

Royal Caribbean International Advanced Wastewater Purification Systems

Royal Caribbean International is installing advanced wastewater purification (AWP) systems on all of its ships. These technologically advanced systems clean the wastewater generated onboard our ships. At the end of the cleaning process, the wastewater is so clean that it far exceeds all international ship wastewater discharge standards.

Royal Caribbean's commitment to advanced wastewater purification systems is an example of our company's policy of continual environmental improvement.

Over the next several years, each of our ships will be equipped with an AWP system. This represents a total investment of well over \$100 million for our company.

THE INSTALLATION PROCESS

We install the new systems either when a ship goes into its normally scheduled dry dock, or, in some cases, while the ship is in service. Our new ships will be delivered with AWP systems already installed.

Typically, it takes approximately four to five months to manufacture a system and four months to install one onboard. Then it takes approximately two months to commission the system, which includes a sampling period to ensure the system's performance meets standards comparable to the U.S. federal standards for ships operating in the State of Alaska (regardless of where the ship is operating.)

Below, you will find a list of our ships currently equipped with AWP systems, and our schedule for future installations. We also list the type of system being used or scheduled for installations, where decisions have been finalized.

Due to the highly technical and experimental nature of AWP systems, installation and completion timeframes are subject to change, based on the availability of AWP systems, installation processes and commissioning procedures. Further below, you will find a list of three advanced wastewater purification systems we use, along with brief explanations of how they are designed to work and a diagram of each system.

AWP INSTALLATION STATUS

Ships with Operational AWP Systems:

Vision of the Seas – Hydroxyl (partial system, slated for replacement)

Serenade of the Seas – Scanship
Enchantment of the Seas – Hydroxyl
Freedom of the Seas – Scanship
Liberty of the Seas – Scanship
Radiance of the Seas – Hydroxyl
Brilliance of the Seas – Hydroxyl
Independence of the Seas - Scanship
Jewel of the Seas – Hydroxyl

Installations Expected To Be Substantially Completed in 2009:

Rhapsody of the Seas - Navalis
Oasis of the Seas – Hydroxyl (Newbuild)
Grandeur of the Seas
Explorer of the Seas
Adventure of the Seas
Splendour of the Seas
Navigator of the Seas
Legend of the Seas
Mariner of the Seas
Monarch of the Seas
Majesty of the Seas
Vision of the Seas (total system replacement)
Voyager of the Seas

AWP SYSTEMS WE USE

We currently have three types of advanced wastewater purification systems on our ships, the Scanship, Hydroxyl and Navalis systems. The Scanship and Hydroxyl systems use a similar process and are based on biological treatment. The Navalis is primarily a filtration and advanced oxidation process.

The first two systems use beneficial bacterial to consume waste particles, similar to a land-based wastewater treatment facility.

How it works:

- Coarse mechanical screens remove wastewater solids, such as plastics, before they enter the treatment system.
- The biological reactor uses a fixed-film media, which looks like small plastic gears or wheels, which give beneficial bacteria a surface on which to attach themselves to aid in breaking down any solids.

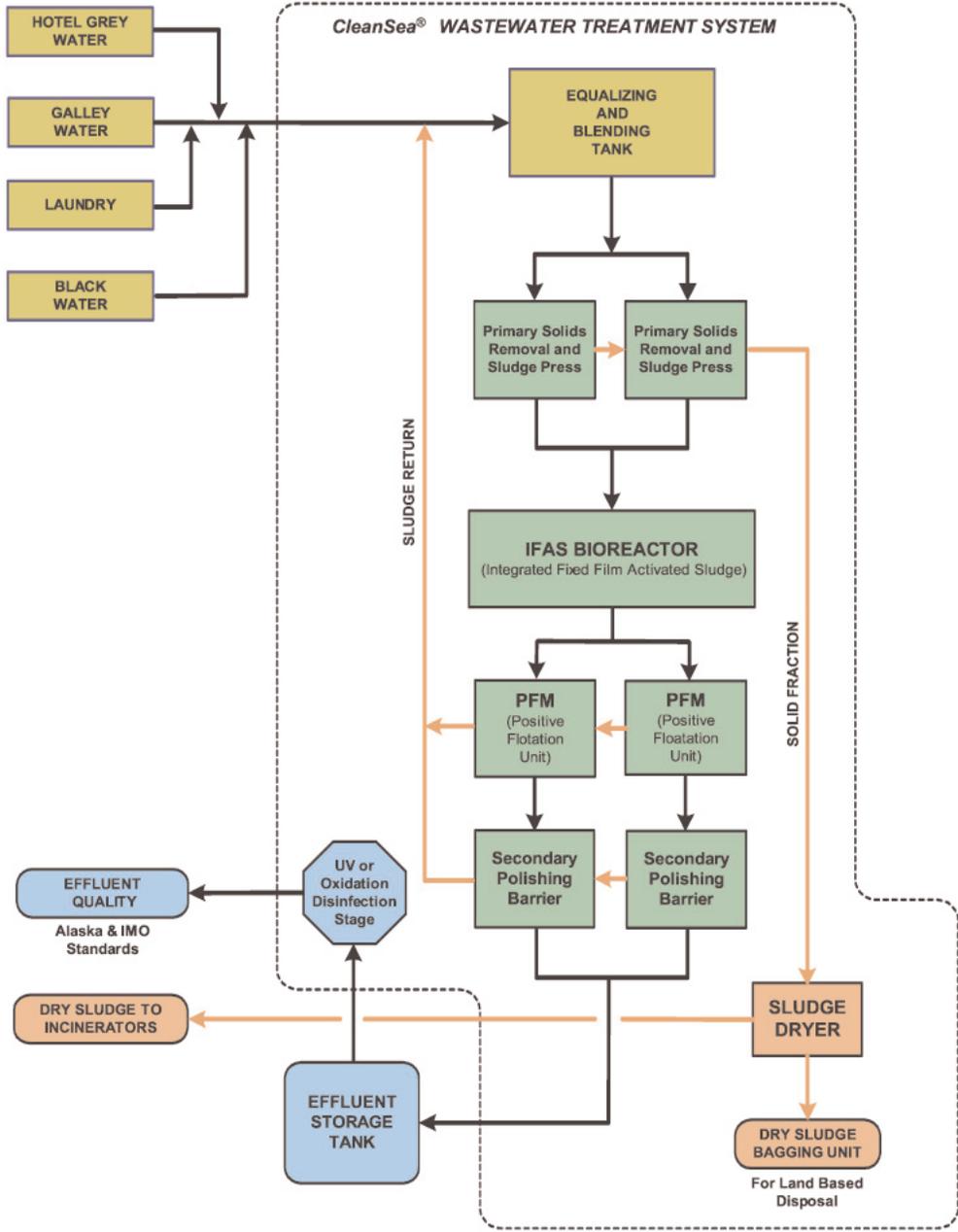
- From the biological reactor, the water and any tiny solids are pumped to machines that mechanically and chemically remove the remaining solids from the water.
- The resulting very clean water is then pumped through polishing filters.
- Next, an ultraviolet light reactor provides the final disinfection.
- The solids that remain from this entire process are pumped to a holding tank for either subsequent drying and incineration, disposal at an approved land-based facility or at sea discharge in accordance with international standards.

AWP SYSTEM DIAGRAMS



Hydroxyl CleanSea® Cruise Ship System

Black and Grey Water Treatment System



NAVALIS

Navalis treats the black and gray water streams in separate systems. Navalis combines hotel accommodation and laundry water together as graywater and sewage, food waste water (pulper) and galley water together as blackwater. In both treatment trains, solids are first removed from the wastewater stream. In the black water system this is accomplished through use of a plastic strainer, flocculation and a fine mesh-vibrating screen, followed by filtration and finally ultrafiltration with ceramic membranes. The graywater system traps plastic at the vibrating shaker screen step where the small amount of solids are bagged and disposed of by incineration and the liquid is treated by filtration and finally ultrafiltration with ceramic membranes.

The clarified water from the membranes (permeate) is directed to a stirred reactor where the wastewater is continuously circulated through a fluidized bed of glass coated plastic media, and a re-circulated stream containing dissolved ozone is introduced. The net result is complete oxidation of pollutants and the production of carbon dioxide gas and water. The ozonated water is next passed through a powerful ultra-violet light reactor where residual ozone is broken down into highly reactive oxygen compounds that further polish the water.

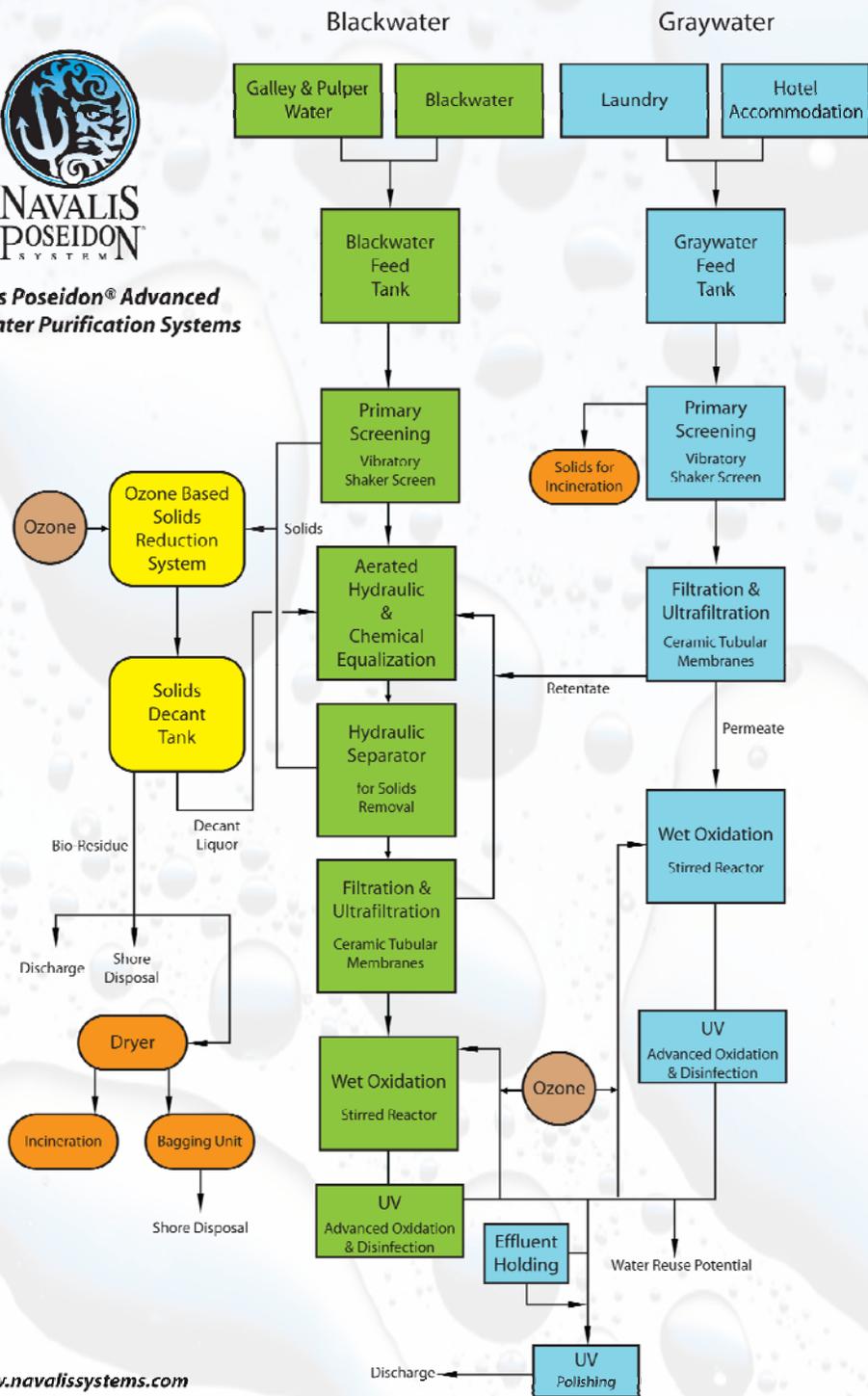
The gray water and black water systems use identical system components. Prior to discharge, the two highly oxygenated streams are combined. Prior to discharge, the treated effluent passes through an additional ultra-violet light reactor for final effluent polishing.

Solids produced by this system are oxidized with ozone reducing their volume and mineralizing them into a safer bio-residue, suitable for drying, ready for land based disposal or at sea discharge.



NAVALIS
POSEIDON
SYSTEM

Navalis Poseidon® Advanced
Wastewater Purification Systems



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