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Royal Caribbean Cruises Ltd.

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Oasis Class
The benchmark for the future

“The Oasis Class (2009) is truly an architectural and nautical feat. This is truly the next step in cruise evolution.”

- Biggest commercial shipbuilding design effort ever undertaken
- Two million design hours and ten million working hours for construction
- Risk-Based Design (first ship designed with a known safety level)
- Modern calculations, simulation tools and model experiments
- Alternative design process as defined in SOLAS
- Extensive Onboard Decision Support System for crisis management
IMO Goal, ”Ship is its best lifeboat”
In the event of casualty, persons can stay safely on board as the ship proceed to port.
Improve ships survivability in the event of collision, grounding, fire or systems failure.

Safe Area Concept
Casualty threshold is the amount of damage a ship is able to withstand and still safely return to port.

Casualty threshold not exceeded
Safe return to port concept.
Essential systems to remain operational.

Casualty threshold exceeded
Time for evacuation and abandonment

<table>
<thead>
<tr>
<th>Fire Protection</th>
<th>Damage Stability</th>
<th>Safe Return to Port</th>
<th>Essential Systems</th>
<th>LSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Design</td>
<td>IMO probabilistic rule</td>
<td>DNV RPS notation</td>
<td>Essential safety systems</td>
<td>Large lifeboats</td>
</tr>
<tr>
<td>- apply Ch. II-2 Reg.17</td>
<td>- required index R</td>
<td>- machinery in two compartments</td>
<td>Failure resistant design</td>
<td>- 370 persons</td>
</tr>
<tr>
<td>- length and area can be increased</td>
<td>- R = f ( Length, Pax )</td>
<td>- three propulsion units, all steerable</td>
<td></td>
<td>- boarding in stowed position</td>
</tr>
<tr>
<td>Genesis</td>
<td>Genesis</td>
<td>Essential safety systems</td>
<td>Large MES</td>
<td>- Hull beam = 47 m</td>
</tr>
<tr>
<td>- Hull beam = 47 m</td>
<td>- Zone length = 41 m</td>
<td>Comfort systems</td>
<td>- 450 persons</td>
<td>- boarding through chutes</td>
</tr>
</tbody>
</table>
Safety
Damage Stability

- IMO probabilistic rules applied ahead of time
- Machinery spaces protected by double hull
- Two years of R&D on Oasis Class Stability
- Extensive simulations and model test verification
RCL has adopted

- 1995 → half-ship concept with separate engine rooms
- 1999 → double hulls in engine rooms and two totally independent engine rooms
- 2007 → principles of SRTP along with enhanced guest comfort requirements
- Extensive 3-D topographic simulations to verify configuration
Due to ships configuration and novel design an alternative design process has been extensively applied.

Extensive fire simulations as per SOLAS Alternative Design and Arrangements.

Alternative means of fire division in the form of roller shutters.
Optimized evacuation as an integral part of the iterative design process

SOLAS equivalent safety approach applied for life saving appliances

Pioneered design for large lifeboats (370 persons each)

Improved utilization of Marine Evacuation System (MES)
Extensive work carried out in order to optimize evacuation as an integral part of the iterative design process.

TraffGo simulations were based on MSC Circular 1033, representative passenger demographics were used.

11 Assembly stations total; 10 located inside.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Assembly Time</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night</td>
<td>44:51</td>
<td>60 minutes</td>
</tr>
<tr>
<td>Day</td>
<td>33:38</td>
<td>60 minutes</td>
</tr>
</tbody>
</table>
Safety
Evacuation and Life Saving

SOLAS equivalent safety approach applied for life saving appliances

Germanischer Lloyd led the Design Team effort

Equipped with 18 lifeboats (Rescue Vessels) for 370 persons each, two fast rescue boats and four MES stations for 450 persons each
Safety
Large Lifeboats – Rescue Vessels.

• Stowed in embarkation position for simplified launch (one vertical movement) and ease of loading
• Center aisle for ease of embarkation and access to provisions & supplies
• Enhanced maneuvering with 2 independent engines/rudders
• GPS, PA-system, windows, stretcher locations and toilet facility
• Extensive model testing and reinforcement to accommodate wave loads in extreme seas
A groundbreaking approach to damage control strategy.

Allowing a ship the size of Oasis to be surveyed and assessed for damage from grounding or collision in only 12 minutes.

Additional decision support to aid in isolation of compartments in a quick and simple fashion.
Enhanced Safety and Security

- Extensive focus on navigation, state of the art technology, cockpit design
- Two years R&D on ships maneuverability with world leading authors
- **Dedicated safety center within bridge** (Improved ability to manage safety and security incidents)
- Electronic emergency mustering system
- Comprehensive digital CCTV system
Overcoming Complexities
Our Approach

- Involve ourselves deeply in the design and building process
- Strong in-house design and project management capability
- Partner with industry leaders, designers, consultants
- Follow rigorous design development processes
- Rigorous risk assessment process
- Third party reviews and Chief Engineer reviews
- Utilization of state of the art technical and design technology
- Continuous improvement and feedback loop
Risk Management
Comprehensive Risk Review

- Transparent for all safety related aspects
- Requires continuous review with experts and close coordination with authorities from concept phase through delivery
- Achieved through internal and external risk review processes
- Oversight through external Maritime Safety Advisory Board
- Process results in large ships that have higher level of built-in safety proven through comprehensive verification through calculations, analyses and model experiments
Well Defined Processes and Phases

- Seamless collaborative team effort with all partners – “Winning Team”
- Well defined processes
- Follow best practices from other manufacturing industries like aviation and automobile
- Adopt a “Quality Gate” mentality with clear timelines
- It’s all about process, people and collaboration!

Phases and Quality Gates

1. Kick-off
2. Business Case Approved
3. Contract Effective
4. Concept Freeze
5. Basic Design Complete
6. GA Freeze
7. Design Approved
8. Ship Delivered
9. First Cruise Complete
10. End of Warranty +3 months

Operational Start Up
Post Delivery Support
### Lifecycle Safety Management

- Continuous improvement and learning from ships in operation to newbuildings
- Enhance operational standards and levels of training
- Fit for purpose and rigorous technology qualification
- Lifecycle stability management
- Emergency response procedures and training

<table>
<thead>
<tr>
<th>Ship Design</th>
<th>Strategic Stability Management</th>
<th>Operational Stability Management</th>
<th>Emergency Stability Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and NB phase</td>
<td>Operational life cycle</td>
<td>Per Voyage</td>
<td>Emergency Situations</td>
</tr>
</tbody>
</table>
“There is no such a thing as perfect Safety, but there is perfect dedication to continuous improvement and Safety, and Royal Caribbean is fully committed to both of them.” – R. Fain

Thank You!