The Royal Institution of Naval Architects

Fire at Sea

International Conference on
Fire at Sea

26-27 March 2014, RINA HQ, London, UK

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DAY 1 PAPERS:

09.00-09.30 COFFEE & REGISTRATION

FIRES ON SHIPS, *Jayan Peter Pillai MSc CEng FIMarEST MRINA MIBM, LNG Training Consultant*
In Europe, on ships over 500 gt, Fire & Explosions are the third largest cause of accidents, after Collision & Grounding. On Fishing Vessels, Fire is also the third largest cause of accidents. Figures for smaller vessels are not readily available, but there is a rising trend of accidents and fatalities. Are we doing enough ?

STUDY ON MARINE FIRE PREVENTION AND IMPLEMENTATION OF MARITIME RULES FOR FIRE CONTROL ON BOARD AT SEA, *Andra Diah Rachmawati, Muhammad Andira Mulia Siregar, Fire Safety Engineering Research Group, Thermodynamics Laboratory, Department of Mechanical Engineering, Universitas Indonesia*
Fire on board at sea is an event that must be avoided. 56% of the fires in the engine room on the board happened as a result of leakage of lubricating oil on a hot surface. In addition to causing death, loss due to an engine room fire can reach 1 to 4 million USD. Hence, there must be a fire safety systems based on maritime rules on board to preventing and overcoming the fire hazard. The main focus of this research was streamlined to prevent fire in ship's machinery spaces and how to implement maritime rules for fire control. An investigation was done to assess those factors which actually contribute or are in association to fire accident on board at sea using literature analysis study. Besides that, fire that may be appeared because of lubricating oil leakage on a hot surface in engine room is modeled in experiments. The results of this study indicates that the initiation of the first flame or time to ignition is always faster due to higher heating temperature, which achieved the fastest time on the ignition temperature of 550 oC, which only requires 117 seconds to reach the auto-ignition point. Thus, we need to implement the maritime rule regarding safety installation system on board properly. This study also develop a fire control and safety plan to prevent fire accident by using a system that can prevent and control the fire appropriately. KEYWORDS: Fire on board, lubricating oil, maritime rules, fire safety systems, fire control.

10.45-11.15 COFFEE

MODELLING FIRES ON SHIPS, *Saffron Wyse MSci PhD, Consultant, Frazer-Nash Consultancy Ltd*
Fires on ships pose a considerable risk during both operation and construction. Evaluating the effect of a fire can identify where additional mitigation is required to allow safe evacuation. The Royal Navy Queen Elizabeth Class Aircraft Carrier is currently undergoing construction, and fire defence systems are not operational. Frazer-Nash Consultancy, working with Babcock – a member of the Aircraft Carrier Alliance – has evaluated the benefit of installing smoke curtains as a risk mitigation option during this construction phase. Frazer-Nash quantified the likely benefit of installing smoke curtains using Computational Fluid Dynamics (CFD), and assessed the expected evacuation times of personnel during a large fire. By assessing the visibility and CO concentrations, the behavioural and physiological effects of the smoke on evacuating personnel could be quantified. The actual evacuation time from fire drills could then be directly compared to the modelled CO toxicity timescales. This demonstrated that the installation of well positioned smoke curtains resulted in significantly extended safe evacuation times. It also demonstrated that all stairwells would still remain safe evacuation routes. By considering the layout of a ship and identifying combustible quantities and locations, a ship design can be assessed and key risk areas identified. Modelling of the fire build-up, smoke and CO spread, allows an operator to see who will be most affected by the worst case fire. Operators can then compare this to evacuation simulations or tests and view mitigation from well positioned smoke curtains to ensure all personnel have a high chance of escaping unharmed.

FIRE MODELLING AND EVENT TREE ANALYSIS FOR NAVAL PLATFORM FIRE INCIDENTS
G. Gamble, B. Suendermann, Z. Mathys, A. Woolley
The ability to control fires on a naval ship is critical for safety of personnel and for the ship to continue to undertake its mission. Fires can be caused by both combat incidents and equipment or procedure failure. Fire behaviour modelling for naval platforms is important for understanding the size, spread and the damage control procedures for the successful mitigation of a fire event. Computational Fluid Dynamics (CFD) modelling has been undertaken to predict the behaviour and spread of fire and validated experimentally. Event tree analysis has also been applied as a method to identify and analyse the consequences of crew actions and the ability of fire safety systems to control fires onboard naval ships. The inclusion of activity duration and cumulative time allows for criticality analysis to identify strategies or configuration changes that provide the best probability of successfully controlling and extinguishing the fire. The methodology is particularly useful for configuration trade-off analysis during the design phase of the capability acquisition process; or for the comparison of competing platform designs. Similarly, during capability upgrade, proposed changes to fire safety procedures, equipment and/or crew complement may be analysed for efficiency during damage control events involving fire fighting. This paper presents CFD modelling of a compartment fire experiment, and event tree methodology to examine naval fire safety with a case scenario to illustrate the application of event trees for fire safety.

12.25-13.25 LUNCH

HISTORY OF SHIP FIRES IN PORTS. THE IMPORTANCE OF PREVENTIVE MEASURES AND TRAINING, *D. Incertis, Port Institute for Studies and Cooperation - FEPORTS, Valencia, Spain*
Commercial ports concentrate in a relatively small space, vessels, vehicles, passengers and cargo, both on board and on the docks and storage areas. They also contain facilities for receiving, handling, transferring and storing all types of goods, comburent or combustible. They are usually intermodal transport nodes, often located very close to cities, containing infrastructure for rail, road or pipeline of such goods and may also include shipyards which may suppose additional risks. Vessels and ports are therefore vulnerable to fires. Fires on ships inside a port suppose the added risk of propagation to other vessels or facilities and may also cause other collateral effects like explosions, collapse of infrastructure and loss of life, but may also have the advantage of easier access to extinction. History is full of dramatic cases that have forged preventive measures, training programmes and technology upgrades for the detection and extinction of fires. Fire has been present at ports through History, from the intentioned "fire ships" used in the battles of antiquity, by way of remarkable accidents such as the "Cabo Machichaco" in 1893 which after a fire exploded in the port of Santander causing over eight hundred dead, up to more recent cases such as the "Proof Spirit", in the shipyards of Union Naval de Levante in Valencia, which caused 18 deaths in 1997. This article is a review of accidents of this type –vessel fires happened in ports- throughout history and what measures have been taken to prevent or cope with them.

EFFECTS OF FIRE FIGHTING WATER ON VESSEL'S FLOATING CONDITION AND HULL STRUCTURE, *Kai Ahlers, DNV GL*
If afire can not be quenched by the use of CO2 fire extinguishing, there is an alternative to use water for fire fighting. This additional fire fighting water has a non-negligible effect on the floating position, stability and strength of a vessel which must be considered in advance to avoid further distressed situations. Due to free surface effects of the additional water, that fire fighting water may collect on a ship's side and lead to a strong heeling of the vessel. But even with a flooding of a cargo hold to put the burning container und water, it must be considered the filling height up to which level the steel structure can be loaded to prevent permanent deformations and damages. For larger damages caused by fire or explosion on board a vessel structural damages as well as changes in the material properties must be taken into account. The Emergency Response Service of Germanischer Lloyd has already been entrusted with several such requests. During the proposed presentation, we would like to present our experience in the use of fire-fighting water onboard, and draw attention to the critical points with respect to stability and strength of a vessel.

14.35-15.05 COFFEE

HUMAN ERRORS LEADING TO FIRE AT SEA, *Tanumoy Sinha, H V Uday Bhaskar, Indian Maritime University-Visakhapatnam Campus, Dept. of Naval Architecture and Ocean Engineering*
History is full of cases where Human errors have caused fires aboard ships. The SS Normandie is one classic case. Man-made causes are said to account for 80% of marine accidents. From the lowliest crew member up through the chain to the CEO of the company, human beings design, build, sail, maintain and manage ships. Any one of these persons or functions can contribute to a shipboard fire, for example through poor system / structural design, poorly built systems (particularly fuel oil systems), inadequate maintenance, and even the company's management policies which govern to a large extent the safety of the vessel. The systems are no good if not understood, tested and maintained. Therefore human errors are at the top of the list. Even if the direct cause of an accident is a human error, finding and eliminating the root cause of such error is vital to prevent its recurrence. A case study of the Bow Mariner disaster (including various other cases) has been taken up, discussing the various human errors which lead to the mishap. A general study on human factors in design, construction, operation and maintenance leading to fires has also been discussed. Based on the data obtained from the research, suggestions have been given to reduce human errors and thus ensure safety at sea.

ENHANCING THE GLOBAL SAFETY BY SITUATIONAL AWARENESS AND ERGONOMIC DESIGN
Sandro Stefani, MARTEC GROUP SpA, Italy
The recent engine room fires occurred on some cruise vessels have highlighted some issues, among others the need of operating redundancies to machineries and systems and enhanced fire suppression. A further aspect of these issues is related to human factors. In fact, any redundant solution could be completely inadequate if the operators do not get immediate and clear information of the casualty in progress. Therefore, it is necessary to improve the situational awareness of the operators by providing them with additional tools in the direction of decision making process and ergonomic working environment. One of the new features introduced in the Safety Monitoring and Control System by Martec is the Decision Support System (DSS). DSS provides a list of ac¬tions to be executed to fight the emergency, prepared in accordance to the emergency proce¬dures defined by the Shipowner. In addition, the DSS can support the reconfiguration of the system after the emergency, in accordance to the Safe Return to Port regulation. Ergonomic working environment is essential in emergency situations where reliable and quick decisions are to be undertaken by the operators. This is the criteria that has led to the development of an integrated safety centre in co-operation with Carnival Corporate Shipbuilding for the new Royal Princess vessel. The integrated safety centre features a number of innovations, such as ergonomic workstations and console, video wall, tactical table, etc. to facilitate the exchange of information and the teamwork by the operators.

16.15- GENERAL DISCUSSION & EVENING DRINKS RECEPTION

AT SEA
RINA HQ, London, UK

DAY 2 PAPERS:

09.00-09.30 **COFFEE & REGISTRATION**

FIRE RISK ANALYSIS OF A CUTTER SUCTION DREDGER, *Eric Jal and Cherie Holland, AMOG Consulting, Australia, Michel Twigt and Vincent Haag, Van Oord, The Netherlands*
Fire represents one of the greatest threats to the safety of ship personnel. In addition to the risk of death or injury, fires on vessels can also cause extensive structural or equipment damage, which invariably result in significant monetary consequences in both repairs and vessel availability. Van Oord operates a fleet of around 100 vessels, and a new self-propelled cutter suction dredger was recently added to this fleet. The proposed paper would describe the results of a performance based risk assessment conducted during this vessel's design phase, demonstrating how such an analysis was able to optimise the design to minimise the risk to personnel and structure from the effects of fire. The studies used to support the risk investigation were a fire and smoke propagation Computational Fluid Dynamics (CFD) analysis combined with an in-house developed method for an egress assessment. The study encompassed a preliminary fire severity screening qualitative risk evaluation for all of the vessel spaces to identify those spaces associated with the highest fire risk. This provided a means to focus the modelling requirements to a number of identified fire scenarios to facilitate input for a semi-quantitative assessment of risk to personnel and equipment due to a fire. The severity and frequency of the outcomes for each fire scenario was determined using an event tree analysis that established the level of risk, and control measures (aligned to SOLAS and IMO requirements) were identified in order to mitigate the level of risk to the crew, equipment and vessel structure.

ANALYSIS ON THE EFFECTIVENESS OF FIRE SAFETY EQUIPMENT IN RESISTING THE SPREAD OF HEAT AND SMOKE DURING FIRE ACCIDENT ON RO-RO PAX CROSSING FERRY (CASE STUDY ON LOCAL INDONESIAN FERRIES), *Sunaryo Sunaryo, Naval Architecture Study Programme University of Indonesia*
The percentage of marine fire accidents is considerably high in Indonesia, reaching about 41% out all major recorded marine accidents. More than a half of those fire accidents happened onboard ro-ro crossing ferries and claimed a great number of casualties. Based on a number of investigation reports the fire mostly came from the vessels' engine room or from the vehicle deck due to various sources. The fire and the smoke created by it then spread to other areas including passenger lounge, that usually made the passengers panic because of the heat, low visibility, and inhale of toxic gas, which made them difficult to find the evacuation routes, and trapped in the confined space. The study was carried out using fire simulation software with the aim to analyze the effectiveness of sprinklers, smoke exhaust and fresh air supply fans operated in the vehicle decks and passenger lounge in resisting the spread of heat and smoke in the ferry's passenger lounge during the fire accident so that passengers would have enough time to evacuate to the safe place. Results of the simulations concluded that the existence of sprinklers could maintain the room temperature under 600 C, and the activation of smoke exhaust and fresh air supply fans could maintain the visibility for 30 m, which means that the passengers are able to evacuate through escape routes.
Keywords: Fire accident, fire safety equipment, heat, smoke, visibility.

10.40-11.10 COFFEE

WHEN IS IT TOO EARLY TO ENTER THE ENGINE ROOM IF FLOODED WITH SMOTHERING GAS?, *Captain Ozan DERMEN,*
Fixed Gas Fire Extinguishing systems are very efficient fire suppression means but it is also vital to keep closed the compartments on fire long enough to prevent a secondary fire due to fresh air ingress. This article aims to find out if there is any relationship between the severity of the re-entry conditions and the duration of the waiting period before and following the release of the smothering gas. Besides, it intends to define a minimum period of time that is sufficiently long enough to safely enter the compartment without any re-ignition hazard. 11 fire incidents were selected among 22 fire reports, all of which has occurred on commercial vessels in the last 17 years. During the organization of the data, only engine room fires extinguished by halon or CO2 are selected for a reliable comparison. Besides, any extinguishing attempt with a deviation from the industry's standard smothering gas release procedure is excluded. Finally, the risk level of each re-entry was rated from low to high according to the presence of post-fire hazards, all of which were observed during these fires. The examination of the incidents indicates that a shorter delay before the release of smothering gas improves the re-entry conditions significantly. Thermal inertia and radiation play an important role in this relationship. Besides, a longer waiting period following the release also produces more favourable conditions for the fire fighters.

REAL TIME PRACTICE THE MISSING LINK BETWEEN FIRE MANAGEMENT TECHNIQUES TAUGHT AND PREVENTATIVE MEASURES AND TRAINING LEARNT AND APPLIED?
Anthony Beckett, Australian Maritime College, Australia
This paper presents an argument that there is a missing link between what a maritime student is taught in the classroom and the ability to provide practical application in a simulated work environment when it comes to dealing with or preventing fire emergencies on-board a vessel. The paper will further argue that whilst international maritime regulating bodies have since 1992 identified the human element as being a dominant feature in ship board fires, there has been little done up until the Manilla amendments of 2010, to address the key areas of training, re-training and demonstration of skills. The paper will follow a typical Presea student through their maritime education and training on subjects that deal with emergency response to the point they are on-baord in charge. The paper concludes the argument by suggesting that whilst we have mandated conventions on vessel design, equipment carried, safety management systems, training and qualifications, unless our ship-board managers of today are tested in real time situations to show how they react whilst under vessel operating pressure with limited resources, we will not be able to address or lower the statistic that ship fires rate as the number three cause of loss for marine vessels worldwide.

12.20 **GENERAL DISCUSSION**

CONFERENCE DETAILS

Fire remains one of the top three causes of loss for marine vessels in the World Fleet, and is a major risk for Ro-Ro ferries, due to their open decks, and Passenger Ships due to ever increasing passenger numbers. The risk of fire may never be eliminated, but its effects can be mitigated.

With a unique operating environment, conventional fire fighting techniques are sometimes difficult to implement onboard ship. Technologies that involve starving a fire of oxygen are generally the most popular, however they still pose risks, especially to the crew. The revision of SOLAS Chapter II-2 has put a greater focus on the prevention of fire through effective crew training and design stage planning. And advances in technology mean that detection equipment can lead to a quick response that maintains the integrity of the vessel.

Attendance at the Fire at Sea conference qualifies as Continuing Professional Development. Delegates to the conference will receive a CPD Certificate

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