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ΘΕΜΑ

Ro-Ro vessel safety: lessons learned from the cases of Herald of Free Enterprise and Estonia

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Ημερομηνία ανάληψης της εργασίας:

Ημερομηνία παράδοσης της εργασίας:

Α/Α	*Ονοματεπώνυμο*	*Ειδικότητα*	*Αξιολόγηση*	*Υπογραφή*
1				
2				
3				
ΤΕΛΙΚΗ ΑΞΙΟΛΟΓΗΣΗ				

Ο ΔΙΕΥΘΥΝΤΗΣ ΣΧΟΛΗΣ : ΤΣΟΥΛΗΣ ΝΙΚΟΛΑΟΣ

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ABSTRACT

In the present project there is an analysis of two major maritime accidents that happened 40 years ago. These accidents happened to vessels “HERALD OF FREE ENTEPRICE” and the “MV ESTONIA”. The aim of this specific work is the general information of anyone who is interested about these accidents and what went wrong with them, what we leanred from these accidents and to inform about the Ro-Ro vessel safety in general.

The project is divided into 8 chapters. Chapter 1 gives us information about the Ro-Ro vessels and their development throughout the years. Chapter 2 presents the infamous accidents. Chapter 3 compares the accidents and the similarities and the differences between them. Chapter 4 analyzes what went wrong in these cases. Chapter 5 discusses about the stuff we learned from these cases. Chapter 6 tells us about the humar error and how much of a factor it is. Chapter 7 analyzes us how safe are the Ro-Ro vessles in reality and Chapter 8 is all about the legisltative framework and the ammendments that came into force after the accident

PREFACE

The roll-on/roll-off ship is one of the most successful types operating today. Its flexibility, ability to integrate with other transport systems and speed of operation have made it extremely popular on many shipping routes. One of the Ro-Ro ship's most important roles is as a passenger/car ferry, particularly on short sea routes. But despite its commercial success, the Ro-Ro concept has always had its critics. There have been disturbing accidents involving different types of Ro-Ro ship, the worst being the sudden and catastrophic capsizing of the passenger/car ferry Herald of Free Enterprise in March 1987 and the MS ESTONIA in September 1994. These terrible accidents demonstrate what can go wrong in a Ro-Ro vessel and how can we learn from these and improve the safety. Furthermore to these accidents, IMO has adopted many amendments to the International Convention for the Safety of Life at Sea (SOLAS) which are intended to ensure that incidents of that type would not happen again and more importantly what actions should be taken before such an event.

CHAPTER 1
RO-RO VESSELS & DEVELOPMENT

CHAPTER 1.1
INTRODUCTION TO RO-RO VESSELS

Roll on-Roll off or Ro-Ro vessels can come in many forms including vehicle ferries and cargo ships carrying truck trailers, but the major type used for the transport of road vehicles is the car carrier. These slab-sided vessels feature multiple vehicle decks comprising parking lanes, linked by internal ramps with access to the shore provided by one or more loading ramp. Cargo capacity of such vessels is measured in Car Equivalent Units (CEU) and the largest car carriers afloat today have a capacity of over 6,000 CEU. The two important measures indicating the size of Ro/Ro are the length of the marked parking lanes and the size of the entrance ramp. Once the cars are aboard, they are braced to the ship’s deck to keep them from moving around while the ship is at sea. Ro/Ro vessels are suitable for cargo which can be driven on/off the ship such as cars, lorries and cargo on trailers. This ship type is quite popular to transport vehicles as it is safer and much faster to just drive a car onto the ship instead of using a crane. Most ferries and cruise ships are Ro-Ro ferries as they usually carry out short journeys for a mix of passengers, cars and commercial vehicles can easily drive straight on and off.

Picture 1

Source : https://www.marineinsight.com/types-of-ships/what-are-ro-ro-ships/

(Retrieved 13/06/20)

According to ShipPax, in 2004, more than 1.3 billion passengers, 188 million cars, 856,000 buses and 28.7 million trailers were carried on 5.9 million crossings globally.The total number of ferries worldwide at 1 January 2006 (excluding ferries less than 1,000 gross tonnage) was 1,162, with a combined capacity of 1.15 million passengers and 226,210 cars or 769,210 lanemetres of commercial vehicles. Combined gross tonnage was 12.8 million and the average age of the fleet was 21

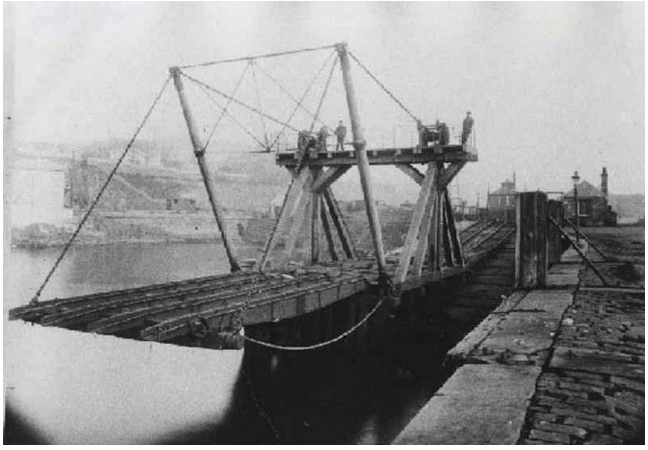
CHAPTER 1.2
DEVELOPMENT OF RO-RO VESSELS

The modern roll-on/roll-off ship can trace its origins back more than one hundred years to the early days of the steam train. Ships were specially designed to take trains across rivers which were too wide for bridges: the ships were equipped with rails, and the trains simply rolled straight on to the ship, which sailed across the river to another rail berth where the train would roll off again. An example is the Firth of Forth ferry in Scotland which began operations in 1851.It was not until the Second World War, however, that the idea of applying the ro-ro principle of road transport became practicable - and was used in constructing the tank landing craft used at D-Day and in other battles. The principle was applied to merchant ships in the late 1940s and early 1950s. It proved to be extremely popular, especially on short-sea ferry routes, encouraged by technical developments on land as well as sea, notably the increase in road transport.For the shipper, the ro-ro ship offered a number of advantages over traditional ships, notably speed. As the name of the system implies, cars and lorries can drive straight on to a ro-ro ship at one port and off at the port on the other side of the sea within a few minutes of the ship docking.Ro-ro ships also integrate well with other transport development, such as containers, and the use of Customs-sealed units (first introduced in the late 1950s) has enabled frontiers to be crossed with the minimum of delay, thereby further increasing speed and efficiency for the shipper.Ro-ros have also proved extremely popular with holiday makers and private car owners and have significantly contributed to the growth of tourism. Until the early 1950s someone wishing to take his car from one country to another by sea had to get it loaded into the ship's hold by crane, a time-consuming and expensive process. The development of the ro-ro car ferry changed all that and many ports boomed as a result.

Picture 2

Source : http://www.grantonhistory.org/transport/train_ferry.htm

(Retrieved 13/06/20)



Picture 3

Source : http://www.grantonhistory.org/transport/train_ferry.htm

(Retrieved 13/06/20)

CHAPTER 2

CASES

CHAPTER 2.1

CASE A : HERALD OF FREE ENTEPRICE

Picture 4

Source : https://en.wikipedia.org/wiki/MS_Herald_of_Free_Enterprise

(Retrieved 09/05/20)

On the 6th March 1987, the Roll on/Roll off passenger and freight ferry HERALD OF FREE ENTERPRISE under the command of Captain David Lewry sailed from Zeebrugge (Belgium). The HERALD was manned by a crew of 80 was laden with 81 cars, 47 freight vehicles and three other vehicles. Approximately 459 passengers had embarked for the voyage to Dover, which they expected to be completed without incident in the prevailing good weather. There was a light easterly breeze and very little sea or swell. Due to negligence of the bosun who felt asleep, her bow doors had not been closed before leaving the harbour. When the ferry reached 18.9 knots (33 km/h), water began to enter the car deck in large quantities. This destroyed her stability. Within seconds, the ship began to list 30 degrees to port. The entire event took place in less than a minute. The water quickly reached the ship's electrical systems, destroying both main and emergency power and leaving the ship in darkness. During the final moments the HERALD turned rapidly to starboard and was prevented from sinking totally because her port side took the ground in shallow water. The HERALD came to rest on a heading of 136" with her starboard side above the surface. The accident resulted in the deaths of 193 passengers and crew members. Many others were injured. The position in which the HERALD came to rest was less than 7 cables from the harbour entrance and was latitude 22' 28.5" North, longitude 3" 11' 26" East

Picture 5

Source : https://www.maritimecyprus.com/2020/03/07/flashback-in-maritime-history-herald-of-free-enterprise-disaster-capsized-and-sank-on-6-mar-1987-193-lives-lost

(Retrieved 16/05/20)

CHAPTER 2.2
CASE B : MV ESTONIA

Picture 6
Source : https://onse.fi/estonia/chapt01.html
(Retrieved 16/05/20)

The Estonian-flagged Ro-Ro passenger ferry ESTONIA departed from Tallinn, the capital of Estonia, on the 27th September 1994 at 19:15 for a scheduled voyage to Stockholm, the capital of Sweden. She carried 989 people, 803 of whom were passengers.

Picture 7

Source : https://onse.fi/estonia/chapt01.html

(Retrieved 16/05/20)

The voyage proceeded normally. Sea conditions along the Estonian coast were moderate, but became more rough when the ship left the sheltered waters. The ship had a slight starboard list due to a combination of athwartships weight disposition, cargo disposition and wind pressure on the port side. During his scheduled round on the car deck the seaman of the watch heard shortly before at 01:00 a metallic bang from the bow area as the vessel hit a heavy wave. The seaman of the watch informed the second officer about what he had heard and was ordered to try to find out what had caused the bang. The seaman did so by waiting at the ramp, listening and checking the indicator lamps for the visor and ramp locking devices. He reported that everything seemed to be normal. Further observations of unusual noise, starting at about 01:05, were made during the following 10 minutes by many passengers and some crew members who were off duty in their cabins. When the seaman of the watch returned from his round, soon after the change of watches, he caught up the master and entered the bridge just behind him. Shortly afterwards he was sent down to the car deck to find out the cause of the sounds reported by telephone to the bridge. He did not, however, manage to reach the car deck. At about 01:15 the visor separated from the bow and tilted over the stem. The ramp was pulled fully open, allowing large amounts of water to enter the car deck. Very rapidly the ship took on a heavy starboard list. She was turned to port and slowed down.

Passengers started to rush up the staircases and panic developed at many places. Many passengers were trapped in their cabins and had no chance of getting out in time. Lifejackets were distributed to those passengers who managed to reach the boat deck. They jumped or were washed into the sea. Some managed to climb into liferafts which had been released from the vessel. No lifeboats could be launched due to the heavy list. water had started to enter the accommodation decks. Flooding of the accommodation continued with considerable speed and the starboard side of the ship was submerged at about 01:30. During the final stage of flooding the list was more than 90 degrees. The ship sank rapidly, stern first, and disappeared from the radar screens of ships in the area at about 01:50. The position of the wreck is at 59°22,9´ N, 21°41,0´ E.

CHAPTER 3

SIMILARITIES AND DIFFERENCES BETWEEN THE TWO CASES

CHAPTER 3.1
SIMILARITIES

Even though these accidents have different causes, it is hard to ignore some simililarities between them. First of all both vessels when they started their voyage, they expected a normal voyage without any setback considering the good weather and the good sea. Even though in the case of MV ESTONIA the weather become rough after a short while. The important similarity is that both vessels were not prepared for such an event, and both were ready for one more routine like day. One more similarity is that both crews on the vessels had poor communication. There are many occasions that shows us how poor the communication was between the officers and the crew. This bad communication led to many wrong decisions. Last but not least we see one more notable similarity. The place of the vessel that we had the inflow was the same, and that was the bow ramp. This indicates how dangerous is this specific part of the vessel and why the Ro-Ro vessels are considered very unsafe.

CHAPTER 3.2
DIFFERENCES

The differences in these accidents are far more apparent. The main difference that we notice is the cause of the accident. In the first case of the HERALD OF FREE ENTEPRICE the only reason that caused the accident was a humar error, and this error is that the bosun felt asleep and did not close the ramp. Contrary to this, in the second case of the MV ESTONIA, the reason that causes the accident was that the visor separated from the bow and tilted over the stem. Another difference is that in the case of HERALD OF FREE ENTERPRICE , the crew had not time to react because they did not know that something was wrong until the very last moment and in the case of MV ESTONIA the crew reported some unsual sounds that came from the bow so they could know that something is wrong.

CHAPTER 4

WHAT WENT WRONG?

CHAPTER 4.1
HERALD OF FREE ENTEPRISE

A small amount of water into the open deck area will cause the ship to capsize very quickly even in a gentle swell. That was the main reason for the capsizing of HERALD OF FREE ENTERPRISE since the outer and inner bow doors had been left open. Also the badly constructed bow doors was another reason that did not help the situation. There are many accidents that a chain of humar error played a big role for them to happen and this is one of them.The combination of human errors (management, design and individual) resulted in the loss of 188 lives. The significant human errors included the following:

- Ship's Design : In the case of the 'HERALD OF FREE ENTERPRISE' the master should have confirmed with the person in-charge if the bow door was closed. The design of the ship made it impossible for the master to see if the bow doors were open or close. Also the construction of the bow door was not good.

- Lack of Communication : Lack of communication is also a main factor for this cause. There was lack of communication between the master and officer in charge of stations to verify the status of the doors. Everything was based on assumptions which should not have been the case for an efficient working atmosphere. Established facts and not assumptions should be relied upon. There was no positive reporting system as to confirm the closure of the doors and it was assumed that the doors were shut.

- Fatigue of personnel : The Herald of free enterprise assistant bosun, who was directly responsible for closing the doors, was asleep in his cabin, having just been relieved from maintenance and cleaning duties,as no record of rest hours of personnel were being monitored . Maybe he was overworked or under the influence of alcohol thus he could not hear the station signal being called out.

- Responsibility of Officers : The chief officer, responsible for ensuring door closure, testified that he thought he saw the assistant bosun going to close the door.Towards the last moments of loading the chief officer took over from the second officer at the loading deck and later proceeded to the bridge not confirming the doors were shut . The chief officer showed lack of competence in ensuring the safety of the vessel again assuming that all was in order .The second officer being at stations did not realise that he was short of a person and it was not reported to the master. The chief officer was also required to be on the bridge 15 minutes before sailing time.

- Stability : The chief officer sailed the ship three feet down at the bow which made the bow doors more close to the waterline and thus easily vulnerable.The loading ramp at Zeebrugge was too short to reach the upper car deck. To clear the gap, the captain put sea water into the ballast tanks to lower the ship, but forgot to release the water afterwards. There was one more factor: when a ship sails, the movement under it creates low pressure, which sucks the bow downwards. In deep water the effect is small and in shallow water it is greater, because as the water passes underhull, it moves faster dragging the bow down more. This reduced the clearance betwen the bow doors and water line to 1.5 metres. Although the bow doors were open and they were 1.5 metres above the water.

- Overload of work : As the cargo duties were shared between two officers , managing time and work pressure had taken a toll on them . Fatigue must have set into them and duties were misunderstood as to who was responsible for being at the loading deck to check the loading was completed and all was in order. The Chief Officer’s primary duty is management and he was proved to be a bad manager because he did not plan the work and rest period of the crew.

- Standing Instructions : It seems that the captain was to assume that the doors were safely closed unless told otherwise, but it was nobody’s particular duty to tell him . The written procedures were unclear There was no written instructions about the responsibility of closure of the doors and duties were not properly understood , this being the reason for the bosun after seeing the bow doors open assumed that the closing of the doors was the responsibility of the able seaman.

- Pre-Departure Checklist : There was no concise checklist determining the closure of the bow doors ,if there was one in place , this would not have gone unnoticed.

- Pressure to leave the berth : Due to the commercial pressure and the vessel was to sail immediately , the chief officer had to go to the bridge without confirming the doors were shut and the vessel was ready to sail , assuming the task would be carried out .

- Bridge and Navigational Procedures: This conflict in duty reflects the poor thought by the management ashore These procedures laid down by the company was not transparent and had ambiguity in it is instructions as to whether the O.O.W or the master was to be on the bridge 15 minutes prior to departure. As the O.O.W (chief officer or second officer) was in charge of loading at the final stage and then report to bridge was impractical as he could not be at two places at the same time.

- Indicator Lights : There was no information display (not even a single warning light) to tell the captain if the bow doors were open. Two years earlier, the captain of a similar vessel owned by the same company had requested that a warning light should be installed, following a similar incident when he had gone to sea with his bow doors open. Company management had treated the request with derision.

- Company Management: Company management did not accept its responsibility for safe management of the vessel. The management failed to give precise orders for safety of the ships. The Master was to assume that if no deficiencies have been reported vessel was ready in all respects to proceed to sea. Master found it safe to leave the berth in the absence of any reports .Since the chief officer did not report possibility of any such occurrence, Master assumed vessel is ready for sea. This was a very dangerous assumption which lead to this disaster. The company, Master and Chief Officer are equally responsible for this.

CHAPTER 4.2
MS ESTONIA

As we said, a very small inflow of water in the ship is enough to capsize it. Although the capsizing of MS ESTONIA was not caused entirely by human errors but rather on ship's design and the fact that the visor attachments were not designed according to realistic design assumptions. More specifically :

- The visor attachments were not designed according to realistic design assumptions, including the design load level, load distribution to the attachments and the failure mode. The attachments were constructed with less strength than the simplistic calculations required. It is believed that this discrepancy was due to lack of sufficiently detailed manufacturing and installation instructions for certain parts of the devices.

- The bow visor locking devices should have been several times stronger to have a reasonable level of safety for the regular traffic between Tallinn and Stockholm.

- The ESTONIA capsized due to large amounts of water entering the car deck, loss of stability and subsequent flooding of the accommodation decks.

- The full-width open car deck contributed to the rapid increase in the list. The turn to port - exposing first the open bow and later the listed side to the waves - shortened the time until the first windows and doors broke, which led to progressive flooding and sinking.

- The design arrangement of bow ramp engaging with visor through the box-like housing had crucial consequences for the development of the accident.

- Non-compliance with the SOLAS regulations regarding the upper extension of the collision bulkhead, accepted originally by the national administration, may have contributed to the vessel's capsizing.

In addition to all these, the crew also did some mistakes. In fact:

- The initial action by the officers on the bridge indicates that they did not realise that the bow was fully open when the list started to develop.

- The bridge officers did not reduce speed after receiving two reports of metallic sounds and ordering an investigation of the bow area. A rapid decrease in speed at this time would have significantly increased the chances of survival.

There are indications that the crew did not use all means to seek or exchange information regarding the occurrence at a stage when it would still have been possible to influence the development of the accident. The bridge crew apparently did not look at the TV monitor which would have shown them that water was entering the car deck; nor did they ask those in the control room from where the ingress was observed, or get information from them.

CHAPTER 5

LESSONS LEARNED

CHAPTER 5.1

HERALD OF FREE ENTERPRICE

A general culture of poor communication in the owner company was highlighted soon after the accident. In this respect, the Court stressed the need for:

- Clear and concise orders.
- Strict discipline.
- Attention at all times to all matters affecting the safety of the ship and those onboard. There must be no “cutting of corners”.
- The maintenance of proper channels of communication between ship and shore for the receipt and dissemination of information.
- A clear and firm management and command structure.

Additionally, shortly after the accident, the UK called IMO to amend SOLAS, 1974. Starting from April 1988, the MSC adopted SOLAS amendments, including among others:

- A new regulation requiring indicators on the navigating bridge for doors which, if left open, could lead to major flooding

- A new regulation requiring monitoring of special category and ro-ro spaces to detect undue movement of vehicles in adverse weather, fire, the presence of water or unauthorized access by passengers whilst the ship is underway.

- Provision of supplementary emergency lighting for ro-ro passenger ships.

- The so-called "SOLAS 90" standard, relating to the stability of passenger ships in damaged condition.

- A new regulation requiring cargo loading doors to be locked before the ship proceeds on any voyage and to remain closed until the ship is at its next berth.

CHAPTER 5.2

MV ESTONIA

Since the accident of the vessel "ESTONIA" was not caused mainly by human error, the only thing we can learn and improve from this accident is the response that it got and how fast it was. Search and rescue cooperation plans have been developed between passenger ships, their operators and SAR services. Ro-Ro passenger ships of the type that responded to the Estonia disaster were quickly required to be fitted with means of rescue and, after long and sometimes difficult debate, all ships on international voyages are now required to have ship-specific plans and procedures for recovery of people from the water – although this regulation only came into force on 1 July 2014. But not everything is as ready as it might be. Mass rescue operations are rare events, and maintaining enough dedicated capability to respond to them is impractical. There is consequently a 'capability gap', which needs to be filled when such an event eventually occurs. "The IMRF has played its part in helping to improve readiness, and to fill that 'capability gap'. We took a leading role in the debate on the recovery regulation, for example, and helped prepare detailed guidance when the International Maritime Organization (IMO) conducted a full review of passenger ship safety some years after the Estonia went down. "Said IMRF CEO Bruce Reid. "Now, with our mass rescue operations (MRO) project, we are seeking to improve things still further, providing a focus on the subject and a forum for discussion. We have run three maritime mass rescue conferences, seeking to learn the lessons of such high consequence incidents. Our first, in 2010, was addressed by Esa Mäkelä, master in 1994 of the ferry Silja Europa and on scene commander (as the role was then called) for the response to the Estonia disaster. Astonishingly, we were the first to ask him to speak about his experience, nearly 16 years after the event. Learning lessons can be a difficult process." From our conferences, and guided by a subject-matter expert group, the IMRF are developing mass rescue guidance covering all the main aspects of such events so that planners and responders can better prepare. Filling that 'capability gap', for instance, can be a matter of sharing resources internationally; of identifying and utilising additional resource such as shipping in the area; or of extending survival times by providing on-scene support. From this gathered and shared experience the IMRF has developed a mass rescue workshop package, designed to bring the main players together to talk through the issues, examining both the problems and potential solutions. Good communication, before, during and after such difficult cases, is vital to good response.

“Disasters like that that befell Estonia*,”* added Reid “are thankfully rare. But their rarity is part of the problem: it is difficult to maintain readiness. The IMRF’s MRO project – getting the right people talking together and providing them with guidance based on accumulated experience – helps to overcome that difficulty. It is 20 years since Estonia – and yes, things have improved. But there are still improvements to be made, and we need to focus on them. For, with mass rescue operations, it is not really a matter of ‘if’. It is a matter of ‘

CHAPTER 6

HUMAN ERROR

As we mentioned before, the main cause of the accident of the HERALD OF FREE ENTERPRICE was simply the human error. The causes that top the list like collisions, fires, explosions, ships being lost, etc are all results of human errors in one way or the other. It is a rather amazing result of studies conducted looking into maritime accidents and their causes. These studies were aimed at finding out root causes of these accidents in a bid to improve maritime security. The results indicated that in most cases (almost 96%) the reason for maritime accidents was human error. Human error can occur in many forms and can even lead to fatal situations. There have been reports of maritime accidents that have occurred solely due to human errors. From small fires that can lead to big explosions to full on collisions, the scale of accidents that can result from human errors is uncomfortably large. The reason why human errors play such a vital role in marine industry despite of excessive mechanization and technical advancement is that even with everything, marine industry remains a people’s industry. There are machines running on software programmed into a computer but you need a person on that computer to be looking into it. Error on part of that person means the entire chain reaction of errors is put into action ultimately leading to a not-so-good outcome. The extensive studies looking into human errors and their implications have categorized few reasons that mostly lead to a mistake somewhere, the top most reason being fatigue. The studies have revealed that in most cases, it is an overworked tired and somewhat disoriented crew that fails to make the right decision which maybe as small as pulling the correct lever. Another of the top reasons for human error is insufficient communication.Where the crew fails to communicate effectively with each other, the risks of maritime accidents increase manifold. Another important reason for human error that is detrimental to marine industry as a whole is insufficient knowledge. High-tech gadgets around people who have not been provided with sufficient training to use them would be equivalent to nothing. This is a seemingly minor thing but ships have been sunk because someone couldn’t operate the emergency alert system. Other reasons include improper hazard management training, faulty managerial decision, insufficient knowledge, lack of maintenance of standards etc which result in a mistake being made somewhere. But whatever the reason maybe, the fact remains that there is a human hand in each major accident. To sum it up, below are the main reasons for maritime accidents:

- Fatigue
- Inadequate Communication
- Lack of general technical knowledge
- Inadequate knowledge of ship's system
- Automation Error
- Decision based on incomplete information
- Faulty standards and procedures being followed
- Poor maintenance
- Hazardous working enviroment

The window for human error is small if you consider it singly in the bigger picture but this single little window is where the sole of ship lies. Maritime industry depends on its manpower to keep it running smoothly. Hence, even seemingly minor errors by a single person can lead to a series of errors, something marine industry can definitely not afford. As such, it is important that implications of such minor things should be understood. Under manning of ships, insufficient marine training, inadequate knowledge about entire technology present on this ship, lack of emergency drills are all the levers that can widen the window for human error. It is important that the implications of such errors should be understood right up to the management level of marine industry so that desired actions can be taken right from the top to the final leg.

CHAPTER 7

HOW SAFE ARE THE RO-RO VESSELS?

Because of the publicity surrounding accidents involving passenger ro-ro ships such as the Herald of Free Enterprise and Estonia, it is sometimes assumed that this type of ship is much more dangerous than others. The statistics are not showing this though. The World Casualty Statistics for 1994 published by Lloyd's Register of Shipping show that passenger/ro-ro cargo loss rate per thousand ships was 2.3 - the same as the average figure for all ships. However, when one considers loss of life at sea the picture changes. Between 1989 and 1994, the Lloyd's Register figures show that 4,583 lives were lost in accidents at sea. Of these 1,544 were lost in accidents involving passenger/ro-ro cargo ships - exactly one third, even though ro-ro ships make up only a small fraction of world merchant marine tonnage. This would seem to indicate that although passenger ro-ro ships are involved in an average number of accidents the consequences of those accidents are usually far worse. Since coming into being in 1959, IMO has adopted numerous international conventions and other instruments which are designed to improve maritime safety in general. Some of these are particularly relevant to ro-ros. The International Regulations for Preventing Collisions at Sea, 1972, for example, contain a series of measures to improve the safety of shipping in confined waters, such as straits and narrow channels. These include the introduction of traffic separation schemes and other routeing measures. Ro-ros, such as passenger ferries, frequently operate in such waters which are not only confined but are frequently congested as well. However, since the early 1970s, when ro-ros were appearing in increasing numbers, IMO has developed various measures with the special features of ro-ro ships in mind. These are dealt with the following different subject headings: Subdivision and damage stability, Fire safety, Cargo safety.
All the years Ro-Ro ships have been criticized for a number of reasons, mainly because of one single reason – safety of the ship. Safety being the primary concern of ship owner, operator, and seafarer, lately ro-ro ship has become less famous to work on. There are many reasons who make Ro-Ro vessels unsafe. More specifically :

- The Problem of Stability

If a vessel maintains its stability at sea then it is safer to sail. However, the problem with the RO-RO ship is its design, which includes cargo in upper decks and accommodation at even higher levels.Even a minor shift of cargo in the ro-ro vessel can become a major threat to the stability of the ship. Similarly, hull failure leading to flooding can result in capsize of the vessel in no time. The effects of wind and bad weather on high accommodation can also disturb the ship's stability.

Picture 8
Source : https://www.marineinsight.com/marine-safety/8-reasons-that-make-ro-ro-ship-unsafe-to-work-on/
(Retrived 23/05/20)

- High Freeboard

In Ro-Ro ships which carry only cargo, the general arrangement of cargo access door is close to the water line. In the event of listing, the door can get submerged leading to high chances for ingress of water inside the ship which will lead to capsize.

- Cargo Access Door

  As discussed above the effect of listing of the ship leads to ingress of water if the cargo doors are open or damaged. One weak point of ro-ro vessel is that sometimes the cargo door itself is used as a ramp which makes the ship more vulnerable to damages.

- Lack of Bulkheads

  The subdivision of ro-ro ship from inside lacks from the transverse bulkheads, leading to lower water tight integrity when water ingress or flooding takes place. Lack of bulkhead also leads to spreading of fire more quickly as no subdivision is present to contain the fire.

- Location of Life Saving Appliances (LSA**)**

  When a ship is to be abandoned, life raft and lifeboats are used to leave the ship as soon as possible. The location of lifeboat and life rafts on ro-ro ships is usually very high, which makes it even difficult to lower them at sea especially when the ship is listing.

- Weather condition

  Another reason which acts externally on the Ro-Ro vessel is the rough weather, which may result in reduction in the stability and cause heavy rolling of the ship. Heavy rolling has lead to capsizing of ships in the past such as “HERALD OF FREE ENTERPRICE” and “MV ESTONIA”.

- Cargo stowage

Cargo stowage is very important operation on Ro-Ro vessel for any loose cargo (trailer, cars etc.) can give rise to a chain reaction leading to heavy shift in cargo position. The trucks and trawlers loaded on board also carry cargo inside them and any shift of that cargo can also lead to listing of the ship.

- Cargo Loading

It is very difficult to have a sequential loading of cargo as cargo arrives on terminals at different intervals and due to lack of time on port. This further leads to uneven cargo distribution, something for which nothing can be done about. Lack of proper cargo distribution has been the reason for several ship accidents in the past

Many of the accidents to ro-ros that have occurred have been because regulations were not properly implemented or through human error. This is true of other ship types as well, of course, but ro-ro ships are perhaps more complex than most ships and any errors made can lead to catastrophic consequences, because of the large number of people on board.

CHAPTER 8

LEGISLATIVE FRAMEWORK

In response to those incidents, IMO has adopted a series of amendments to the International Convention for the Safety of Life at Sea (SOLAS) which are intended to ensure that incidents of that type would not re-occur. More importantly, action should be taken before an incident occurs, applying the proactive policy IMO adopted in the 1990s. The review of large passenger ship safety, initiated by the Organization in 2000, is an example of a proactive holistic approach to the consideration of safety issues pertaining to passenger ships, with particular emphasis on large cruise ships. This work culminated in the adoption of a series of amendments to SOLAS adopted in December 2006, with anticipated entry into force in July 2010. The amendments will have a profound impact on the design of future passenger ships, taking into account the guiding philosophy based on the dual premise that the regulatory framework should place more emphasis on the prevention of a casualty from occurring in the first place and that future passenger ships should be designed for improved survivability so that, in the event of a casualty, persons can stay safely on board as the ship proceeds to port. The outcome of this proactive initiative has resulted in an entirely new regulatory philosophy for the design, construction and operation of passenger ships that will better address the future needs of the passenger ship industry. Many of the new regulations adopted will apply equally to passenger ro-ro ferries as to cruise ships. IMO has also recognized the need to focus on those ferries which do not come under SOLAS and is working on the development of standards for "non-convention" vessels - those passenger ferries which for reasons of being operated inland or solely on domestic routes are not required to conform with SOLAS. On 20 January 2006, IMO signed a Memorandum of understanding (MoU) with Interferry formalizing the two Organizations' intent to work together towards enhancing the safety of non-Convention ferries by collaborating, through IMO's Integrated Technical Co-operation Programme, on related capacity-building activities within developing countries. Under the agreement, the two Organizations will work closely with interested parties such as Bangladesh, which has been selected as a pilot country for the Organizations' work, with the aim of identifying potential solutions to increasing ferry safety. The two Organizations have agreed to share certain costs and IMO will seek financial support from governments and multilateral funding organizations. Interferry will reach out to private sector ferry operators and its own members, as well as other international private sector organizations, to inform them of the initiative and seek their support, as well as seeking the assistance of private sector ferry operators in the pilot country itself. The two Organizations will also collaborate on the preparation of materials and documentation to support the operation of a national working group in the pilot country which will seek to involve all stakeholders in improving ferry safety. Preparatory work has taken place and the pilot project will be launched later in 2007.

CHAPTER 8.1

HERALD OF FREE ENTERPRICE ACCIDENT

Shortly after the Herald of Free Enterprise disaster in 1987, the United Kingdom came to IMO with a request that a series of emergency measures by considered for adoption.The Maritime Safety Committee (MSC) adopted the first package of amendments to the International Convention for the Safety of Life at Sea (SOLAS) in April 1988, including a new regulation requiring indicators on the navigating bridge for all doors which, if left open, could lead to major flooding of a special category space or a ro-ro cargo space, as well as means such as monitoring to detect water leakage. Another new regulation required monitoring of special category and ro-ro spaces to detect undue movement of vehicles in adverse weather, fire, the presence of water or unauthorized access by passengers whilst the ship is underway. Another amendment dealt with provision of supplementary emergency lighting for ro-ro passenger ships. The amendments entered into force on 22 October 1989, 18 months after adoption, the minimum time period allowed under SOLAS. Further amendments were adopted in October 1988 at a special MSC session requested and paid for by the United Kingdom. The amendments adopted entered into force on 29 April 1990 and have become known as the "SOLAS 90" standard, relating to the stability of passenger ships in the damaged condition. In fact, work on developing this standard had begun following the accident involving the European Gateway, which had capsized following a collision with another ship in 1982, and ended up lying on her side in relatively shallow water with only five lives lost. The amendment applied to ships built after 29 April 1990 and stipulated that the maximum angle of heel after flooding but before equalization shall not exceed 15 degrees. A further amendment addressed intact stability, requiring masters to be supplied with data necessary to maintain sufficient intact stability, including information showing the influence of various trims, taking into account operational limits. Another amendment added a new regulation requiring cargo loading doors to be locked before the ship proceeds on any voyage and to remain closed until the ship is at its next berth. Another amendment required a a lightweight survey must be carried out to passenger ships to verify any changes in lightweight displacement and the longitudinal centre of gravity, at periods not exceeding five years. Further amendments to SOLAS were adopted by the MSC in April 1989, also entering into force on 1 February 1992. The most important dealt with openings in watertight bulkheads in passenger ships. From 1 February 1992 new ships have had to be equipped with power-operated sliding doors, except in specific cases, which must be capable of being closed from a console on the bridge in not more than 60 seconds. All watertight doors must be kept closed except in exceptional circumstances. In May 1990, new amendments relating to the subdivision and damage stability of cargo ships (including freight-only ro-ro ships) were adopted, applying to ships of 100 metres or more in length built after 1 February 1992. The amendments were based upon the so-called "probabilistic" concept of survival, originally developed through study of data relating to collisions collected by IMO. A series of amendments relating to safe stowage and securing of cargoes were adopted in May 1991, with a revised SOLAS chapter VI Carriage of cargoes entering into force on 1 January 1994. The new chapter refers to the Code of Safe Practice for Cargo Stowage and Securing, which includes a number of annexes dealing with such "problem" cargoes as wheel-based cargoes and unit loads, both of which are carried on ro-ro ships. Other amendments adopted in May 1991 improved fire safety on ships, in particular concerning large open spaces such as atriums on passenger ships built on or after 1 January 1994. Such spaces were to be provided with two means of escape, one of which gives direct access to an enclosed vertical means of escape and be .fitted with a smoke extraction system and with automatic sprinkler systems. Under the April 1992 Amendments to SOLAS, a slightly modified SOLAS 90 standard was adopted to be phased in for existing ro-ro passenger ships between 1 October 1994 and 1 October 2005, based on the value of a ratio known as A/Amax, determined in accordance with a calculation procedure developed by the MSC to assess the survivability characteristics of existing ro-ro passenger ships. A/Amax is a simplified probabilistic approach attempting to assess the survivability standard of one ferry against another. It assumes a number of simplifications and is a rough guide used because it allowed all countries to carry out relatively quick calculations on a representative number of ferries. It is not a survivability standard as such but enables a hierarchy of vessels to be established. Meanwhile, Denmark, Finland, Norway, Sweden and the United Kingdom in 1993 adopted the "Stockholm Agreement" concerning specific stability requirements for ro-ro passenger ships undertaking regular scheduled international voyages between or from designated ports in North West Europe and the Baltic Sea, which meant that existing ferries operating on most of these routes would have to meet the full SOLAS 1990 standard. Important fire safety measures for existing passenger ships carrying more than 36 passengers were also adopted in April 1992, influenced by another accident - that involving the ro-ro passenger ferry Scandinavian Star caught fire during a voyage in 1990 from Norway to Denmark, resulting in the loss of 165 lives. Further fire safety standards for new passenger ships, built on or after 1 October 1994, were adopted in December 1992.

ISPS CODE

The Herald of Free Enterprise accident was one of a number of very serious accidents which occurred during the late 1980's, were manifestly caused by human errors, with management faults also identified as contributing factors. At its 16th Assembly in October 1989, IMO adopted resolution A.647(16), Guidelines on Management for the Safe Operation of Ships and for Pollution Prevention. The purpose of these Guidelines was to provide those responsible for the operation of ships with a framework for the proper development, implementation and assessment of safety and pollution prevention management in accordance with good practice. The objective was to ensure safety, to prevent human injury or loss of life, and to avoid damage to the environment, in particular, the marine environment, and to property. The Guidelines were based on general principles and objectives so as to promote evolution of sound management and operating practices within the industry as a whole. The Guidelines recognised the importance of the existing international instruments as the most important means of preventing maritime casualties and pollution of the sea and included sections on management and the importance of a safety and environmental policy. After some experience in the use of the Guidelines, in 1993 the International Management Code for the Safe Operation of Ships and for Pollution Prevention (the ISM Code) was adopted by the 1993 Assembly as resolution A.741(18). In 1994, a conference adopted amendments to SOLAS to make the Code mandatory, in a new chapter IX Management for the Safe Operation of Ships. The ISM Code establishes safety-management objectives and requires a safety management system (SMS) to be established by "the Company", which is defined as the shipowner or any person, such as the manager or bareboat charterer, who has assumed responsibility for operating the ship. The Company is then required to establish and implement a policy for achieving these objectives. This includes providing the necessary resources and shore-based support. Every company is expected "to designate a person or persons ashore having direct access to the highest level of management". The procedures required by the Code should be documented and compiled in a Safety Management Manual, a copy of which should be kept on board.

CHAPTER 8.2
ESTONIA ACCIDENT

On 4 October 1994 (i.e. five days after the incident), a proposal to establish a panel of experts to look into all aspects of ro-ro safety was put forward by Mr. W.A. O'Neil leading to a SOLAS Conference, which was convened in the shortest time possible, in November 1995 and succeeded in the adoption of a series of amendments and new regulations incorporated in the Convention applicable to both new and existing ro-ro passenger ships (and to other passenger ships). Further work recommended by the same conference (e.g. on AIS, VDRs, passenger evacuation/escape routes, etc.) has now all been completed. It is, however, important to recall that there had been a considerable amount of work with a direct bearing on ro-ro passenger ships' safety, which IMO had concluded even prior to the loss of the Estonia. For example, the "SOLAS 90" standard and the adoption of the ISM Code in 1994 had its roots in concerns over ro-ro passenger ship constructional and operational safety. The impact of the Estonia incident was to accelerate a comprehensive review of all aspects of ro-ro ferry safety, including search and rescue requirements. The Maritime Safety Committee (MSC), which met from 5 to 9 December 1994, established the panel of experts, which reported to the MSC in May 1995. The IMO Assembly, meeting for its 19th session in November 1995, adopted five resolutions directly relating to safety of roll on-roll off passenger ships. The Assembly was followed immediately by the SOLAS conference on ro-ro safety which adopted a series of regulations intended to ensure no repeat of the Estonia incident, including stability regulations applicable to both new and existing ro-ro passenger ships as well as operational requirements, such as that for an established working language. The conference also adopted 12 resolutions relating to future work and it is safe to say that, 10 years later, all of the work has now been completed. The panel of experts on ro-ro safety worked under the supervision of a Steering Committee, chaired by the late Dr. Giuliano Pattofatto. Mr Torkild Funder of Denmark, a former chairman of the MSC, was chosen to be chairman of the panel of experts, which was to consist of designated specialists and the chairmen of a number of IMO sub-committees. The panel's reports and recommendations were considered by a Steering Committee, which was established to co-ordinate the work of the panel of experts, in April and then by the full MSC at its 65th session in May 1995.

19th IMO Assembly - November 1995 - adopted:
A.792(19) Safety culture in and around passenger ships.
A.793(19) Strength and securing and locking arrangements of shell doors on ro-ro passenger

ships.
A.794(19) Surveys and inspections of ro-ro passenger ships.
A.795(19) Navigational guidance and information scheme for ro-ro ferry operations.
A.796(19) Recommendations on a decision-support system for masters on passenger ships

SOLAS CONFERENCE 1995

The conference adopted a series of amendments to SOLAS, based on proposals put forward by the Panel of Experts on the safety of roll on-roll off passenger ships which was established in December 1994 following the sinking of the ferry Estonia. The most important changes relate to the stability of ro-ro passenger ships in Chapter II-1. The SOLAS 90 damage stability standard, which had applied to all ro-ro passenger ships built since 1990, was extended to existing ships in accordance with an agreed phase-in programme. Ships that only meet 85% of the standard had to comply fully by 1 October 1998 and those meeting 97.5% or above, by 1 October 2005. (The SOLAS 90 standard refers to the damage stability standard in the 1988 (October) amendments to SOLAS adopted 28 October 1988 and entering into force on 29 April 1990.) The conference also adopted a new regulation 8-2, containing special requirements for ro-ro passenger ships carrying 400 passengers or more. This is intended to phase out ships built to a one-compartment standard and ensure that they can survive without capsizing with two main compartments flooded following damage.Amendments to other Chapters in the SOLAS Convention included changes to Chapter III, which deals with life saving appliances and arrangements, including the addition of a section requiring ro-ro passenger ships to be fitted with public address systems, a regulation providing improved requirements for life-saving appliances and arrangements and a requirement for all passenger ships to have full information on the details of passengers on board and requirements for the provision of a helicopter pick-up or landing area.Other amendments were made to Chapter IV (radiocommunications); Chapter V (safety of navigation) - including a requirement that all ro-ro passenger ships should have an established working language - and Chapter VI (carriage of cargoes). The conference also adopted a resolution which permits regional arrangements to be made on special safety requirements for ro-ro passenger ships

CONCLUSION

As we mentioned before, Ro-Ro vessels are very dangerous vessels and many things can go wrong and lead to an accident such as the case of THE HERALD OF FREE ENTERPRICE and the case of MV ESTONIA. In the first case, we can see how human error can lead to chain of errors and make up an accident. In the second case, we can see how the ship's design and the ignorance from the crew on this can also lead to an accident. After all, accidents can happen anytime and anywhere, the important thing is to keep improving and not do the same mistakes again. Safety inside the vessels is the most important matter and we must do anything to maintain it as much is possible. To do that we must know all the dangers that are hidden inside and outside the vessel such as human errors and negligence of certain things. Human errors are very common and all the crew in every ship must be well prepared to avoid them. These major accidents showed the world, what can happen in the sea if you are not careful enough and made it clear to everybody that we must do anything to be safe. That is why we have so many regulations regarding the safety on the ships and more specific the Ro-Ro vessels and that is why IMO has adopted a series of amendments to the International Convention for the Safety of Life at Sea (SOLAS) which are intended to ensure that incidents of that type would not re-occur.

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