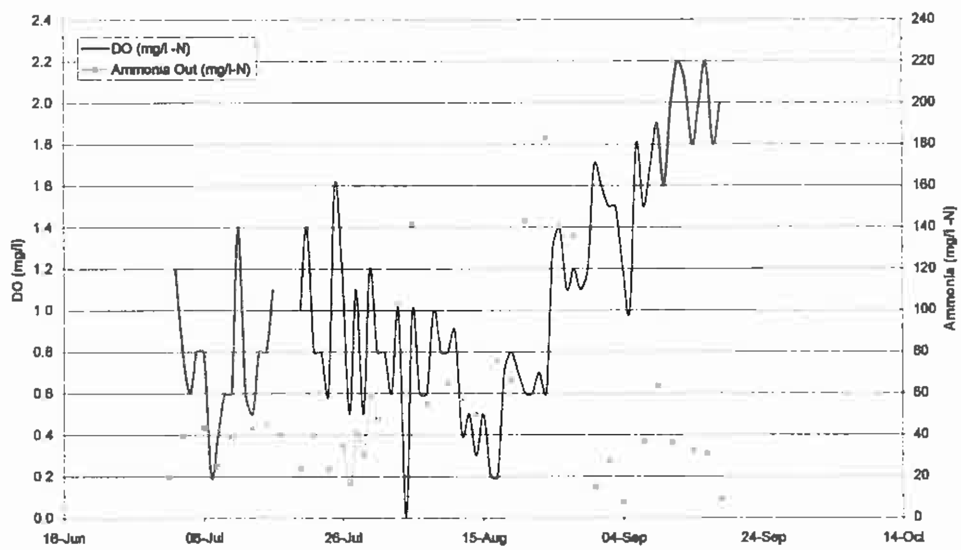

MBR 3 ISF Flows
Appendix 4
ISF Filtrate
ISF Screenings
Flowrate (m³/day)
1200
1000
800
600
400
200
0
16-Jun
06-Jul
26-Jul
15-Aug
04-Sep
24-Sep
14-Oct


MBR3 Influent Details
Appendix 1
Inlet Flow (m³/day)
Ammonia Out (mg/l -N)
Ratio Grey/Black
Inlet Flow (m³/day) Ammonia Out (mg/l-N)
Ratio (Grey/Black)
240
220
200
180
160
140
120
100
80
60
40
20
0
12
10
8
6
4
2
0
16-Jun
06-Jul
26-Jul
15-Aug
04-Sep
24-Sep
14-Oct

MBR3 Influent Details **Appendix 1b**

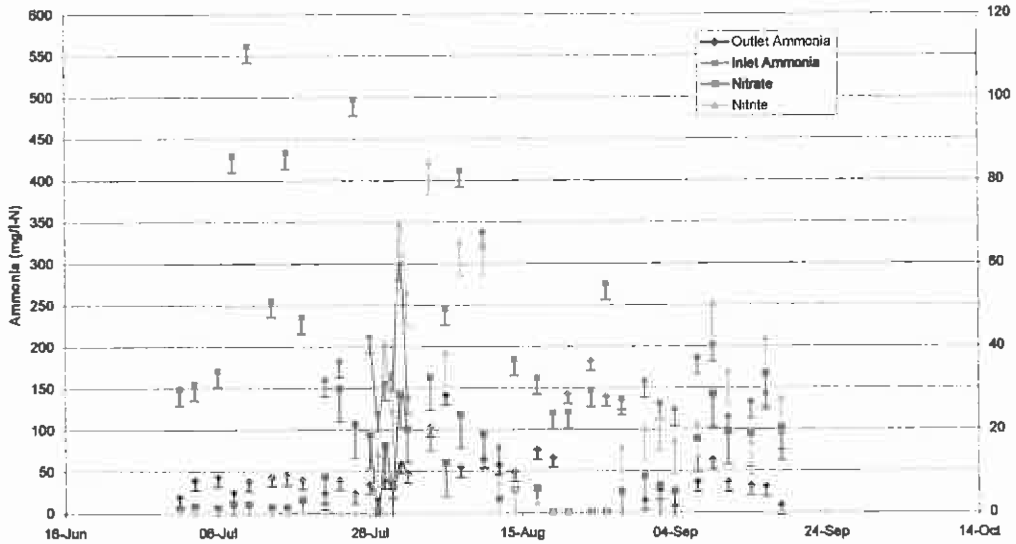


MBR 3 DO **Appendix 2**

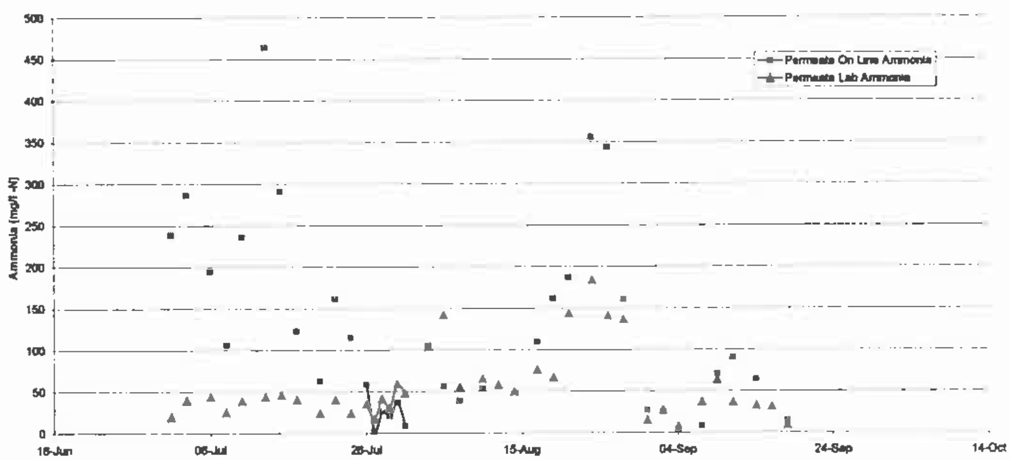


Hamworthy

MBR 3 Permeate/ Influent Appendix 3b



MBR3 On line Comparison Appendix 5



Hamworthy

Appendix C: Scenario 1 Progress Report No. 2

Hamworthy carried out a further progress review on board on 28/08/2009, by W Chen, after his visit a week before (Appendix B). The visit was accompanied and supported by Giuseppe Farris (Hotel Engineer), Wilfredo Saavedra (1st Plumber), Roy Van Acuzar (2nd Plumber) and Jovy (Plumber). Some progresses were made between the visits, and the key findings are summarised below.

No.	Subject	Action
1	MBR No.3 capacity The operator believes the MBR No.3 capacity cannot be reduced to 80 m3/day. The reason is the MBR 1&2 membrane banks rely on the extended back flush procedures to remove blockage. The modification to prevent membrane blockage was not yet implemented. This item must be concluded asap. In the mean time, Hamworthy agrees to a compromise of 100 m3/day.	HWS
2	Black and grey water mix The mixing ratio is more stable now. The water level in Tank 5 is now 66%. Hamworthy agreed to not to increase the level further, until Hamworthy engineer can stay on board again to examine the situation over a number of days.	HWS
3	Dissolved Oxygen (DO) DO has now been increased to 1.1-1.5 mg/l– which is encouraging. Operator reported foaming problem – which is contained and managed. The leaking seal of the spray pump is not yet replaced. Hamworthy emphasised the purpose of the spray system provided for this trial.	Ship
4	Anoxic zone and Swing zone During the visit, it was found the half-opened aeration down pipe observed in the last visit remained the same. It was closed immediately during this visit. Mixing within the anoxic zone and the swing zone was further adjusted during the visit.	
5	ISF flows The ISF flows remained too high. Action is needed immediately.	Ship
6	Communications It was found that Jovy had not seen the Hamworthy instructions (Appendix A). Hamworthy raised the concern over this situation.	
7	Resources It was revealed that Jovy will leave the ship in Oct, and 1st and 2nd plumber on duties will leave in Dec. Considering the progress so far, further operational resource, and the associated trainings, must be allowed for.	PCL
8	Program A further visit by both Ken Cooksley and W Chen may be planned in mid September. The aim will be to assist implementing the scenario 1 conditions to that the trial can start. Hamworthy will also observe the operational resource to ensure progress.	HWS

(W Chen 08/2009)

Appendix B: Scenario 1 Progress Report No. 1

Hamworthy carried out a progress review on board. The visit was accompanied and supported by (Farris Giuseppe, Hotel Engineer) and (Saavedra Wilfredo, 1st Plumber). It was concluded that the Test Scenario 1 (and some elements within Scenario 0) has not progressed substantially in accordance to the Plan (Appendix A). The key findings are summarised below.

No.	Subject	Action
2	MBR No.3 capacity Scenario 1 calls for MBR No. 3 daily capacity of 80 m3/day. This is considered too low during the Alaska Season. The reason is that for MBR No. 1 and No. 2, extended membrane bank back flush is required to prevent blockage or membrane bank high pressure. Hence: - Hamworthy must implement the MBR No. 1 and 2 membrane bank fail-safe controls (to automated the actuated valves on the membrane bank feed lines) which is now long overdue. - In the mean time, Hamworthy agrees to keep the MBR No. 3 capacity to 100 m3/day.	HWS
3	Black and grey water mix The situation has improved. The level in Tank 5 has been increased to 66%. Further increase can not be agreed upon due to concerns of possible overflowing. It is agreed that no further increase is attempted until Hamworthy engineer is on board again to observe and examine the situation.	
5	Dissolved Oxygen (DO) The importance of DO to a good nitrification process was again emphasised. While the target DO is 1.5 mg/l, the actual DO has been merely 0.2 to 1.0 mg/l. During the visit, the operator indicated concerned about foaming when aeration is increased. It was found that the spray pump and the spray system, specifically designed to cope with possible foaming, was actually not running. When the operator attempted to run the spray pump, the seal was found leaking when isolation valves were opened. The pump seal shall be replaced, and the spray system shall be made functional. This shall give operator a peace of mind in maintaining the required aeration. Prior to a satisfactory DO level is maintained, a stable nitrification process cannot be established.	
6	Anoxic zone and Swing zone During the visit, it was observed that at least one of the aeration down pipes into the anoxic zone was half open, with air bubbles visible in the reactor content (from side low level viewing hatch). It was emphasised that air shall not be supplied to the anoxic zone. It was also observed that the mixing line to the swing zone was closed. It was recommended to keep it open so that the mixing is sufficient in both the anoxic zone and the swing zone.	
7	Alkalinity Sodium hydroxide solution is being dosed to the system. Two dosing systems are made available to provide sufficient dosing capacity. It was advised that the permeate alkalinity shall be maintained between 100~200 mg/l CaCO3. The dosing of sodium hydroxide shall be adjusted to suit.	
8	ISF flows The importance of ISF flows was emphasised. ISF screening flow was in some cases as	

	high as 300 m3/day, comparing to a target of 100 m3/day or less.	
9	Tank 5 Ammonia on-line meter The ammonia on-line meter showed weak agitation within the flow cell. It was recommended to increase the flow through the cell to prevent accumulation of solids that cause un-reliable readings or blockage.	
10	Program A short visit by W Chen is planned in Victoria on 28/08 (in the evening). A further visit by both Ken Cooksley and W Chen may be planned in mid September.	

(W Chen 08/2009)

Hamworthy

Appendix A: Scenario 0 and Scenario 1 (July 2009)

Background – Progress so far

The ammonia removal trial on Golden Princess is now ready to start. The key activities so far, achieved with full support by Carnival Corporation and Princess Cruises, are summarised below:

- Ship survey completed	Nov 2008
- Scope of work and contract agreement	Jan 2009
- Allocation of one plumber for this trial by Princess	Mar 2009
- Wastewater characterisations (Phase 1) completed	Mar 2009
- Phase 1 report submitted	Apr 2009
- Trial plant installation and commissioning (Phase 2) completed	Jun 2009
- Trial period starts (Phase 3)	Jul 2009

Ammonia removal trial plan - general

Over the next few months, *ammonia and phosphorus removal* performance will be investigated using the modified MBR No.3. Hamworthy relies primarily on a strictly structured communication regime with the ship staffs to implement all trial scenarios. Additional resource, including one additional plumber, had been allowed for by Princess Cruises.

Recognising the fundamental importance of keeping good communications for this project, Hamworthy decided to allow a 'Scenario 0' prior to starting the nitrification process (Scenario 1). The subsequent test scenarios will be developed based on the outcome of the previous scenarios. This technical note outlines Scenario 0 and scenario 1, in a very simplified way. Detailed communication are carried out separately with ship staffs, which are on-going.

Scenario 0

The objectives are:
- To establish a rigid communication regime so that data are complete, and correct;
- To establish a stable operational condition to the new feed system and MBR3;
- To clear any snags.

No.	Tasks
1.	Data to be received by Hamworthy on every Monday and Thursday morning: 1) Ammonia Removal Trial Log Sheets 2) Golden Princess Log Sheets 3) Feed Panel PLC data down load 4) SC1000 data down load
2	Tank 5 and MBR3 operational parameters required (to be implemented from 18/07): 1) MBR feed rate ~100 m3/day, with grey:black ratio 2:1 – by adjust Tank 5 level settings (reducing the black water level bend). 2) MBR sludge age 10 days – by desludge 3-4 m3 daily. 3) ISF filtrate ~400 m3/d, screenings ~100 m3/d – by throttling ISF feed valve. 4) Stop Nutrient solution (Hepburn) dosing into MBR3 during the trial period.
3	Program Start date: 01/07, and expected to last for a period of 4 weeks. Ken Cooksley of Hamworthy will attend the ship by the end of July to resolve any snags.

Hamworthy

Scenario 1

The objectives are:
- To establish nitrification and denitrification in the system;
- To stablise nitrification and denitrification in the system;
- To clear any snags.

No.	Tasks
1	Tank 5 and MBR3 operational parameters required (implementation date TBA, expected on 01/08): 1) Create Anoxic Zone – by switch off air supply to Anoxic and Swing zones; 2) Maintain DO 2.0 mg/l – by running a maximum of two blowers; 3) MBR feed ~ 80 m3/d; grey:black = 2:1; 4) MBR sludge age 20 days – by desludge 1-2 m3 daily; 5) ISF filtrate ~300 m3/d, screenings ~80 m3/d; 6) Introduce AMMO1000 (Hepburn) to MBR3.
2	Program Start date: TBA, and expected to last for a period of 8 weeks. W Chen of Hamworthy will attend the ship in early August to support the trial.

(Wei Chen, July 2009)