

## **Celebrity Cruises Advanced Wastewater Purification Systems**

Celebrity Cruises 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.

Celebrity'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 \$50 million for our company.

### **THE INSTALLATION PROCESS**

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

Ideally, 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 the 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 AWP Systems Installed:**

Celebrity Century – Hamworthy

Celebrity Xpedition – Evac (ZODIAC)  
Celebrity Infinity – GE/Zenon  
Celebrity Summit – Hydroxyl  
Celebrity Millennium – Hydroxyl  
Celebrity Constellation – Hydroxyl  
Celebrity Solstice- Kruger/WABAG  
Celebrity Equinox – Kruger/WABAG/RWO  
Celebrity Eclipse – Kruger/WABAG/RWO  
Celebrity Silhouette – Kruger/WABAG/RWO  
Celebrity Reflection – Kruger/WABAG/RWO

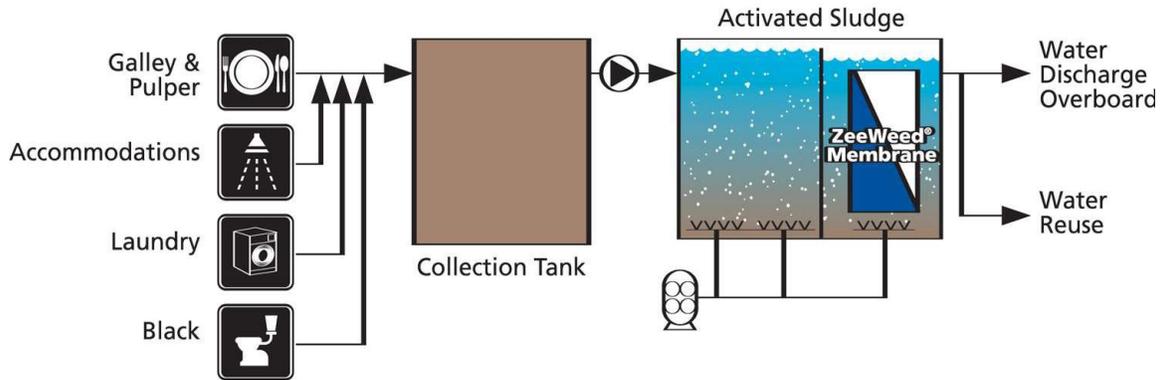
## **AWP SYSTEMS WE USE**

All of our systems use beneficial bacterial to consume waste particles, similar to a land-based wastewater treatment facility.

### **Zenon**

The Zenon system uses a combination of biological treatment and membrane filtration processes:

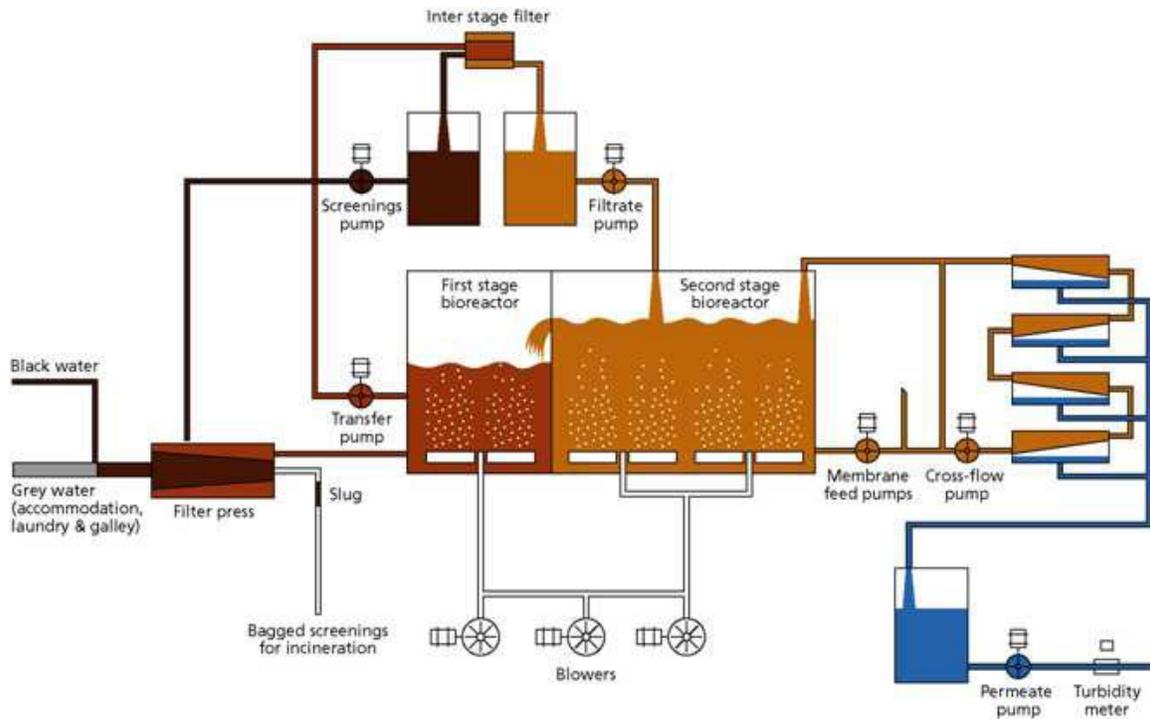
- Coarse mechanical screens remove wastewater solids, such as paper and plastics, before they enter the treatment system.
- Submerged within the biological reactor are filtration membrane fibers resembling spaghetti strands. The fibers create a physical barrier between the water and the tiny solid materials.
- Using a very slight vacuum, the water is pulled through membranes that are so fine they even filter out most bacteria.
- The resulting clean water is then pumped to an ultraviolet light reactor for final disinfection.
- The solids that remain from this entire process are pumped to a holding tank for subsequent drying and incineration, for disposal at an approved land-based facility, or at sea in accordance with international standards.



## Hamworthy

The Hamworthy system uses a combination of biological treatment and membrane filtration processes:

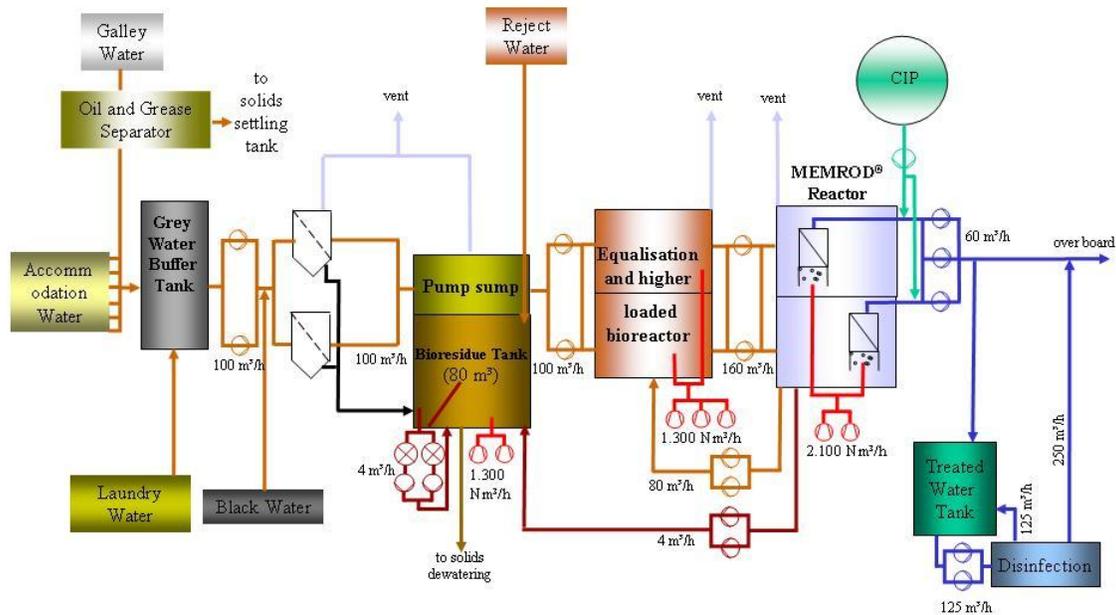
- A coarse screen filters out large solid waste, such as paper and plastics, before they enter the treatment system.
- The screened wastewater enters a two-stage biological reactor, where aerobic micro-organisms biodegrade the pollutants.
- An inter-stage filter (fine screen) positioned between the two bioreactor stages then removes smaller solids from the biomass. After the second stage bioreactor, the water passes through an ultra-filtration membrane system.
- The membrane forms a physical barrier to bacteria and produces particle-free clean water.
- The resulting very clean water is pumped to an ultraviolet light reactor for final disinfection.
- The solids that remain from this entire process are pumped to a holding tank for subsequent drying and incineration, for disposal at an approved land-based facility, or at sea in accordance with international standards.



## Kruger/WABAG

The Kruger/WABAG system uses a submerged membrane process similar to the Zenon, it also combines biological treatment and membrane filtration processes:

- Coarse mechanical screens remove wastewater solids, such as paper and plastics, before they enter the treatment system.
- This process includes a two stage bioreactor. The first is solely an aerated bioreactor. Submerged within the second stage biological reactor are filtration membrane cartridges. The membranes create a physical barrier between the water and tiny solid materials.
- Using a very slight vacuum, the water is pulled through membranes that are so fine they even filter out most bacteria.
- The resulting clean water is then pumped to an ultraviolet light reactor for final disinfection.
- The solids that remain from this entire process are pumped to a holding tank for subsequent drying and incineration, for disposal at an approved land-based facility, or at sea in accordance with international standards.



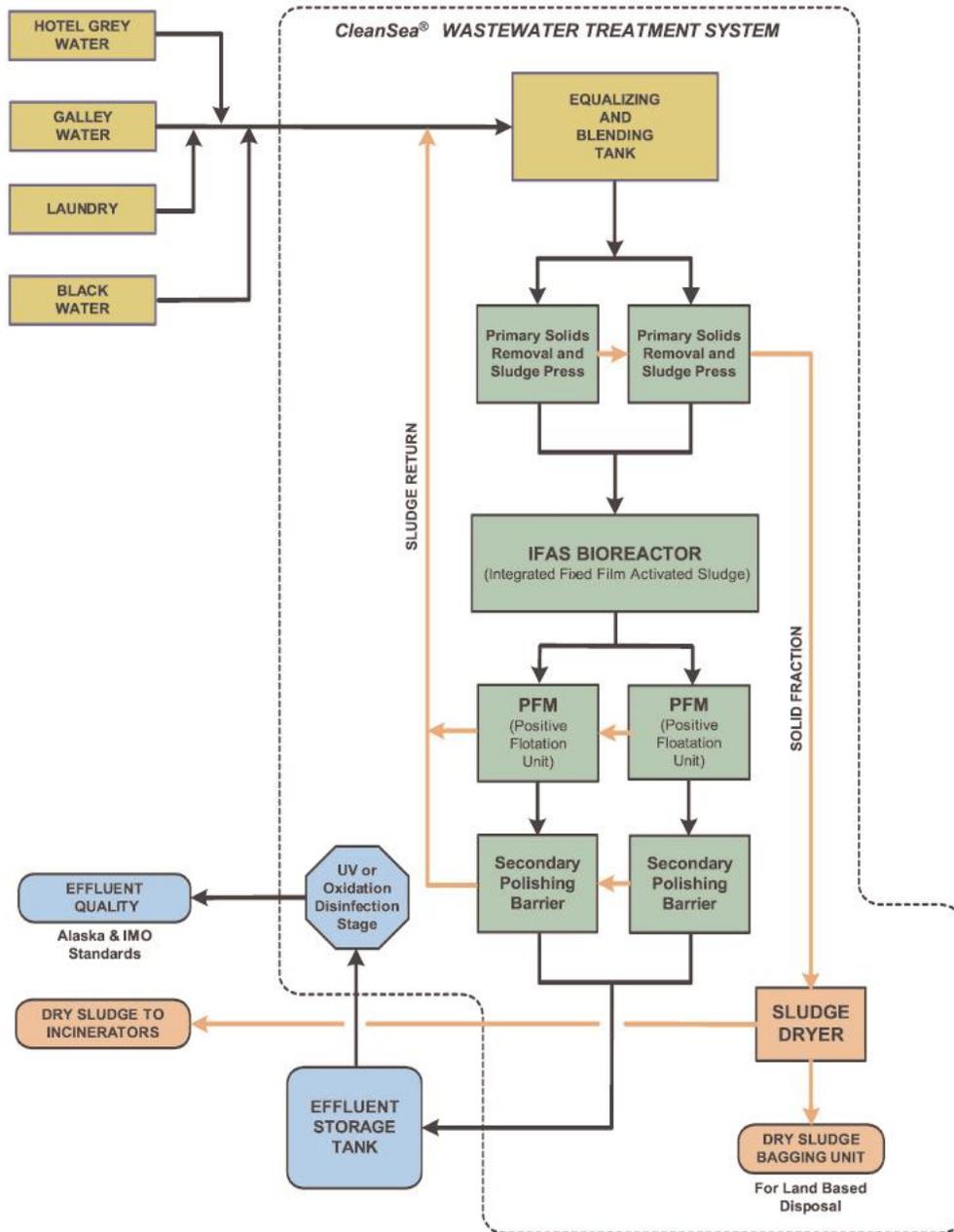
## Hydroxyl

How it works:

- Coarse mechanical screens remove wastewater solids, such as paper and 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 subsequent drying and incineration, disposal at an approved land-based facility, or at sea in accordance with international standards.

**Hydroxyl CleanSea® Cruise Ship System**  
**Black and Grey Water Treatment System**



## Evac (ZODIAC)

How it works:

- Black and gray water are pumped into a dedicated holding tank for mixing.
- The wastewater is then pumped to coarse pretreatment screens where up to 40 percent of the solids are removed.
- The resulting water is moved to a membrane bioreactor that uses submerged flat sheet membrane modules.
- The resulting very clean water is removed from the membrane bioreactor through the membrane surface – either by gravity or by a slight vacuum.
- Next, an ultraviolet light reactor provides the final disinfection.
- The solids that remain from this entire process are pumped to a holding tank for subsequent drying and incineration, disposal at an approved land-based facility, or at sea in accordance with international standards.

### Evac-Zodiac Membrane Bioreactor

