LESSONS LEARNED FROM GREENING CRUISE VESSELS

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Royal Caribbean’s approach to minimizing environmental impacts

• Energy and Air Emissions

• Water and Wastewater

• Waste and Chemical Management

• Conservation, Destinations and Education
Energy and Air Emissions

- In 2010, our ships reduced fuel consumption by 4.7% per available passenger cruise day (APCD) over 2009 levels
- This corresponds to just over 25,000 fewer metric tons of fuel than planned
- Since 2005, we have reduced our fuel consumption by 13.6% per APCD
Generate cleaner and more efficient power

- Exhaust Scrubber
- Optimize Engine Overhaul Schedule
- Waste Heat Recovery
Measures to improve energy efficiencies

- Improved hydrodynamics
- Propeller, propulsion and hull design
- Adjusting ship speed to increase fuel efficiency
- Itinerary planning to optimize timing route, speed, and distance traveled
- Utilizing waste heat produced by our engines (e.g. heating water for showers, galleys, and preheating fuel burned in engines)
- When operating in cold climates, utilizing cold seawater to chill water, rather than running air-conditioning compressors, saving 4-5 MT fuel/day
- Application of solar films/window tinting, solar panels, advanced energy efficient glass
- Replacing halogen and incandescent bulbs with LED and compact fluorescent lights
Optimize propulsion

Pod & Rudder / Propeller Design

Hull Coating & Maintenance

Speed, Route, & Trim Optimization

Advanced Bulbous Bow Design
Hull cleaning and maintenance

- Biofouling degrades underwater hull conditions

- Results in more power needed for propulsion to maintain service speeds

- Biofouling varies from region, ship speed and type of underwater coat used
Optimize propulsion - initiatives

• Hull Cleaning & Maintenance
  • Approx. 10% improvement in propulsion efficiency immediately after dry dock

• Radiance Azipod Modification
  • Hydrodynamic efficiency increased via aft cone and fin shape
  • Approx. 3.5% improvement in propulsion efficiency

• Vision Prop & Rudder Re-design
  • Improved hydrodynamic flow between propeller and rudder
  • New blades optimized for 18 knots rather than 24
  • Early test results show a 5% improvement in propulsion efficiency
Reducing emissions - exhaust gas scrubbers

*How scrubbing works*

Uses a method of charging sea water droplets, changing pH, capturing particles, breaking hydrogen bonding and turning gases such as SOx into non-air polluting substances.

SOx $\rightarrow$ Sulfates or Sulfur + Oxygen
Reducing emissions - exhaust gas scrubbers

The Ecospec System

- Installation on *Independence of the Seas*
- First “test run” was Sept 23, 2011

Electrodes change water pH
Reducing emissions - exhaust gas scrubbers

The Greentech System

• Installation began on Liberty on Oct 19, 2011

• First test run is expected on March 3, 2012
Wastewater treatment
Advanced wastewater purification systems

• Installing Advanced Wastewater Purification (AWPs) systems and treating gray and blackwater prior to discharge into the Ocean

• These systems produce an effluent that is cleaner than what is required by international sewage regulations and what is discharged from most leading municipal wastewater treatment facilities

• We currently have 25 of 32 installations completed and within the year will have 31 out of 33 ships completed

• Evidence of effluent quality is confirmed by routine onboard sampling and third party testing
Overview of AWP system
Waste Management

• One of the key principles of our environmental program, Save the Waves, is *Reduce, Reuse, Recycle*

• We contract with suppliers to reduce packaging sources and use more sustainable materials
  • For example, we utilize larger containers with concentrated products to minimize waste, reduce packaging and transportation impacts (environmental & economic)

• We recycle and reuse approximately 40% of all waste landed globally – upwards of 90% in S. Florida homeports.

• All garbage is hand sorted and segregated onboard allowing the recycling of:
  • glass, paper, cardboard, aluminum and steel cans, scrap metal, incinerator ash, plastics, toner cartridges, wooden pallets, batteries, fluorescent lamps, electronics, plastic wrap and kitchen oil
Waste Management

- Various equipment are used to enable the most recycling with limited storage space
  - Depressurizers for releasing residual liquids from aerosol cans
  - Compactors for processing plastic, cardboard and metal
  - Glass crushers
  - Fluorescent lamp crushers to separate mercury from recyclable items such as aluminum and glass

- Each ship is also equipped with climate controlled storage facilities that allow them to hold recyclables until appropriate and approved recycling hubs are reached
Questions? Comments?

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