

# RINA

The Royal Institution of Naval Architects



International Conference

## DESIGN AND OPERATION OF PASSENGER SHIPS

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The passenger vessel market is emerging from one of the most challenging economic climates and is now showing strong signs of recovery. Vessels are growing not only in size but in complexity as passengers expect a greater level of comfort and greater range of activities on board. Vessels are also now operating in a wider range of areas than ever, polar cruises are particularly becoming more common, these bring their own challenges not only in design but also in terms of vessel fit out and minimising the local environmental impact of vessels. Changes in regulations have also had a large impact on design, probabilistic rules for damaged stability and new rules for the structural use of composites open up new possibilities but also bring new challenges for all involved in design and manufacture. The introduction of the Energy Efficiency Design Index also places greater restrictions on the design of new vessels.

## day 1

### 09.30 - 10.00 COFFEE AND REGISTRATION

### 10.00 - 10.35 KEYNOTE ADDRESS STEPHEN PAYNE OBE

### 10.35 - 11.10 THE OPERATIONAL CONSEQUENCES OF CURRENT EXTERNAL PRESSURES ON THE CRUISE INDUSTRY *G P Wild and J Evans, G. P. Wild (International) Limited, UK*

In this paper the authors will explore how the industry has already responded and how we anticipate further responses will be required to the following and very current external pressures. Such as the explosion in the size of new cruise ships, the death of smaller ships, the price of fuel, and the environmental push against exhaust emissions. Particular attention will be paid to implications of these and others for the design, operation, economic and equipment fit of cruise ships in the future.

### 11.10 - 11.40 COFFEE

### 11.40 - 12.15 A CONCEPT FOR A MEGA-SCALE TWIN HULL CRUISE SHIP *C Jang and P Bergan, Department of Ocean Systems Engineering, KAIST, S. Korea*

The proposed concept is a wide, catamaran type ship with two sleek, wave-piercing hulls. The overall length is 360 m, the total width 70 m, there are two separate superstructures facilitating more than two thousand passenger cabins, all with exterior balconies. There is also extensive exterior deck space. The twin hull design implies good stability and seaworthiness; however, the deck connecting the two hulls will be exposed to extreme forces in severe weather; in particular, the warping forces on the twin hull represent a formidable challenge. To this end a ship-wide cellular deck structure is devised for strength and stiffness; at the same time the interior of this large deck structure offer significant interior space for multiple usages.

### 12.15 - 12.50 EARLY STRUCTURAL ASSESSMENT AND OPTIMIZATION OF PASSENGER SHIPS *J Caprace, F Bair, and P Rigo, University of Liege, Belgium*

It is in preliminary design, however, that basic decisions are made, such as structural components, scantlings and the principal structural materials such as use of high tensile steel, ordinary steel or combination of these. It is therefore the most relevant period to assess the steel weight and production cost, to compare fabrication sequences and to find the optimal frame/stiffener spacings and the most suitable scantling to increase the ship life cycle performance. A multi-criteria optimisation of a passenger ship is conducted in this paper. Minimum production cost and minimum steel weight are the both conflicting objectives studied. Moreover the study answers to the following question: "From when will the higher costs of high tensile steel should be offset by a gain of steel weight?". For a passenger ship, a significant reduction of the steel weight, for a controlled raise of the gravity centre, should lead either to a reduction of fuel consumption either to an additional deck, which for a ship owner means a faster return on investment.

### 12.50 - 14.00 LUNCH

### 14.00 - 14.35 FIRE RISK SCREENING OF PASSENGER SHIPS LAYOUT IN SUPPORT OF THE ASSESSMENT OF ALTERNATIVE DESIGN AND ARRANGEMENTS *L Guarin, J Logan, Safety At Sea Ltd*

Contemporary large passenger ship layouts, almost invariably, feature design arrangements deviating from certain prescriptive aspects of Chapter II-2 of SOLAS. Such aspects may include, among others, the size of fire zones (limited to 48m in length and 1600m<sup>2</sup> in deck area). To this end, a fire risk screening methodology was developed to estimate and assess the risk contribution from every space, which may be considered a space of fire origin onboard a passenger vessel. The risk contribution from every space is added to estimate the risk contribution of specific areas of the vessel or fire zones in relation to the risk attained by the vessel. The method has proven useful

when undertaking preliminary assessments of alternative designs as it facilitates making informed choices of casualty scenarios for quantitative and fire engineering analysis. This paper will outline the basis of the method, discuss some trends in the results and offer some insight into its use in modern ship design development.

### 14.35 - 15.10 FIRE SAFETY ONBOARD PASSENGER SHIPS *C Azzi and Dracos Vassalos*

The general arrangements inside passenger ships are getting more complicated to fulfil the passengers' expectations in comfort, luxury and variety of services. Hence, with the new designs, safety is becoming a target hard to achieve and especially regarding fire safety where the new materials and complexity in arrangement can pose great hazards. Prescriptive rules in this sense are becoming outdated as it has proven hard to keep regulations development at the same pace with novel designs. This is also shown in the introduction of the alternative design and arrangements regulations to provide a new methodology for novel design safety. This fast advance in ship design and regulations necessitate the use of performance based means to address fire protection among other safety aspects onboard. Simulation tools form the core of performance based techniques where the level of safety performance of a design can be measured. This paper will illustrate the use of computerized programs in assessing fire safety onboard passenger ships.

### 15.10 - 15.40 COFFEE

### 15.40 - 16.15 DEMONSTRATING AND TESTING COMPLIANCE WITH SAFE RETURN TO PORT REQUIREMENTS *S Russo, Lloyd's Register EMEA*

Since 1st July 2010 amendments to SOLAS, approved at IMO in 2006, on safe return to port for passenger ships, have finally come into force. Over that time a number of ships have been designed and constructed as to proactively achieve early compliance with the new requirements, while IMO has continued working and finalised in May 2010 development of Interim Explanatory Notes for the assessment of passenger Ship systems' capabilities after a fire or flooding casualty, directly related to the above. These processes have required various parties to address and start building up experience on the range of approaches that can be followed to demonstrate and, where applicable, test compliance of the ships design and of the essential systems. Notwithstanding the above the passenger ships community is still at the early stages in handling the tools now available, and the paper aims to offer as far as practicable an insight on possible methodologies which may enable and facilitate the preparation, production and use of the necessary documentation for appraisal, testing and operation of the ship and its systems.

### 16.15 - 16.50 ASSESSMENT OF SHIP SYSTEMS' CAPABILITIES IN ACCORDANCE WITH NEW SOLAS REQUIREMENTS FOR SAFE RETURN TO PORT *L Guarin and A Douglas, Safety at Sea Ltd, J Cichowicz, University of Strathclyde*

Ship systems are extensive and topologically complex; in addition their physical components are intrinsically linked to the watertight and fire-rated boundaries of the vessel's layout. The systems' common dependency on power generation and distribution adds challenges to the problem of verification of systems' operability when subjected to damages affecting individual spaces or group of spaces, as damage in a space may impact on the functionality and availability of one or more systems in different parts of the vessel. In this paper, a quantitative method for undertaking this assessment at early design stages is presented. The method is a practical application of Binary Decision Diagrams, used to model the functional relationships and dependencies of the system's physical components; these dependencies are defined on the basis of the ship systems' design principles and diagrams, which may vary in detail and resolution, allowing undertaking the assessment even at concept design stages.

### 16.50 - EVENING DRINKS RECEPTION

## day 2

09.30 - 10.00 COFFEE AND REGISTRATION

10.00 - 10.35 **LE BOREAL & L'AUSTRAL DESIGN : THE CRUISING YACHT CONCEPT**  
*T Tincelin, Stirling Design*  
*G Scherl, Fincantieri*  
*B Leblond, Ponant Cruises*

The aim at the heart of the Le Boreal and L'Austral designs was the concept of a cruising yacht. Entirely successful, the completed ships emanate a majestic and contemporary ambiance. Custom-built at the Fincantieri Shipyard in Ancona, Italy, Le Boreal was delivered to Compagnie du Ponant in April 2010. As the fourth ship of their cruise fleet, she can accommodate 264 passengers in 132 cabins with 95% passenger cabins featuring a private balcony.

This paper will also present the innovative and special solutions concerning safety, energy saving and new flag regulation for passengers with movement difficulties.

10.35 - 11.10 **NORWEGIAN EPIC PERFORMANCE**

*S Cordier, L Morand, S Branchereau and L Lemoine, STX France*  
*Cruise SA*

The Norwegian Epic was delivered to NCL by STX France in Saint Nazaire in July 2010 after it demonstrated its ability to meet the highest levels of standards in the cruise industry. The present paper addresses in detail the performance levels achieved in the key technical areas of naval architecture: hydrodynamics, noise and vibration and stability. Overall, the performance levels achieved in the key areas hydrodynamic, noise and vibration and stability, have heightened the comfort and safety standards of cruise vessels. In addition to the many new and exciting features for a cruise vessel, the Norwegian Epic is above all an outstanding ship.

11.10 - 11.40 COFFEE

11.40 - 12.15 **VOYAGE SIMULATION TECHNIQUES AS DESIGN TOOL FOR CRUISE VESSELS**  
*R Grin, Marin, The Netherlands*

An important aspect of the design and the operation of cruise vessels is the operational performance in terms of comfort, fuel efficiency and the ability to maintain schedule. Naval architects know that this is a trade-off, an improvement on one side means often a deterioration on the other side. For instance recovery of delays increase fuel costs and probably reduces the passenger comfort. A design with a good operational performance is therefore a design which has a good balance between these conflicting issues. This paper focuses on voyage simulations techniques, which help to find this delicate balance. Voyage simulations make it possible to account in detail for the dilemmas of the master and the incidental character of adverse weather. For each time step in the simulation the local weather conditions are obtained from large environmental time records. Subsequently the behaviour of the ship can be calculated and based on for instance passenger comfort it can be decided to reduce vessel speed. The operational performance is obtained by simulating a large number of voyages during several years of service. A case study will be presented for two modern cruise vessel designs of around 200 m and 300 m. For these vessels the effect of sailing area on sea keeping behaviour will be shown for a typical Caribbean, Mediterranean and World cruise. Furthermore, the effect of the changed regulations for damaged stability will be shown.

12.15 - 12.50 **ADAPTATION OF THE ARCHITECTURAL PROJECT TO THE NEW REGULATIONS S.R.T.P. (SAFE RETURN TO PORT).**  
*J Oliver, Oliver Design, Spain*

The aim of this paper is to present an innovative approach to integrate the new regulations (S.R.T.P.) in the general arrangement of conventional ferries between 1000 and 1500 passengers combining the Safety with the Innovation in the frame of a pleasant and functional internal accommodation attractive to the passenger. Regarding safety the proposal is based in the creation of three independent towers interconnected by staircase trunks, fire doors and a passage to the outside level. These towers have a margin in space and in case of accident it is possible to accommodate the remaining passengers dislodged from the damaged tower and incorporate them to accessible places perfectly integrated with the necessary services of food, drink and medical care. If the accident reaches a level that evacuation became necessary, this arrangement is very favourable for evacuation using the conventional means available on board.

12.50 - 14.00 LUNCH

14.00 - 14.35 **SURROGATE OPTIMISATION OF PROBABILISTIC SUBDIVISION INDEX**  
*R Puisa, D Vassalos, University of Strathclyde, UK*

Design of ship subdivision is a routine task in ship design. Probabilistic subdivision index "A", currently enforced by SOLAS2009, is used to assess the damage survivability of a designed vessel against the required survivability level, further maximising it as long as practicable. Due to complex relationship between subdivision design variables and Index "A", manual tuning of Index "A" proved generally irrelevant and computer algorithms implementing formal optimisation have been applied. However, recent research results indicate that the optimised function behind Index "A" is highly irregular and the optimisation has to be very intensive in order to succeed, i.e. find the global optimum. As direct calculation of Index "A" is tedious, such an intensive optimisation becomes prohibitive in practice, satisfying with suboptimal subdivision designs as a result. In this paper we further develop a surrogate function for Index "A" calculation, for complex subdivisions of passenger ships. This allows us replacing tedious calculations of Index "A" by quick and sufficiently accurate Index "A" estimates, so that intensive optimisation can be accomplished within minutes. We apply the developed method to subdivision optimisation of passenger ships and discuss the results in terms of accuracy and their relevancy to the global optimum.

14.35 - 15.10 **APPLICATION OF RISK ASSESSMENTS FOR THE COMPARISON OF ALTERNATIVE DESIGNS OF LIFE-SAVING APPLIANCES FOR PASSENGER VESSELS**

*K Loer and R Hamann, Germanischer Lloyd AG, Germany*  
*T Boekholt, Fr Fassmer GmbH & Co. KG, Germany*  
*P Kerveillant, STX France SA, France*

A process for analysing the equivalence for LSA appliances is defined in MSC.1/Circ.1212, it forms the foundation of GL's Guidelines on Guidelines for the Analysis of Alternative Design and Arrangements. In this paper the process of risk-based analysis of equivalency in the shipping industry is illustrated by the alternative design of survival craft. Due to the fact that regulators for the shipping industry have not yet specified risk evaluation and risk acceptance criteria, a relative risk analysis is performed. In such an analysis risk levels associated with SOLAS compliant designs are compared to risk levels associated with novel designs. From the risk assessment perspective, the risk model that was developed for the analysis is explained and the experiences from the application of the model are reported. From the operational perspective the practical experiences from the application of the alternative design process are described from the point of view of a shipyard and a lifeboat manufacturer.

15.10 - 15.40 COFFEE

15.40 - 16.15 **2000 - 2010 - A SUMMARY OF THE REGULATION CHANGES AFFECTING THE DESIGN & OPERATION OF PASSENGER SHIPS**  
*D Smith, Burness Corlett Three Quays, UK*

Over the past decade, there have been significant changes to the rules and regulations affecting the design and operation of passenger ships. These changes cover many diverse issues from environmental impact such as SOX and NOX emissions, ballast water and waste water treatment, to passenger safety such as disabled access and probabilistic damage stability regulations (SOLAS 2009) and affect the designers, builders and operators in different ways. This paper is an attempt at identifying the significant changes in the regulations within this time frame and to summarise the effects of such changes on all concerned.

16.15 - 16.50 **SAFETY (TOTAL RISK) MANAGEMENT FOR PASSENGER SHIPS**  
*W Cai, D Vassalos, D Konovessis and G Mermiris, University of Strathclyde*

This papers details a promising solution to this issue by considering maximisation of the engagement of all objective sources by systematically integrating available data into a centralised system that could closely support risk assessment. Thankfully, the time to realise such configuration is appropriate. Mandatory code of conduct (originating from implementation of the ISM Code) in conjunction with technological advancement of computer hardware and related software has made accident and incident data available at organisational level. At the same time, use of advanced data processing techniques, typically data mining, is capable of revealing patterns, trends and tendencies through large amount of data, by utilising appropriate scientific and mathematical techniques.

