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Maritime casualties and the lessons to be learned : their application and use in the maritime teaching and training process

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MARITIME CASUALTIES AND THE LESSONS TO BE LEARNED:

Their application and use in the Maritime Teaching and Training process.

By

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A dissertation submitted to the World Maritime University in partial fulfilment of the requirements for the award of the degree of

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in

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1998

DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

....(Signature)

23 JULY 1999 ....(Date)

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ABSTRACT

Title of Dissertation: **Maritime Casualties and the Lessons to be Learned: Their application and use in the Maritime Teaching and Training process.**

Degree: **MSc**

The dissertation is a study of maritime casualties drawing on investigations and critically analysing the failures due to human factors, equipment or a combination of both that has culminated in causing these casualties. The ultimate aim of this work is to help in the education and training of seafarers in accordance with the STCW95 convention so as to prevent the occurrence of casualties.

The roles of the master, officers and ratings were examined with emphasis on their contribution to the casualties.

The growth and development of ships' instrumentation, technological improvements and the ergonomics of the ships' layout were investigated to evaluate their effects on human performance and possible contribution to casualties.

Some major casualties were investigated to draw out lessons to be learned in view of their benchmark effect in the introduction of major IMO conventions and other international and national rules and regulations.

Casualties were evaluated to highlight the things that went wrong, problems faced and to identify major causal effects.

The impact of human factors, human elements and human error in relation to casualties, including the effect of fatigue, stress, age and experience, was emphasised in the context of the infallibility of the man-machine interface.

Major causal effects such as Fire, Collision, Stranding, and Explosion, were identified and defined.

The concluding chapter examines the result of the investigations and discusses the proposals. A number of recommendations are made for a more effective and efficient personnel and ship to prevent future occurrence of casualties.

KEYWORDS: Analysis, Assessment, Education, Evaluation, Examination, Investigation, Training.

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LIST OF ABBREVIATIONS

ANRIS	Automated Navigation Risk Indication System
ARPA	Automatic Radar Plotting Aid
BIMCO	The Baltic and International Maritime Council
Co.	Company
CPA	Closest Point of Approach
CS	Cruise Ship
Dwt	Deadweight
ECDIS	Electronic Chart Display and Information Systems
ESP	Enhanced Survey Programme
FSI	Flag State Implementation
GPS	Global Positioning System
grt	Gross registered tonnes
Hz	Hertz
IACS	International Association of Classification Societies
ICS	International Chamber of Shipping
IGS	Inert Gas System
ILO	International Labour Organisation
IMO	International Maritime Organisation
ISGOTT	International Safety Guide for Oil Tankers and Terminals
ISM	International Safety Management Code
ITF	International Transport Workers Federation
KW	Kilowatt
MARPOL	International Convention for the Prevention of Pollution from Sea
MARS	Marine Accident Reporting Scheme
MEPC	Marine Environmental Protection Committee
MOU	Memorandum of Understanding
MSC	Marine Safety Committee
Nm	Newton-metre
OBO	Oil/Bulk/Ore
OCIMF	Oil Companies International Marine Forum
OOW	Officer on Watch
OPA	Oil Pollution Act 1990 (USA)
P&I	Protection and Indemnity
P&S	Port and Starboard
SMCP	Standard Marine Communication Phrases
SMS	Safety Management System
SNVP	Standard Marine Navigational Vocabulary
SOLAS	International Convention for the Safety of Life at Sea
STCW	International Convention on Standard of Training, Certification & Watchkeeping for Seafarers
ULCC	Ultra Large Crude Carrier
UK	United Kingdom
USA	United States of America
USD	United States Dollar
V	Volt
VLCC	Very Large Crude Carrier

CHAPTER 1

INTRODUCTION

The purpose of this dissertation is to highlight the causal effects of maritime casualties so as to draw lessons that lead eventually to preventing future occurrence. It is also to apply lessons learned in the pedagogical environment especially in simulator training where a lot of casualty scenario can be reviewed within the safe confines of the classroom.

In addition, it is intended to synthesise the investigation of casualties in order to develop skill in navigation and collision avoidance technique, passage planning and to keep safe and good teamwork on the ship.

The yearly number and cost of casualties in the maritime industry for the past ten years have been steadily reducing though at a slow rate compared to the number of conventions and amount of legislation passed. Investigation was directed at finding the reasons for these casualties highlighting factors like machine, weather, ship environment and ergonomic parameters. The various kinds of casualties from fire, collision, stranding, explosion were examined as major causal effects. The effects of human error on casualties including age, experience, motivation, language, fatigue and stress were noted.

Maritime casualty is a serious or fatal accident in the marine environment. The damage done to the environment and the economy of the industry is devastating not to mention lives lost. Eighty percent of all accidents are postulated to have been as a result of human error thus this work examines the interface between man, machine and nature. The investigation examines human interaction with nature, whether man is forcing nature to obey his rules or whether man should align his rules to conform with nature.

Materials were drawn upon from publications from the classification societies, maritime administrations, the IMO and various periodicals. The selected material was reviewed, evaluated and critically analysed so as to develop relevant argument.

The difficulties faced during the writing process were kept under control because from the beginning in October 1997, the process was defined and refined several times until a clearly identified statement emerged. The planning and management of the work was carefully organised in accordance with the research plan. A critical path analysis, for data collection and writing, was drawn up so that time was not wasted on unnecessary items no matter how interesting they might be. A clear and detailed record of references was kept.

This work has been divided into six chapters. The first chapter covers the introduction which outlines the purpose of the study and methodology used.

The second chapter explores maritime casualties with emphasis on the incidents that have caused them. The causal effects are analysed.

Chapter three looks at maritime casualty investigation, examining the methods of investigation that will bring out all the relevant parameters to encourage better understanding of casualties thereby preventing them from reoccurring.

The fourth chapter focuses on the casualties that have had major media attention and caused the introduction of new regulations, conventions and codes over the years.

Chapter five expands on the effect of human factor in maritime casualties. It highlights the obstacle to safety at sea, education and training of crew as a source of curtailing casualties. The influence of age, experience, stress, fatigue, management ethics or its non existence and navigation aids as causes of casualties is highlighted.

The definition of casualty extends to include Constructive Total Loss and as stated by Hooke (1997, ix):

> A right of a marine assured to claim a total loss on the policy
> because either (1) the property has been lost and recovery is

> unlikely, or (2) an actual loss appears to be unavoidable, or (3) to prevent an actual total loss it would be necessary to incur an expenditure which would exceed the saved value of the property or, in the case of a hull policy, the 'insured' value expressed in the policy. To establish a claim for constructive total loss the assured must abandon what remains of the property to underwriters and give his intention to do so.

The coverage of the investigation extends beyond the actual loss situation and includes casualties that have been declared a constructive total loss.

CHAPTER 2

2.1 *CLASSIFICATION OF CASUALTIES*

Marine casualty means a fatal accident, according to IMO document FSI5/10/1, that has resulted in ;

- the death of, or serious injury to, a person that is caused by, or in connection with, the operations of a ship; or
- the loss of a person from a ship that is caused by or in connection with, the operations of a ship, or
- the loss, presumed loss or abandonment of a ship; or
- serious material damage to a ship; or
- the stranding or disabling of a ship, or the involvement of a ship in a collision; or
- serious material damage being caused by, or in connection with the operations of a ship; or
- serious damage to the environment (brought about by the damage of a ship or ships) being caused by, or in connection with, the operations of a ship or ships.

Marine casualties, according to the IMO definition, are classed under two main categories- serious and very serious.

Very serious casualty means a fatal accident which involves the total loss of a ship, loss of life or severe pollution. The other category defines a situation other than that above but involves fire, explosion, grounding, contact, heavy weather damage, ice damage, hull cracking or hull defect. These subsequently result in structural damage making the ship unseaworthy. This could lead to the ship's hull underwater being holed, immobilisation of the main propulsion system, extensive accommodation damage or pollution to the environment (irrespective of quantity) and possibly a breakdown necessitating towage or shore assistance.

2.2 *ANALYSIS OF CASUALTIES*

A project to investigate the Norwegian registered ships in the 1970s, by the classification society Det Norske Veritas in co-operation with Norwegian Maritime Authorities, shows that external conditions were found to be the largest causal effects for ships over 100 grt, with channel and shallow water effects accounting for approximately 19 per cent of grounding of ships over 1599 grt. Reduced visual conditions were the main factor for 12.6 per cent of cases for bigger ships. There are twice as many groundings in dark conditions as in daylight.

It was found that for ships of less than 1600 grt, the main cause for 19.1 per cent of groundings was due to inadequate coverage of the watch, mostly through having an unmanned bridge. Another 4 per cent due to crew asleep on watch.

Collisions and Groundings top the Table 2.1 and figure 2.1 of causes of casualties with Groundings at 45.68 per cent and collisions at 30.51 per cent. The occurrence of reported cases of casualties of ships below 100 grt is low compared to that of ships above 1499 grt because of inadequate reporting. The lower percentage casualty frequency for ships of over 1499 grt is attributed to the fact that such ships spend less time in the more difficult coastal waters.

The major causal effects of casualties can be categorised under six broad areas as shown on Table 2.2 and figure 2.2 as explained below.

External conditions- these are conditions that mitigate against efficient navigational aids; fault and deficiency from lights, marks etc.; reduced visual conditions and external influences due to channel and shallow water effects.

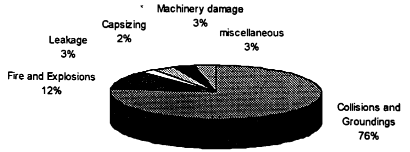
Technical failure/ergonomics- these are faults due to the ship's technical system; serviceability of navigational aids; remote control of steering and main propulsion units; and failure or deficiency in communication equipment.

Inadequate navigational factors- these are due to bridge design and arrangement; error in chart or nautical publications; bridge manning and organisation; poor communication on the bridge; and inadequate knowledge and experience.

Table 2.1: Type, number and percentage distribution of casualties under Norwegian flag from 1970-1978.

Collisions and Groundings	2742	76.19%
Fire and Explosions	420	11.67%
Capsizing	74	2.06%
Leakage	125	3.47%
Machinery damage	121	3.36%
Miscellaneous	117	3.25%

FIG.2.1-Casualty Frequency



Navigational errors- these are due to navigational and manoeuvring factors; misinterpretation or incomplete utilisation of information from fixed objects like light and marks; ship's operating equipment; and wrong interpretation of traffic information.

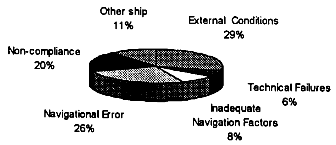
Non-compliance- these are due to inadequate watch keeping and other human factors.

Other Ship- these are due primarily to the fault of other ship and navigational error on the other ship.

Table 2.2 below shows the causal effects under six broad areas.

External Conditions	28.4
Technical Failures	6.8
Inadequate Navigation Factors	8.6
Navigational Error	25.2
Non-compliance	19.5
Other Ship	11.5

Fig. 2.2 Causal Effects



2.3 *FIRE*

This is one of the most dreaded forms of casualty that is experienced on the ship. The reason being there is nowhere to escape to and one of the best forms of stopping it, that is by water, if not controlled could affect the stability of the ship. Fire is a component of three basic elements that have to be present to complete the equation for it to manifest. These are: Fuel- which is the combustible material; Oxygen- that is twenty (20) percent of Air, to confirm the fire cannot occur in vacuum; and Heat- this causes the spontaneous combustion, helping the molecules of the fuel and that of oxygen to combine spontaneously to form fire. The extra danger of fire is the fumes formed and depletion of oxygen that makes it deadly to human.

The engine room explosion on the motor tanker *Haralabos* is an example of a casualty caused by fire on the ship. She was a 99308 dwt tanker built in 1966 which was declared a constructive total loss on 1 December 1982. An explosion in the engine control room followed by a fire on the 26 November 1982 after loading cargo at Ras Gharib, Egypt caused the casualty.

The analysis of the fuel oil bunkered for use in the engine room of this ship showed it had a low flash point of 4 deg Celsius or less which is very low compared to the recommended safe value of 60 deg Celsius. This low flash point fuel oil released sufficient hydrocarbon gas to form a flammable mixture with the air in the engine room. Under this highly flammable atmosphere, all that is needed to start a fire or an explosion is a spark or flame from any source within the room, including a spark from the electric switch board or somebody smoking. This is why there is a limit to the flash point of fuel carried on ships. This recommendation is neither statutory nor mandatory and so is dependent on the owner of the ship. It is suspected that this fuel was tapped from the cargo tank through cross-connections between the bunker line, stripping line and the tank-cleaning line.

For economic reasons certain operators are willing to take a dangerous risk by the use of low-flash-point oil.

2.4 *COLLISION*

This could be as a result of inadequate bridge organisation and the absence of a methodical system of navigation for example plotting not being undertaken and in some cases the officer of the watch not having the training to construct a forecast plot in possible collision situations. In cases of collision in reduced visibility, excessive speed could be a factor. Collisions have occurred between a high speed ferry and a poorly/unlit tow in congested waters.

Greenen (Seaways, Aug 1996, 13-14) has noted that:

> A disturbing factor which is common place in all collisions which occur at sea is that the persons involved were considerably above average ability- indeed some of these professionals were persons of high standing and held in esteem by their peers. From this I conclude that the present regulations are too complex in their nature and open to conflicting interpretations.

In part, it is the complexity in the wording of the rules of the road and to a certain extent conventions, codes and regulations that the maritime industry has had to live with. These rules are worded in mostly legal languages that the average seafarer cannot easily decipher under intense pressure at sea and are open to conflicting interpretations. All regulations must be both practical and effective.

The motor ship "*Feddy*" was a bulk carrier 11381gt built in 1962, which was struck on the port side by the Greek motor ship "*Sounion*" on the 10 February 1981 and sank within thirty minutes. There were only three crewmen rescued after the "*Feddy*" capsized to port and sank so quickly by the bow.

The figure 2.3 below shows the geographical plot that describes how this collision occurred.

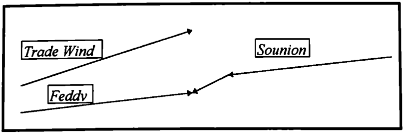


Figure 2.3 Geographical plot of *Feddy/Sounion* collision, 10 February 1981.

There was a third ship involved in this casualty, the Greek motor ship *Trade Wind*. The m/s *Sounion* was heading West for Gibraltar on a course of 265 degrees true, whilst the m/s *Trade Wind* and *Feddy* were heading East. *Trade Wind* was on course 070 degrees true. *Feddy* was on course 077 degrees true. *Sounion* sighted the two ships on radar at 0645 hours from a distance of about 17 miles (31.5 kilometres). The Master of *Sounion*. thought both ships were off his starboard bow because of poor visibility due to fog but he was wrong. At 0645 hours *Feddy* must have been about 10 degrees off *Sounion's* port bow. At 0705 the Master of *Sounion* altered course 13 degrees to port, to bring him to a new course of 245 degrees true. At 0720 the Master was advised that a fog signal was heard 25-30 degrees off her starboard bow. The signal was from *Trade Wind*. It was at this moment that the Master of the *Sounion* put his helm hard to port, placing her on a collision course with the *Feddy*. The result was a serious violation of the rules of the Regulations for Preventing Collisions at Sea, 1972.

- The *Sounion* was in violation of rule 7 (b). The Master of *Sounion* failed to use his radar properly to obtain an accurate early warning of the risk of collision, by radar plotting.

- ♦ The *Sounion* was in violation of rule 7 (c). The Master of *Sounion* based his assumptions on scanty radar information. His interpretations were in error.
- ♦ The *Sounion* was in violation of rule 14 (a) and 17 (c). The master of *Sounion* altered course to port.
- ♦ Both ships were in violation of rule 6. Both ships were proceeding at an unsafe fast speed for this foggy condition.

This casualty highlights the importance of education ashore, training and experience at sea to develop proficiency in radar plotting and interpretation. The human factor in casualties forced the IMO to amend the international convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 in 1995.

Some deck watch officers will not use the technique of radar plotting to determine the course, speed and closest point of approach (CPA) of approaching ships, even when faced with the risk of collision. Sometimes assumptions and actions are based on scanty radar data. The use of an automatic radar plotting aid (ARPA) could eliminate or reduce this problem.

2.5 *GROUNDING*

Human error accounts for most cases of grounding and a sizeable portion of these are due to steering or propulsion machinery failure. This is significant because in ninety-nine percent of the time if the steering gear and main propulsion system is functional the ship could easily be manoeuvred from danger. Even though the fault is placed on the machinery it is known that remotely the failure originates from humans. So the failure of the machinery in open ocean can be rectified without further danger to a ship, but in close proximity to land the quick response of the engineer coupled with a good anchor holding ground could save the ship.

Three causal factors behind the grounding of ships as a result of dragging anchor can be identified:

- ♦ Poor basic seamanship, anchoring ships close to shore and failing to monitor the weather by forecast and observation, resulting in ships being caught on a lee shore.
- ♦ General lack of understanding of the holding power of anchors and the International Association of Classification Societies requirements concerning anchors particularly in the case of ship anchored off a fully exposed coast in rough weather or to hold ship which is moving or drifting, and where the scope of the ratio between the length of chain paid out and water depth is not understood.
- ♦ A resistance by mariners to weigh anchor and put out to sea to ride out adverse weather, although in some cases the ship may not have sufficient fuel to put to sea.

Common causal factors relating to grounding while on passage mostly focus on poor bridge resource management and the absence of any plan when manoeuvring in port approaches or coastal waters. Also the lack of the understanding that anchors cannot hold if the assumed current or wind speed is more than 2.5 metres per second (4.86 Knots).

A case study of the grounding of the steam turbine VLCC *Olympic Bravery* will be considered. This vessel went aground on her maiden voyage to lay-up in Norway from Brest, in France on 24 January of 1976. She had a modern steam turbine main propulsion system with automatic controls with which the chief engineer was unfamiliar, and that played a significant part in the loss of propulsion and subsequent grounding of the ship off Ushant, France. According to the Liberian board of Inquiry Investigating Officer,

> The chief engineer did not appear to have either the detailed knowledge or the ability to explain clearly the relevant features and functions of the boiler control system, although he had joined the ship some four months previously in order to become familiar with the propulsion system. Nor was he able to give any detailed account of what he did and what he thought during the critical period of more than two hours.

The good point of having the shipbuilder's warranty engineer on the maiden voyage of a ship was lost to the owners of this ship because his presence on the ship could have prevented the failure due to unfamiliar personnel. Part of the work of the shipbuilder's representative engineer on board is to help in the safe operation of the ship's machinery during this most crucial initial running-in period.

The *Olympic Bravery*, a 270000 dwt crude oil carrier was powered by a Stal Laval type AP 280/86 steam turbine unit supplying 24161 kW at 86 rev/min. Steam being generated by two Foster Wheeler boilers fitted with automatic feed and combustion controls. Electrical power was provided by two type- VMO 8D6/TV56K steam turbines of Stal Laval design each driving through a reduction gearing a Jeumont Schneider alternator of 440 V, 60 Hz, 1450kW output, with an emergency supply provided by a 450 kW diesel generator.

The main cause of the ship going aground was due to loss of power on the propulsion system; the main boiler generating steam for the steam turbine could not function long enough to maintain the ship in manoeuvrable state. Secondly the ship was too close to land in spite of the traffic separating zone. Also the master delayed the call for a tug to rescue the ship, maybe because of inadequate information from the engine room as to the possibility of recovering from the blackout. The ship's anchor could not hold the drifting tanker. Maybe if both port and starboard anchors had been used in tandem they could have checked the momentum of the ship towards the rocks.

This ship ended up being a total loss after she went on the rocks off Ushant and the only safeguard against this sort of loss is dependable and well maintained machinery manned by competent and alert engineers.

2.6 *EXPLOSION*

It was on 3 April 1980 off the coast of West Africa that the motor tanker *Mycene*, 238889 dwt VLCC built in 1975, broke in two and sank following a series of explosions and a fire. M/T *Mycene* was cleaning her cargo tanks on a ballast voyage from Genoa, Italy to Ras Tanura when the first explosion occurred. This ship had an inert gas system, but on this day of tank-cleaning the system was not activated to prevent an explosive mixture in the cargo tanks due to confusion on the part of the master. And so an explosive mixture built up in the cargo tanks as recirculating washing water from the slop tank, in a closed circuit system, was used to clean the cargo tanks with fixed high-capacity machines.

According to an investigation conducted on behalf of the Bureau of Maritime Affairs of Liberia (1984):

> The source of ignition was an incendiary spark released by an electrostatic ..charge which was produced by isolated cylindrical lengths of water, or 'water slugs', generated by tank washing with recirculating water.

The cause of explosion in cargo tanks could be a tank not inerted and/or the use of recirculating washing water in conjunction with fixed high-capacity washing machines. To avoid cargo tank explosion, rigid application of the safety precautions in the ISGOTT documents is advised. The standards of training and experience need to be improved and the master and cargo officer should be highly motivated by a proper sense of urgency to inert cargo tanks at all times.

The inert gas system is the main and absolute way of protection against an explosion in a cargo tank.

2.7 *STRUCTURAL FAILURE*

The structural failure of the steam tanker *Energy Concentration*, 216269 dwt VLCC built in 1970, occurred when she broke in two amidships while discharging at the Mobil terminal, Europort, Rotterdam, on 22 July 1980. She remained connected only by the main deck plate but there was no fire or explosion because her IGS was operating properly. At the instant of the fracture, all cargo and ballast tanks across the entire midsection, including tanks nos. 2, 3 and 4, were empty or nearly so. (Table 2.3)

Bureau Veritas calculated the bending moment at frame 76, the point of the break, as 1809458 metre tons (Nm) which was 1.7 times greater than the maximum permissible bending moment of 1072098 Nm. The chief officer could not calculate the stress on the ship's hull by using the cargo-loading calculator on board because he did not have the English translation of the manual. Yet he did not deem it fit to inform the master, which is rather unfortunate. *Energy Concentration* had a hog of 17 inches on 20 July 1980 upon departure from Antifer for Europort; draft forward was 46 ft 10 in; draft amidships 49 ft 06 in, and draft aft was 55 ft 00 in. Unfortunately this did not alert the master of the unacceptable hog of the ship. The ship operating booklet displays sample trim and stability calculations under different load conditions and an instruction for the longitudinal strength calculation and manual method of strength computation were on board but never used.

The use of electronic loading calculators on VLCC and ULCC should be encouraged and owners and operators to ensure that master and cargo officers are proficient in the use of loading calculators. The cargo discharge plan must be documented and bending moment calculations must be made and recorded for actual and projected phases of the discharge.

Table 2.3: *Energy Concentration*: cargo and ballast tank weights at time of casualty.

LOCATION	WEIGHT (tonnes x 1000)
No. 1 centre tank	30.7
No. 1 wing tanks (P & S)	27.1
No. 2 centre tank	0.0
No. 2 wing tanks	2.0
No. 3 centre tank	0.0
No. 3 wing tanks (P & S)	0.0
No. 4 centre tank	0.0
No. 4 wing tanks (P & S)	2.0
No. 5 centre tank	29.3
No. 5 wing tanks (P & S)	20.1
Slop tanks (P & S)	4.1

2.8 *LOST AT SEA- DERBYSHIRE*

The loss at sea of the OBO (oil/bulk/ore) *Derbyshire* laden with ore in a typhoon in the western pacific, in position approximately 25° 30' North, 130° 30' East, on about 9 September 1980 re-opened the enquiry into the large number of predominantly old bulk carrier sinkings that have taken place since. This British flag OBO was only four years old, 294 metres in length and 169,000 dwt (91,654 gross tons) when she sank with all forty-four members of her officers and ratings. She was typical of the type of large combination carrier that had been built in the previous decade.

She had a flushed deck, with wide side rolling hatches giving the greatest possible access for the grabs that would normally discharge the dry cargo. The access to the fore part of the ship was provided by a ladder on top of the hatch covers, which makes it difficult to walk during heavy head seas when she is deeply laden. Originally bulk carriers were assumed to be very heavy and so could have little or no trouble from heavy weather. It was judged unnecessary to provide them with a raised forecastle, which would have increased the freeboard by more than three metres and provide some protection to the forward hatches.

These vessels were just bigger versions of the smaller, oil ships and the structural designs were the same. These vessels were built in the age where economy and cargo carrying capacity were required and of more priority by the shipowners, that is lighter than their contemporaries. They were ships that were permitted by the load lines rules to load deeper than before, largely because of their size and supposed strength.

The information given here is an extrapolation of the findings of the assessors after they had gone through over 135,000 photographs, several hundred hours of video tape of the more than 2,000 pieces of wreckage on the sea bed (Grey, 1998, 26).

From this extrapolation it is assumed that the ship did not break up on the surface as was previously believed, in way of a frame just forward of the bridge. This being the assumption from findings on three of the existing sister ships built to the same design.

As she steamed with her bows into the swell generated by the gradually worsening typhoon, water came over the bow on to a flush decked forecastle with a small access hatch into the bow store, protected only by a bulwark around the bow. In addition around the foredeck were a number of ventilators for the spaces and tanks below. There was no breakwater or, other than a couple windlasses, any other obstruction, between the foredeck and the hatchcovers over no. 1 hold.

The *Derbyshire* broke up into pieces on the sea bottom about 600 kilometres off Okinawa, with the largest section least damaged being that of the bow. The ship must have been subjected to colossal explosions or implosions as the water pressure burst open the tanks as the ship sank whilst the bow section had been filled up with water prior to the sinking on the surface.

From photographs of the under water wreckage, the small access hatch was found open and the forecastle ventilators had been torn off at some stage. It is suspected that heavy seas coming over the bow damaged the access hatch and tore off the ventilators, so that the bow section of the ship forward of no. 1 hold became flooded. This would have reduced the forward freeboard by up to 2.5 metres and make the ship sluggish and less likely to rise to oncoming waves.

With this scenario where the forecastle space had been flooded and the freeboard reduced, heavy green water would have swept down the foredeck and smashed its way into no. 1 hold, crushing the starboard hatchcover. The bow would have then sunk further, and in quick succession, water would have poured into other holds. *Derbyshire* must have then sank rapidly within a few minutes of the first hold being opened. No distress message was ever received.

The *Derbyshire* was a flush decked ship with very little protection forward and a greater reserve buoyancy would have been helpful. The bow height and the overall freeboard would have required to be increased to counter the high sea state experienced in bad weather condition. It was recommended by the assessors also that the fastenings and strength of cargo hatch covers should be looked into and the positioning and design of ventilators, air pipes and access hatches on the fore and main decks should be reconsidered to prevent seaway damage. Also the access to the forecastle and fore end spaces should be made safe so that the crew could go forward and inspect during heavy weather condition.

The *Derbyshire* was four years old when she sank and so the problem associated with old bulk carriers of shell plating getting damaged following corrosion and detachment from frames could be ruled less likely. The investigation of this ship at that depth of water showed that it is possible to reach a significant reason for the sinking.

The above conclusions were drawn after the investigators had the opportunity to inspect the videos and photographs from the vessel at the bottom of the sea. Following a number of bulk carrier disasters, especially after the loss of the *Derbyshire*, the International Association of Classification Societies (IACS) introduced new rules for the construction of new ships and the structural alterations to existing ships.

The introduction of the Enhanced Survey Programme (ESP) in 1993 had improved the record of bulk carrier losses. Whilst IACS and IMO are continually working together to get to the root cause of these maritime casualties, the IMO Maritime Safety Committee decided to recommend the amendment of Assembly resolution A.744(18) to bring it in line with IACS' ESP. IACS still believe that the most important element in avoiding structural loss is preserving the integrity of the hull and hatch covers forming the primary watertight barrier.

2.9 *HUMAN ELEMENT IN CASUALTIES- IMO APPROACH.*

The IMO is working on a Resolution on human element vision, principles and goals, that is, taking the human element into consideration when drawing up regulations on safety of shipping and prevention of marine pollution. The Resolution was drafted by a meeting of the Marine Safety Committee(MSC) / Marine Environmental Protection Committee (MEPC) Working Group on the human element which met in December 1996 and looked at issues such as the effects of fatigue on seafarers and how accidents might be prevented by considering the human factor. There is an estimate that up to 80 percent of maritime accidents may be caused by human error.

Some problems that might affect the work of a seafarer, and thereby contribute to accidents, include alcohol abuse, inadequate technical knowledge or language skills, fatigue, low morale and injury; but also staffing levels, work environment and company management.

The US Coast Guard did a study that found that fatigue is a more significant factor in maritime accidents than previously expected. According to the survey, it was estimated that fatigue was a contributory factor in 33 percent of critical ship casualties and 16 percent of personnel injury casualties, compared to figures of just 1.2 percent and 1.3 percent found in a previous study. This study also found that factors contributing to fatigue included the number of consecutive days worked prior to the incident, hours on duty prior to the incident and absence of company or union policy on work hours. There is an IMO/ILO (International Labour Organisation) working group that will draft the format of records to be kept of seafarers' daily hours of work and rest, in order to ensure compliance with established limits on working hours.

Language difference is another human element that has been found to cause human error. The Committee considered the IMO Standard Marine Communication Phrases (SMCP), drawn up by the Sub-Committee on Safety of Navigation and agreed to use the same procedure for introducing the SMCP as was used for introducing the Standard Marine Navigational Vocabulary (SNVP), which was developed in the 1970s. Germany has co-ordinated the development of SMCP which is designed to be more comprehensive than the SNVP and "Seaspeak" currently in use. The SMCP is made up of phrases that have been developed to cover the most important safety-related fields of verbal shore-to-ship (either way), ship-to-ship and on board communications.

Who has the Con? This is a question that comes up when the master of a ship is on the bridge with a watch officer and the confusion is who is in charge of the bridge at this time. This has caused major casualties because the officer on watch assumed that the arrival of the master on the bridge meant that he is relieved of control (who has the Con?) whilst the master believed he is only there to observe. It is imperative under this circumstance that the master should give a clearly understood instruction as to the procedure to follow under this sort of situation to prevent disaster. Alternatively the master on arrival on the bridge should inform the watch officer that he is taking the "Con" and also when he wants the officer to take over. Of course this does not relieve the officer on watch of all responsibility for safe navigation of the ship by questioning any order of the master (be it diplomatically) that he sees to be detrimental to the safety of the ship. The master of the ship will have to show his greater leadership ability by encouraging officers to question his order anytime they find it not to be safe for the ship or personnel.

An example of a casualty caused by navigation error and poor bridge procedure, is shown by the grounding of the motor ship *Sevillan Reefer* just after midnight on the

12 June 1978 on the Gordon Reef in the Tiran Strait, off the Sinai Peninsula in the Red Sea. She was a reefer ship of 4280 gt built in Bilbao, Spain in 1967.

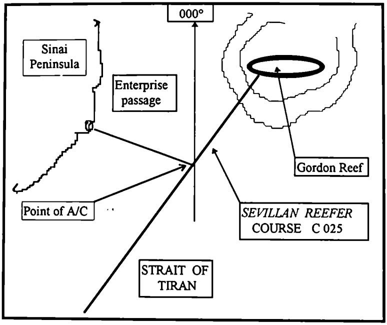
The second officer took over the 0000-0400 watch as the ship was already on course 025 degree true and was supposed to alter course to 360 degree true when she began to transit the Enterprise Passage (See figure 2.4 next page). The second mate called the Master to the bridge at 0050 when he saw the channel light to port, marking the Enterprise passage, as directed by the master's night order book. According to the second mate,

> Both the Gordon Reef light dead ahead and the Enterprise Passage light fine on the port bow were so clearly visible I felt certain that the master had seen them for himself...... The master and I stood in the wheelhouse watching the Gordon Reef light get closer..... As to why he remained silent when the master did not alter course to 360 degrees true, he said, I had of course realised that very shortly after the 0059 position had been reached the course of the ship should have been altered to 360 degrees true.......However I expected the master to give the order......I did not think it was open to me to give any helm or engine order or to say anything to the master and I awaited his instructions (Chadwick, 1984, 8)

It is clear from above that the second mate had failed to take the necessary actions demanded of him as the deck watch officer when he knew the ship was heading towards Gordon Reef. The master having just been on the bridge for ten minutes before the grounding, had difficulty in visually detecting the Enterprise light and the Gordon Reef light due to limited night vision. The lack of co-operation on the bridge is evident and the ship was proceeding into this restricted water space at an unnecessarily high sea speed.

It is imperative that in this case, a faithful adherence to an organised bridge procedure such as those distributed by the IMO and team co-operation between the master and his deck watch officers is of importance to prevent this disaster. And masters should be sensitive to the psychological make up of the watch officers when they go on the bridge so as not to intimidate the officer with their presence.

FIG.2.4 Geographical plot of M/S *Sevillan Reefer* to point of stranding on the Reef



CHAPTER 3

3. *MARINE CASUALTY INVESTIGATION*

The objective of investigating any marine casualty is to learn from it, prevent such casualty from occurring again and to help the designs of the future. Investigation should identify the circumstances of the casualty under investigation and establish the causes and the contributing factors, by gathering and analysing information and drawing conclusions. The investigating authority should not refrain from fully reporting the causes because fault or liability may be inferred from the findings.

Flag States are recommended to conduct investigations into all casualties occurring to its ships. As a minimum, all cases of serious and very serious nature should be investigated and a casualty investigation report issued. These reports should contain facts that are needed for a variety of reasons for safety, to meet the requirements of the I.S.M. Code, for governmental inspectorates, and for legal and insurance purposes.

It is pertinent therefore that anytime we investigate an accident, be it a collision, fire, or any disaster for that matter, we do so with a high level of thoroughness and attention to detail that can stand up to any question.

3.1 *METHODOLOGY*

The fundaments of any investigation is to make it as simple as possible but at the same time not to lose focus on the objectives, and to allow experience to guide progress. It is well known that accidents can occur from a simple occurrence often masked by complex mistakes. Patience, understanding and experience give the investigator a better perspective and allow him to refine his/her methodology to meet the ever changing technologically advancing world. This world is marked by its dynamics in technology: sail gave way to steam and then to diesel; rudders and propellers are changing to water jets especially in small craft; and paper charts and sun sights are on the verge of being replaced by electronic charts and differential global positioning systems.

The common factor in any investigation is the seafarer. Human error is responsible in this high tech age for an alarmingly high proportion of accidents and incidents whether direct or indirect.

The methodology used by Thomas Cooper & Stibbard, London is as follows (1996, 30)

- Establish the facts.
- Recreate the Events.
- Identify the Errors.
- Obtain the Evidence.
- Check that the story works.

This method is not complex or difficult and if consistently applied to every incident investigated, will provide a solid platform of evidence on which to negotiate, litigate, legislate in government, educate in the case of an owner and eradicate or prevent the incident reoccurring.

3.1.1 *Establish the Facts*:

- ***Collision Position and Time (C)***

Collision is all about space and only occurs if two (or more) ships arrive at the same place at the same time. The collision position is an important criteria relevant to the issues of blame. Whatever the collision time is, allocate the letter C to it so that all times to the collision from the ships involved can be related to that time. This removes the time differences contained in the evidence of both ships.

- ***Course, Speed and Angle of Blow at Collision***:

The approach of own ship before the collision needs to be recorded and in some cases it is better to start with the collision and work backwards. The angle of blow evidence is a very important piece of the investigation, helping to collaborate all other evidence. A general indication of position and angle can be obtained by looking at the impact area.

It is common that the investigator will only have access to one of the ships involved in the collision. And so it might be later before he knows about the scenario surrounding the other ship. Take advantage of the access to the first ship to know about the other ship. The time, distance and bearing of the other ship when first sighted are important facts to be established. This is the starting point from where a better understanding of the navigational countdown to collision is taken.

3.1.2 *Recreate the Events*:

♦ ***Examine the Deck and Engine Logs:***

The Log book of the ship should be noted because it gives a better and relatively accurate information of the situation on the ship leading to the collision. This log book information is mostly unbiased and tells a lot about the ship, the officers and the navigation.

♦ ***Interview Watch Officers and Crew***:

These are the people who individually, or collectively, did not avoid the collision. In most cases they all have different but interlocking versions of the same events. Statements should be taken from all those on watch at the time of the collision.

♦ ***Plot information on a Chart***:

A new, clean, up-to-date chart should always be taken on board by the investigator. The working chart is evidence and must not be used again. A clean chart should be used to plot out the navigation information obtained from the navigation team.

3.1.3 *Identify the Errors*

♦ ***Compare Deck and Engine Logs:***

Access to both the deck and engine log books is of paramount importance in order to help to confirm or deny what is put into the deck log book after the collision. The engineer on watch does not have the events outside the bridge window to confuse his recollection of time, or the sequence of events, in relation to the engine.

♦ *Examine the Equipment Logs:*

Reliance on any equipment should only be accepted when the variances and tolerances which may affect the output of these are verified.

♦ ***Compare deck and engine statements*:**

The log books on the bridge and in the engine room if synchronised should identify errors.

3.1.4 *Obtain the Evidence*:

♦ ***Secure the original Deck and Engine logs and the working Chart*:**

These are the basic pieces of evidence which are needed for any negotiation, or litigation. In a collision the working chart is the most important. Secure it and remove it from the ship. This applies to other recorded navigation information from the bridge or engine room.

♦ ***Ensure signed statements are obtained*:**

Those who give oral evidence must have it reduced to writing, be asked to read it, correct it and sign it as being true. This process concentrates their minds and preserves their evidence in case they are called upon later.

♦ ***Copy all Transmissions (ship or shore)*:**

This includes calling other ships within the vicinity of the ship being investigated and interviewing those who may have witnessed the collision.

3.1.5 *Check that the Final Story Works*:

Compare and analyse all data to ensure a logical, rational record of events leading to the collision. The objective of the investigator is to ensure that a clear explanation of how the collision occurred that is supported by the evidence and statements is available. All the evidence must then be arranged to give a scenario of the collision.
The jurisdiction under which the casualty investigator operates should be defined for this might not be obvious at the outset. The investigator is to be clearly instructed and guided on how to proceed by a counsel regarding the laws to follow and to maintain confidentiality in the preparation of the initial report. The issue might be complicated

further, not only by the various flag states' enquiries, but also those of the government agencies of the country within whose waters the casualty took place.

Mr. Leslie R. Morris of London Offshore Consultants (1996, 34) has stated:

> The Master of a ship involved in an accident should consult an attorney before committing anything in writing. Many masters were taught to record details of an incident in writing as soon as possible after an event. This is good advice in general, but the record should be maintained by the master as his notes until his own attorney has had an opportunity to advise him.

In general, as soon as an investigation has been completed, the investigator proceeds to prepare a report in a draft form initially of a "Speed and Angle of Blow Report". This is based only on a survey of damages sustained by the ship/s involved. After this initial survey he could then proceed to do a thorough navigation assessment of both ships in the case of collision.

3.2 *Statistics*:

3.2.1. *Analysis of Major Claims*

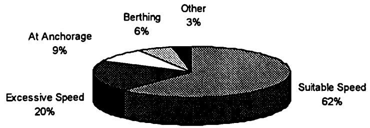
The UK P&I Club has published statistics since 1990 about various types of claims it has handled:

> For the purpose of analysis it was decided to review only those claims which exceeded USD100,000 in value. Each year the club deals with as many as 15,000 individual claims the majority of which are worth less than this amount. Although claims over USD100,000 represent only 2% in number, nonetheless they represent more than 69% by value. During a period of several years, a total of 123 collision claims were analysed which represented 10% of the value of the total claim analysed. The total value of these claims was USD79 million.

3.2.2 *Status of the Ship at Time of Collision*:

The table 3.1 below shows the status of the ship at the time of collision. In 82% of cases, the ship is described as being 'underway'. In the table, this category is divided into two headings- underway at a suitable speed and underway at excessive speed. It will be noted that 20% of the claims fall into the earlier category. So a relatively small number of collisions occurred in close quarter manoeuvring such as anchoring or berthing.

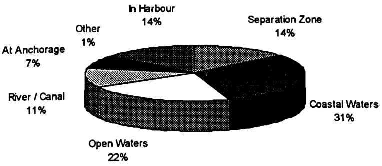
Table 3.1- Status at Time of Collision



3.2.3 *Place of Occurrence*:

The table 3.2 below shows where the majority of claims took place. Collisions are much more likely to happen in coastal waters and in areas of restricted navigation. However open water collisions accounted for a larger proportion of the total value of claims than those in coastal waters (30% as opposed to 16%). There is a high number of collisions taking place at anchorage.

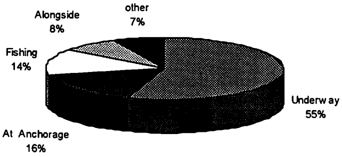
Table 3.2- Place of Occurrence



3.2.4 *Status of 'Other' Ship*:

The table 3.3 shows that the number of collisions involving fishing vessels is high and in 55% of cases, the other ship was underway.

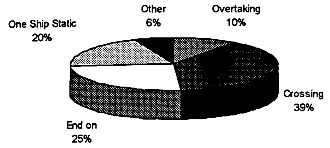
Table 3.3- Status of 'other' Ship.



3.2.5 *Type of Collision*:

The table 3.4 shows clearly that the greatest number of accidents occurred in a crossing situation.

Table 3.4- Type of Collision



3.2.6 *Visibility and Sea State*:

Table.3.5- VISIBILITY

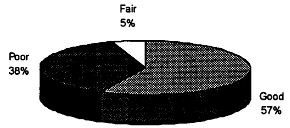
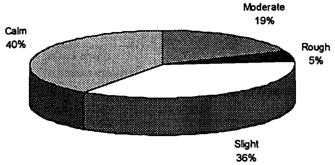


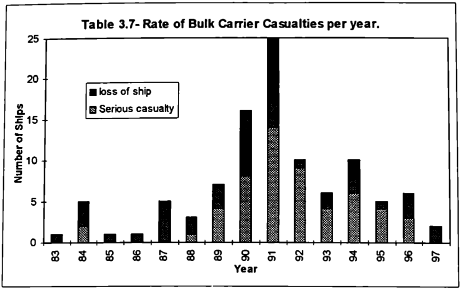
Table 3.6- SEA STATE



These tables 3.5 and 3.6- Visibility and Sea State, show a most interesting outcome, in the sense that it is assumed that poor weather conditions would play a large part in such accidents but this table shows this not to be the case. 62% of collisions were in good or fair visibility and the sea state was described as 'slight' or 'calm' in 76% of cases.

3.2.7. *Bulk Carrier casualties*:

Table 3.7 shows that the rate of structural failures and ship lost at sea of bulk carriers increased between 1989 and 1994, with the worst year being 1991 when 11 ships were lost and 14 serious structural failures occurred.



3.2.8 *Cost of casualties*

The table 3.8 shows a summary of net claims paid during the financial years 1989 to 1997 by the Assuranceforeningen Gard (mutual protection and indemnity insurance). It is shown that total claims paid over a decade ago have doubled.

Table 3.8- Summary of net claims paid 1989 to 1997.

Source: Gard, 1998

	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
	USD Mill.	*USD Mill*	*USD Mill*	*USD Mill*	*USD Mill*	*USD Mill*	*USD Mill*	*USD Mill*	*USD Mill*
Claim category									
Crew	15.8	18.9	23.8	32.3	31.1	15.9	33.7	27.0	27.5
Cargo	22.2	17.3	21.1	26.5	15.3	24.3	26.9	31.5	14.5
Death & P. Injury	5.1	7.3	11.1	9.1	8.4	6.5	12.1	9.7	4.4
Coll. / Dock damage	0.7	3.5	2.1	2.8	10.7	13.7	7.6	9.5	5.9
Oil spills	1.6	12.1	6.3	5.3	2.3	11.6	13.0	16.7	19.7
Other claims	4.3	13.5	15.3	13.9	14.0	8.1	12.9	12.3	22.3
TOTAL	**49.7**	**72.6**	**79.7**	**89.9**	**81.8**	**80.1**	**106.2**	**106.7**	**94.3**

CHAPTER 4

4. *MAJOR AND SERIOUS CASUALTIES AT SEA*

This chapter is focused on maritime casualties that have had major media attention and caused the introduction of new regulations, conventions or codes over the years. An overview of these casualties and the lessons learned from them will be considered. It is vitally important that investigations are carried out anytime a casualty occurs so that the why, how, where and what facts of the casualties can be deduced to prevent reoccurrence of this sort of casualty. The obligation to carry out the investigation is on the flag state and stems in part from the International Convention for the Safety of Life at Sea, 1974 (SOLAS), Annex to Chapter 1, part C, Regulation 21(a) which states:

> Each Administration undertakes to conduct an investigation of any casualty occurring to any of its ships subject to the provisions of the present Convention when it judges that such an investigation may assist in determining what changes in the present regulations might be desirable.

The impact of human factors in casualties pre-empts the provision of IMO Resolution A.285(VIII) which contains principles for a good bridge watch preventing overconfidence.

The effect of the media had been the main motivation in finding preventive methods following a casualty. Some of the major casualties at sea that have changed the way things had been previously are;

- *TITANIC* (1912)- SOLAS.
- *TORREY CANYON* (1967)- MARPOL.
- *AMOCO CADIZ* (1978)- STEERING GEAR REGULATION / OILPOL COMPENSATION.

- *HERALD OF FREE ENTERPRISE* (1987)- GUIDELINES ON SAFETY MANAGEMENT. 19/10/89.
- *ESTONIA* (1994)- THE REVISED STCW CONVENTION.
- *EXXON VALDEZ* (1989)- OPA 90.
- *SCANDINAVIAN STAR* (1990)- ISM-CODE.

4.1. *Titanic*

The steam ship *Titanic* was a three-screw ship built by Harland and Wolff shipbuilding yard in Belfast, Northern Ireland in 1912 for the White star Line. She was about 270 metres in length; 28 metres breadth; depth of hold 18 metres; displacement at 10.5 metres was 52,310 tons with a gross tonnage of 46,328 tons and 21,831 net register tons. The owners were the Oceanic Steam Navigation Company, Limited usually known as the White Star line and registered in Britain. She carried a crew of 885 men and women and the total number of passengers onboard was 1,316.

The ship was built throughout of steel and had a cellular double bottom with a floor at every frame, its depth at the centre line being 63 inches (1.6 metres), except in way of the reciprocating machinery where it was 78 inches (1.98 metres). For about half of the length of the ship this double bottom extended up to the ship's side to a height of 7 feet (2.13 metres) above the keel. Forward and aft of the machinery space the protection of the inner bottom extended to a lesser height above the keel. It was so divided that there were four separate watertight compartments in the breadth of the ship. Before and abaft the machinery space there was a watertight division at the centre line only, except in the foremost and aftermost tanks. Above the double bottom the ship was constructed on the usual transverse frame system, reinforced by web frames, which extended to the highest decks. At the forward end the framing and plating was strengthened with a view to preventing panting and damage when meeting thin harbour ice.

There were four elliptical-shaped funnels, the three forward ones were for the exhaust of combustion gases from the boiler furnaces, and the aft one was placed over the turbine space and used as a ventilator. The galley funnels were led up this funnel. All overboard discharge from the circulating pumps, ballast pumps, and bilge pumps were below the deep load-line but above the light load line.

The investigation of the sinking of this ship was thorough but the exposure of information to the public was inadequate. She sank in the early hours of 15 April 1912 after striking ice in or near Latitude 41° 46' N. Longitude 50° 14' W. in the North Atlantic Ocean. The proximate loss of 1,490 lives on the Titanic was due to an insufficient number of life saving apparatus on board. She carried collapsible life boats on deck that were not easy to launch. Only about seventy percent of the passengers could have been saved even if all the lifeboats on board were launched. Unfortunately, a lot of the passengers refused to use the makeshift liferafts supposing that it was safer to remain on board the *Titanic* than go to the liferafts.

The *Titanic* proximate cause, that is, the highest contributable cause the inferior quality of the hull steel. The steel material used for making the rivets fractured in cold conditions allowing the overlapping hull to be pushed in by the icebergs thereby allowing the ingress of water to flood the ship.

With hindsight, it is easy to see some of the failures on board the ship. There was the lack of responding quickly to reports from other ships of sightings of icebergs on her route. The master should have had a better lookout posted and slowed down the speed of the ship. Communication between management/master/crew should be direct and to the point. The drop of night time temperature should have indicated the presence of ice in the vicinity which could cause brittle fracture on steel. The efficient closing of watertight doors was questionable. The number of lifeboats were inadequate to take all the people onboard. In an emergency the noise from the steam blowing ships horn prevented clear understanding of instructions from the officer in-charge on the boat deck.

This casualty helped the maritime industry to introduce some regulations to stop some of the anomalies experienced on the *Titanic*. For example, rules requiring lifeboats to have the following:

- Sufficient side heights to prevent easy access of water and ample stability in a sea-way, when loaded with their full complement of persons and equipment.
- The ratio of lifeboat depth to the breadth was 4/10 giving the boat a good freeboard.

- There were no binoculars on board to allow the lookout man to see the iceberg further away from the ship than the seventy-one metres on this occasion.
- Providing the ship with a double skin carried up above the waterline.
- The accommodation of the lifeboat and the raft should be enough to cover the number of persons intended to be carried and not upon the tonnage of the ship.
- All the lifeboats must be protected from damage whilst being lowered.
- Recommended that one or more of the lifeboats should be fitted with some form of mechanical propulsion to help rescue other ships and survivors.
- All boats should carry lamps and pyrotechnics lights for the purposes of signalling.
- All the lifeboats should be marked with the number of adult persons they could carry.
- All lifeboats should be provided with compass and provisions.

The first meeting arranged by the government of the United Kingdom on safety of life at sea in 1912 was because of the sinking of this ship. A lot of the recommendations recorded still apply today.

4.2. *Herald of Free Enterprise*

The Herald of Free Enterprise was a ferry boat of overall length of 132 metres and breadth of 23 metres with gross registered tonnage of 8,000 tons. The British ferry boat was owned by the shipping company Townsend Thoresen, a subsidiary of P&O. She left her mooring at Zeebrugge at 1908 hours on Friday 6 March 1987 destination Dover. At 1928 hours she suddenly capsized portside, without time nor opportunity to send out a 'mayday' distress signal over the radio, just outside the port of Zeebrugge in calm weather, mild sea and without warning as a result of becoming unstable due to water in her car deck. 193 people lost their lives while 348 were saved. This instability came about due to the free surface effect of water on the main deck, because the ship had sailed from Zeebrugge with her bow doors open. The oversight for not detecting the opened bow doors before sailing was as a result of the rating, who was supposed to close this bow, being asleep. Whereas the back-up system, that is the two deck officers, who were to confirm that these bow doors were effectively closed had already proceeded to the standby stations without checking.

The final check in the system to make sure that the ship was ready and safe to proceed to sea did not occur, that of the master of the ship confirming from the chief officer that all is safe to proceed. In extending the flaw on this ship, the owners' standing orders to masters states, "....that in the absence of any deficiency being reported, the master was to assume at sailing time that the ship was ready for all respects." The danger here was that nobody even checked, the bow doors went unnoticed. The construction of the ship's superstructure prevented the master from seeing whether the bow doors were properly closed from the wheelhouse or wings.

The best scenario to describe this casualty was that a number of factors, none of which in themselves could be disastrous, combined with fatal results. The rudder of the ferry was found to be on hard to starboard after the incident, it is postulated that the master on finding that she was taking in water via the bow doors took a sharp rudder manoeuvre to return to port. This manoeuvre caused the 1,100 tons of the unsecured cargo to shift and slide as water gushed through the open doors. Alternatively, the ingress of water through the open bow doors caused the ferry to roll due to free surface effect. The car decks are open spaces of about 100 metres by 20 metres. The effect of water in this space, which is about 3 metres above the ferries water line would reduce the metacentric height drastically or even become negative, thereby causing instability. At a speed of 17-20 knots the sea would have surged 3.5 metres high on the prow of the ship and the effect of a mass of water sloshing about uncontrollably would easily have caused instability.

The investigation of this casualty resulted in the recommendation that indicator lights in the wheelhouse and closed circuit television be installed on passenger ferries to confirm the state of the bow doors.

The court of enquiry findings revealed some other faults: (Heathcote, 1989, 2)

> That to fit the berth in Zeebrugge, the ship had to be trimmed by the head and that the pumps were of insufficient capacity to de-ballast the tanks to attain a desirable seagoing trim at the time of departure. That the draft could not be read from the dock prior to sailing. The nominal weights used for rule-of-thumb stability calculations were inaccurate. The stability booklet did not address certain conditions of loading and

unloading, nor did it consider stability at large angles of trim. Also in some occasions, the passenger manifest was inaccurate and that the ship may well be carrying passengers in excess of the permitted number.

The management came under criticism in light of their unclear operating procedures for the ship; the conflicting standing orders for the master; the confusion in respect of the responsibilities of the senior master; the poor organisation of crewing; the tolerance of past unsafe practices; and the lack of concern of shore management to serious ship board problems. The entire management system was rebuked for sloppiness. And the cost of this casualty was estimated at USD40 million. It is well known that regulations have contributed greatly in reducing the risk of casualty at sea, but the case of Herald of Free Enterprise has confirmed that proper monitoring of equipment and personnel including training is of greater importance. A clear and firm management and command structure should be in place. Clear, concise and unambiguous standing orders must be given, with proper channels of communication between ship and shore. The owners or operators of the ship should attend constantly to all matters affecting the safety of the ship and those on board.

The findings on the cause of this casualty brought about the IMO guidelines on safety management for ships in 1989.

4.3 *Torrey Canyon*

The IMO resolution A.173(1968) was passed after the disaster of the *Torrey Canyon*. The steam ship *Torrey Canyon* was a single screw tanker built in 1959 at Newport News, Virginia, USA and enlarged at Sasebo, Japan, in 1965. After the enlargement, she was 61,263 gross tons, 48,437 net registered tons and 120,890 dwt capacity on her winter marks. The main dimensions were 974 feet 5 inches (297 metres) overall length, 125 feet 5 inches (38.32 metres) beam and 68 feet 8 inches (21 metres) depth and classed under Lloyds Register of Shipping at 100 A-1 which is the highest classification.

She was registered by the Republic of Liberia and owned by the Barracuda Tanker Corporation, a corporation organised and existing under the laws of the Republic of

Liberia. This ship sailed from Mina Al Ahmadi in the Persian Gulf on 18 February 1967 with 119,328 tons of crude oil for Milford Haven, England via the Cape of Good Hope. Her draft on departure was 51 feet 3 inches (15.62 metres) forward, 54 feet 3 inches (16.54 metres) aft and 52 feet 9 inches (16.08 metres) amidships. She had a crew of 36 officers and ratings including her master on board at the time of the casualty.

The voyage had proceeded normally until 14 March, whilst the ship was passing between the Spanish islands of Tenerife and Grand Canary in the Canary islands, the master set a new course of 18.25°, which was intended to take the ship about 5 miles (8 kilometres) to the west of the Scilly Islands about 1,400 miles (2240 kilometres) away. She got stranded on Seven Stones whilst proceeding at full sea speed of about 15.75 knots and never recovered.

The following description, by the investigators, of the layout of a section of the wheelhouse control panel could have contributed to the casualty (Malcom, 1967, 2):

> The *Torrey Canyon* was equipped with a Sperry Gyroscope automatic steering system. The selection lever for operating this system was located on the right hand side of the steering stand in the wheelhouse. This lever or switch had three positions. The aft position was for 'automatic', the central position was 'hand' and the forward position was 'control'. The 'control' position permitted the rudder to be operated by a control handle located to the left of the wheel.

On this ship there was no set procedure to follow for the operation of the selector lever by the steering stand. Sometimes the officer on watch has the discretion to operate or give the helmsman the order to operate it. As the ship approached the Scilly islands there were a lot of mistakes such as that the ship could not get her accurate position and the master took unwarranted action so as to meet the arrival tide, otherwise the ship could be delayed for an extra five days waiting the right tide. The master of the ship changed his plan as to which side of the Scilly isles he wanted to pass but decided to change his plan without adequately briefing his officers. Originally he planned to pass by the west of the Scilly Islands but changed to pass between the Scilly Islands and the Seven Stones. The master forgot to confirm the position of the selector lever by the steering stand at the critical moment which caused a delay turning the ship out of danger whilst there was still time.

The master failed to follow the Sailing Directions issued by various authorities to avoid the dangers that are imminent around these waters. The possibility of fatigue after a long voyage could not be ruled untenable on behalf of the master. The master continued on automatic steering while proceeding in the vicinity of the Scilly Islands in close proximity of fishing vessels and other ships. The master failed to practise a good bridge resource management co-ordinating all the watches and officers.

The introduction of the ISM Code in force for Tankers, Passenger Ships and Bulk carriers will go a long way to eliminate this type of disaster, because the responsibilities of the master and crew are properly defined and documented including shore management also. This casualty resulted in the total loss of the ship and her cargo, resulting in the oil pollution of the entire south-western coast of England. This casualty also highlights the importance of establishing sea lanes or routes to be followed by ships approaching or passing near coastal or areas where natural or other hazards to shipping may be encountered. The STCW95 recommends the revalidation of certificates of competency of officers every five years to enhance retraining and updating of masters and crew on board ships.

4.4. *Amoco Cadiz*

The VLCC *Amoco Cadiz* was a single-screw 232,182 dwt motor tanker built in Cadiz, Spain in 1974 by Astilleros Espanoles, S.A. Owned by Amoco Transport Co. with gross tonnes of 109,700 with length of 334.02 metres, breadth of 51.06 metres and depth of 26.19 metres. She drifted on to the rocks on the north coast of France near Portsall on 16 March 1978 and spilled 220,000 tons of crude oil. The ship's steering gear system failed about 13 kilometres north of Ushant and was never regained.

She had a four-ram steering gear system with two hydraulic pumps which were able to deliver 196 litres per minute of oil at a working pressure of 126 kg/cm^2. Two main pipes connected each of the pumps to a main oil distribution block. All four rams could be operated from any one or both pumps.

The problem started when the helmsman noticed the rudder indicator being at hard to port even though he had 10 degrees starboard helm on to hold his course. At this time, in the steering gear room, oil was streaming out of the distribution block under pressure. The port side flange leading from the hydraulic pumps to the distribution block was broken. The chief engineer tried isolating this section of the hydraulic piping system so as to keep the integrity of the system but to no avail. A relief valve pipe connection at the top of the distribution block blew out, which is not normal. Chain blocks and slings were used without success to prevent the violent movement of the rudder, which did not work. The attempt to control the steering system was stopped when the bolts on the forward guide shoe and the universal joint in the forward arm of the tiller disintegrated and injured one of the engineers. The design of and selection of the studs and flanges connecting the main piping to the distribution block was not adequate.

Without steering ability the ship went on the rocks. The master failed to co-ordinate properly the assistance from the tug boat. This casualty brought about the introduction of the amendments to the International Convention for the Safety of Life at Sea, 1974, in chapter II-1, Regulation 29 Steering Gear 16.1. It requires all tankers of 10,000 gross tons and above to comply:

> The main steering gear shall be so arranged that in the event of loss of steering capability due to a single failure in any part of one of the power actuating systems of the main steering gear, excluding the tiller, quadrant or components serving the same purpose, or seizure of the rudder actuators, steering capability shall be regained in not more than 45 seconds after the loss of one power actuating system.

The IMO passed resolution A440 (1979) as a result of the disaster of the *Amoco Cadiz*. The main reason why this ship could not be rescued in time by tug boats was because the master was waiting for instruction from the owners for permission to sign the salvage tug Lloyds open form. By the time the clearance was given she was so much driven aground by the weather that she could not be refloated before spilling her oil cargo. The ISM Code will go a long way to remedy this anomaly by giving the master the authority to take action quicker and contact a responsible manager in charge of ship safety without much delay.

4.5. *Estonia*

The roll-on/roll-off motor passenger ferry *Estonia* capsized and sank in the Baltic sea, off Uto Island, during the night of 27/28 September 1994 with 912 lives lost on her voyage from Tallinn to Stockholm. She was built in 1980 by Jos. L. Meyer, Papenburg in Germany and owned by Estline Marine Co., Ltd., at the time it sank. She was 21,794 gross tonnes (grt) with length of 157.02 metres, breadth was 24.21 metres and the depth was 7.62 metres. She was previously named 'Wasa King' (1992), ex 'Silja Star' (1992) and ex 'Viking Sally' (1990). She capsized due to large amounts of water entering the car deck, loss of stability and subsequent flooding of the accommodation decks. The waves of the sea created forces that caused the door hinges to open because the bow visor locking devices failed. The ship experienced one of her most devastating and worst wave loading conditions since she was built. There were some design deficiencies that did not meet with the accepted regulations at that time. This is a case where a ship is caught in the transition period of a new regulation of the IMO and due to time, cost and exemptions the structural defects were not repaired to standard.

The three main areas of concern that culminated in the casualty were: the Visor; the Locking Devices; and the Bow Ramp. The visor attachments were not designed according to normal assumptions, which include load level, load distribution to the attachments and the failure mode. The attachments were constructed with less strength than the calculations required. It was assumed that this discrepancy was due to lack of sufficiently detailed manufacturing and installation instructions for certain parts of the devices. The decision of the owner's representatives of the *Estonia* not to renew or repair missing and damaged rubber packing on the visor had reduced the weathertightness of the inside of the visor. (Vogel, 1997, 2)

There was severe structural damage caused by sailing at excessive speed in heavy icy sea. Some of the consequences of the missing rubber seals were that at sea the visor was filled up to the outside water level meaning that water not planned for had found its way into the ship causing corrosion of the ship as well as impacting the bow door ramp itself. The door ramp serves as a "collision bulkhead" to the open car deck and if threatened ends in a disaster. Proceeding at high speed in icy conditions is an invitation to a casualty. The pressure from owners under which masters operate to meet scheduled sailing and arrivals could have contributed to this casualty. This is one of the anomalies that the ISM Code would correct by making the master and owners more accountable and with better authority for masters to act to save crew and property. With hindsight, even in tropical heavy seas masters take precautionary steps of slowing down a ship to reduce the effect of pounding, vibration, heaving and other external forces because the forces generated on impact are approximately twice that of normal loading. The missing rubber packing on the visor means that the pre-tension function of the rubber packing was lost causing the visor to shake and vibrate at sea with the eventual result of failure due to fatigue of connecting parts.

The bow visor locking devices should have been a lot stronger to be able to withstand the rigours and safety requirements for the regular voyages between Tallinn and Stockholm. When the *Estonia* was constructed the maritime industry's general experience of hydrodynamic loads on large ship structures was limited, and the design procedures for bow doors were not up-to-date. The classification society design requirement for bow doors was upgraded after the *Estonia* had been built but the new rules did not apply to existing ships. Unfortunately the dissemination of bow visor incidents, and analysis of information were not properly spread within the shipping industry. Masters thus had very little knowledge of the dangers of not keeping the bow door visors in good condition and of the load limit they can handle.

The bow ramp is a part of the upper extension of the collision bulkhead above the bulkhead deck and as such has to be absolutely watertight. This is a SOLAS requirement and contrary to this mandatory requirement, the bow ramp was severely leaking at several locations (Vogel, 1997, 31). The whole ramp was misaligned due to a collapsed bearing of the port outer hinge. The consequence of this misalignment according to a German group of experts investigating the sinking: (Vogel, 1997, 33)

> In closed condition the ramp was pulled by two hooks engaging mating lugs at the upper side tight against the rubber packing, which in this area were apparently intact. Thereafter

two bolts at each side, that is four in total, moved out of the vessel's side, one after the other, into mating pockets at the ramp side. In fully extended position the bolts contacted magnetic limit switches and if all four had this contact, the "green indicator light" on the cardeck became activated indicating: 'Ramp secured'.

As a consequence of the misalignment of the ramp the port lower securing bolt was unable to fully extend, whilst the port upper bolt was just touching the inside of the ramp pocket.

The investigation by divers revealed that the pocket for the port lower bolt was fully intact and the port upper pocket was just slightly deformed, whilst both starboard pockets were completely torn open.

The full-width open car deck contributed to the rapid increase in the list to starboard. The ship's trim had changed from the time she left Tallinn to when the increase in list started to be noticed. She was down by the stern on departure and had changed to being trimmed by the head because of the full visor and the water having entered the cardeck via the damaged bow ramp and other openings. The ramp had collapsed due to the pressure of water from the inside but prevented from falling on the visor because of the hydraulic holding device still in place. Some of the actions of the crew on the ship need to be addressed, for example the officer on watch did not make adequate use of the television monitor to see that water had started coming into the ship. The engineer officer in the engine control room did notice this ingress of water but for some reason did not inform the bridge. The sinking of the *Estonia* brought into focus the revision and amendment of the convention on training with the arrival of STCW95. When a severe crash noise was heard on the cardeck about midnight indicating that the ramp had smashed open from the inside of the cardeck, the crew tried to use the hydraulic pumps and simultaneously the ship's speed was reduced and the bow turned into the wind/sea, that is to port. The ship's list increased to starboard due to this action, the water in the open cardeck must have flowed to the starboard side due to centrifugal force.

The ship took a sudden starboard list at 0102 hours to 18°, which most probably was caused by additional water on the cardeck coming in through the partly open bow ramp, all of which accumulated at starboard side. In addition to water movement, the increase in list was due to the loss of uprighting moment by the stabilisers due to the speed reduction from about 15 to 6 knots and the shifting of cargo by about one metre. (Vogel, 1997, 35)

The ship continued to turn to port, but more rapidly because with the increasing starboard list the still active starboard stabiliser fin took over the function of a rudder blade and made the ship turn to port rather quickly. The effect of the starboard fin being down to counter the starboard list was more than that of the rudder blades, although being at hard to starboard, had little or no effect due to the list compared to the stabiliser fin. The list had exceeded 30° at about 0110 hours and the main engines stopped. When the list was in excess of 40° the auxiliary engines stopped and the emergency generator started. The ship, stabilised at a list of between 40° to 50°, was then already heading South East with the funnel pointing in the direction where the wind was blowing from. At 0131 hours she was on her side and the emergency generator stopped. The lessons learned from the *Estonia* were:

- that during a transition period of a new convention steps should be taken to limit the parameters under which existing ships work to keep within the new regulation.
- that the safety factors placed on materials and constructions should be maintained as high as possible, making safety a priority rather than economy.
- that masters should be encouraged that getting the ship safe to port is more honourable than keeping to schedule.
- that chief engineers should be encouraged to refuse inadequate repairs even if the class surveyor says it is good enough, because he knows the ship better than the surveyor.
- it is high time that speed limit be placed on ships of various size and design especially in heavy seas.

CHAPTER 5

5. *THE HUMAN FACTOR IN MARINE CASUALTIES*

The IMO defines human error as a departure from acceptable or desirable practice on the part of an individual or group of individuals that can result in unacceptable or undesirable results.

It should not be surprising that the human factor accounts for eighty percent of accidents because of the dominant influence of human beings on Earth. God created man and gave him authority and the will to choose good from evil over all the earth. Taking a broad look at the world today will show that the influence of man has always been to challenge 'nature' and has continuously done more damage than good. George Bernard Shaw, a great British playwright, said "experience has taught that man does not learn from experience". It is evident today that the greenhouse effect, that is overheating of the atmosphere, is a result of the damage caused by the industrial revolution, which is an energy based development. Of course this has reduced the effort required by man to do work but in the process some fundamental rules governing the earth have been broken. The excessive discharge of carbondioxide into the atmosphere and the depletion of the forest wood are two diametrically opposed situations. Man is pumping so much carbondioxide into the atmosphere and at the same time destroying the forest which is the main source of converting this gas back to oxygen. The other source of oxygen being the plankton in the ocean is destroyed by man's pollution of the sea.

This chapter will deal with the human factor, vis-à-vis, its effect on casualties in the maritime environment and maritime industry. Recently there has been a lot of debate on the growing rate of casualties in the shipping industry in spite of the advance in technological know how. The argument to eliminate the human factor can only be achieved when there are no human operators. But as long as crew are carried on board ships the best scenario is how best to complement human action with technology.

The Department of Transport, UK record of casualties states that the human element was found to be present in over ninety percent of collisions and groundings, and in over seventy-five percent of contacts and fires/explosions (Bryant, 1988, I/3).

An accident is an unexpected, unintended event with an unpleasant outcome which is neither predictable nor controllable. The failure of a light bulb is not normally classified as an accident even though we cannot predict the precise life, nor control it, but to a certain extent scientifically, the failure is due to the erosion of the tungsten element. On the other hand accidents due to the human factor are unpredictable because the behaviour of the human being is uncertain and there are few universally acceptable laws within the range of the human five senses to define his action. For this reason there is the danger of categorising most causes of accidents that cannot be readily explained on to human factors as an easy way out of the problem.

5.1 *Obstacles to safety at sea*

Losses at sea may be classified under four main broad areas:

- Those pertaining to personnel- this could result in the death of personnel, partial or total disability and loss of personal effects.
- Those pertaining to property- the loss of property could be either partial or total which could be actual or constructive.
- Those pertaining to profits- resulting in off-hire or other delays due to injury to personnel.
- Those pertaining to liability- this could be as a result of legal liabilities either in tort (common law), statute or due to contract agreement.

Losses may be as a result of one or more of the following:

- Acts of God;
- Failures due to human beings;
- Unexplained accidents;
- Unavoidable occurrences.

Acts of God are abnormal situations beyond human control, like cyclones, hurricanes, tidal waves, earthquakes etc.

It is not right to say that casualties befall only incompetent crew, but also competent ones, even in beneficial surroundings, can make serious mistakes. It is well known that anyone can and will eventually make a mistake but similar mistakes can have widely different causes and effects. A casualty is a result of accumulated small mistakes and each little one centres on a decision. The decision is a choice taken from a range of options and once taken may not include the other options. It is this contrast between risk and gain, selection and exclusion, that makes effective decision making difficult (Johnson, 1995, 27).

To predict the outcome of a decision even under controlled conditions is difficult and more so in crisis where the situation changes from just being under control to being out of control. In addition being under pressure contributes to the difficulty to take the right and effective decision. The judgement to make the right decision is a complex process that only the human mind can do well which is governed by the individual's training, experience, and the information at hand.

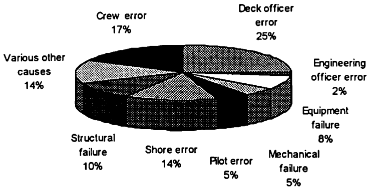
One of the main obstacles to safety at sea is the difficulty for the industry to draw from past experience. This is borne out of the inability to extract all the information from personnel involved in previous casualties because of fear of being blamed. The priority of investigators had previously been to find who and where to lay the blame on rather than finding the root cause of a casualty to prevent future occurrence. In the aviation industry the confidential reporting of accidents is allowed and is working well and so is the Marine Accident Reporting Scheme (MARS) where the emphasis is not mainly to find a culprit but to prevent future reoccurrence.

The old school of thought of punishing the incompetent should be discarded if only to encourage them to come out of the woodwork and tell all in order to prevent future casualties. This will allow incompetence to be widely discussed in the work place thereby putting pressure on the incompetent through colleagues rather than by the management and this type of pressure has been found to be a better solution to change behaviour and standards.

It is now generally accepted that the organisational responsibility may be a fundamental cause of the majority of accidents classed under human error. The United States

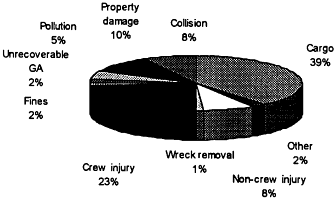
National Academy of Sciences has listed fourteen factors as being the most common causes for human error in the maritime industry (Chatterjee, 1997, 23). These include: inattention; poor operational procedures; poor physical fitness, fatigue; excessive personnel turnover; high level of calculated risk; and stress on the job. These certainly could not be attributed to the human only but to management.

Table 5.1 Main causes of major claims



Source: Safety at Sea International, 1996, 28.

Table 5.2 Main types of major claims



Source: Safety at Sea International, 1996, 28.

Table 5.1 illustrates the main causes of major maritime claims (Safety at Sea, 1996). It will be seen that at least half of the claims were due to human error and in accidents like collisions the proportion is higher. Poor standards of maintenance and bad practice are partly or wholly to blame for cases of structural failure or of machinery failure.

From table 5.2 over sixty percent of UK P&I Club major claims are from causes related to human error. Ships are required to operate on a twenty-four hours per day basis and so are the crews. The effect of working all day and all night and the disturbance of the normal rhythm of time of sleep in the maritime industry is a major contributor to stress and fatigue at sea.

Some other human factors to be taken into consideration are experience, morale, motivation, management policies, standards of certification, conditions of service, environment, loyalty, language, and training.

Some of the other obstacles are that people do not recall accurately what they have witnessed before, during and after a casualty. Unlike the airline industry, where the black-box will give a lot of information, the log-books and reports at sea are subject to human processes. Also the scene of the casualty does not remain constant. This will not allow a better understanding of the physical inter-relations that culminated in the casualty.

What crew members recall from a casualty could be less of the external occurrence but mainly of their perception and all the disturbing processes that affect memory. It is known that after a trauma, people may undergo a period of not remembering, having distorted, blurred and hazy memory. And as stated earlier the fear that anything divulged during interrogation could be harmful to the individual, including the need to protect ones security and to protect the community by closing ranks could prevent witnesses from testifying correctly.

Human error, as contributing to 80 percent of the cause of casualty, will not be complete if the effect of those who employ the seafarers and those who issue the certificates of competency are not taken into consideration. So the blame should not all go to the seafarers but also to these other institutions.

It is pertinent to look at the overall cause of a casualty and not just the final influence be it human to arrive at a better picture as to the cause of a casualty. This is because a casualty could have been caused by series of problems that needed the final human touch for it to manifest.

casualty could have been caused by series of problems that needed the final human touch for it to manifest.

The six main causal area already identified are: external conditions; technical failure; inadequate navigational factors; navigational error; non-compliance; and other ships. External conditions; navigational error; and non-compliance were found to predominate and account for 75 percent of registered causes (Quinn, 1982, 4).

It was found that for ships of 1599 grt and above, collision occurred mostly in open sea or restricted waters and poor visibility was a controlling factor. But for small ships of between 100 to 1599 grt, navigational error was the main factor.

Some of the human failures that have been noted to contribute to casualties are incompetence, negligence, confusion, inattention, fatigue, ignorance, anxiety, panic or shock, sickness, drunkenness, lack of communication, negative transfer of training, calculated risk and fear.

5.2 *Education and training of crew*

The common use of the term 'human error' is misleading because the human as the main and only cause of a casualty is not possible. The cause usually is by the interaction of the human and other components. The human could be classified as one of the component failures in a whole system component that makes up the process. It will be more feasible to say 'human involvement'.

In practice it is hard to separate the human from the technical elements in a total system. The difference between the terms human factor and human element is that the element refers to the peculiar aspects of human involvement which require a lot of interpretation in order to be understood.

The manning, education and training of officers and ratings on board ships has become an increasingly important factor in the regulation of ships both by the international convention and national law.

The STCW Convention (1978) amended in 1995; the SOLAS Convention as related to crew training and skills in the various areas; the International Safety Management Code chapter IX of the SOLAS Convention; and the US Oil Pollution Act 1990

(OPA90) manning and management of the ship both ashore and afloat, are some of the international conventions and laws that pertain to the crew on the ship.

In order to curtail casualties the training of seafarers must be extended from the training to carry out routine task to the acquisition of knowledge, skills and attitudes that a person requires in a crisis situation. A psychologist, David Kolb, described the process by which people learn, known as the Kolb's 'learning circle': (Johnson, 1995, 28)

- Experience- something happens to the learner.
- Reflection- the learner thinks about what happened.
- Conclusion- the learner works out a theory, or modifies an existing one, or determines that the original theory holds good.
- Planning- the learner applies the conclusion to the situation when it next occurs.

The learning process would not be complete if this cycle is not complete. It is common for this cycle to be broken at the reflection stage, that is where the affected party usually shrug their shoulder and say 'just one of those things'. In practical terms this is the stage where de-briefing is better carried out with the emphasis laid on finding out the reason for the incident and not to find out who is to be blamed.

Another component that could affect decision making before a casualty is information. How much information has the individual accumulated prior to that point and the ability for the human mind to absorb and process information is very complex.

The complex nature of how the mind processes information could be explained thus (Johnson, 1995, 30):

> The brain has two basic memory types- short term and long term memory. Figures vary for the duration of the short term memory, but it would seem to be based upon the individual and whether the information stored has arrived via the ears, eyes or other senses. Unless that information is used it will be lost (hence the use of the pocket notebook). Information is transferred from the short term to the long term memory by repetition. A lot of training design is based on the old maxim

> of 'thirty percent tuition, eighty percent repetition' to transfer facts, data, rule of the road, from the short term to the long term memory. The long term memory uses this information to build mental models.

The master and crew onboard the ships have been trained to operate these ships to the highest possible standard but the increase of other factors like size, speed, technology, reduction in crew size, increase of new national flags and pressure to increase profit margin have all accumulated to increase casualties rate. The introduction of STCW95 and the ISM code is in the right direction, also as stated by Professor P Muirhead, the additional and proper training of other workers (bulk cargo terminal) related to the ship must be taken into consideration so as to eliminate the problem of the weakest link in the chain vis-à-vis the training of terminal operators (Bimco special bulletin, 1998, 98-99)

The IMO being a regulatory body has been in the forefront in providing international conventions and codes agreed to by participating member countries in improving the education and training of personnel in the maritime industry. The ISM code is in place now to ensure that the shore staff are themselves adequately trained, informed and equipped to take up operational responsibilities of the ships in co-operation with the ships management structure. This code came into force 1 July 1998 and the main safety management objectives are: that it provides a safety documentation and safety practice of the operational and working environment; that it establishes a safeguard against all identified risk expected on board; and that the skills of personnel ashore and on board the ships are continuously improved to take care of emergencies related to safety and the environment.

The idea of Port State Control has helped to detect and control a lot of the defective ships sailing around the world and the MOU (memorandum of understanding) among states and regions would block the loop-hole for escape of any ship. It is easier for a neutral body to find fault than for the shipowner and flag states. The new chapter XI of SOLAS regulation which came into force on 1 January 1996 gives the state control authority power to check for the competence on operational requirements of ships officers and ratings calling at their port.

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) 1978 entered into force on 20 April 1984 to ensure that masters, officers and ratings on board sea going ships are competent to safely operate these ships. Being the first convention of its type, with all the compromises required before a convention could be ratified, it introduced an internationally accepted regulation. STCW78 lacked the teeth to effectively monitor the training of seafarers allowing different administrations to interpret it as they wish.
The effect of STCW95 on preventing casualties is that previously the training and education of seafarers were knowledge based whilst STCW95 lays more emphasis on competence based training and education. Competence being the 'ability to apply skills, knowledge and understanding in performing to the standards expected in employment across different conditions and in meeting changing demands'. The STCW95 recognised the varying level of educational systems in the various parts of the world and has tried to provide a basic standard and reference system for the future. For the first time the IMO has been given the authority to enforce this convention.
Training being one of the three main factors, that is, in addition to safety equipment and the attitude of the individual or group of individuals to prevent casualties, is very important. As well as mental impairment, that is, low mental ability can reduce a persons' level of assimilation required to carry out work as well as study.

5.3 *Influence of age, experience, stress and fatigue.*

When the term human factor is used it does not mean that there is a unitary human fault that has caused the casualty but there are several constituent factors which are each worthy of separate consideration.
Fatigue is an example of one of these factors that plays a significant part in a casualty. Ships are required to be operated for twenty-four hours every day and so are the ships' crews. The effects of working around the clock and the disturbance of the normal rhythm of a human being's waking times on the ships is a source of fatigue. It is well known that crew members must be allowed at least an eight hours rest between any two watch or working period. Notwithstanding this rest period, the fact that the crew

are not allowed to leave the ship, being at sea, and in an emergency the crew member is supposed to be on-standby puts him/her on stress practically all the time.

Fatigue is a more significant factor in maritime accident than previously thought. According to a US-coast guard survey, fatigue was a contributory factor in thirty-three percent of critical ship casualties and sixteen percent of personnel injury casualties, compared to figures of just 1.2 percent and 1.3 percent in a previous study.

Some of the factors that could trigger fatigue are;

- Hours of work
- Short term or long term issues
- Condition of service at work
- Condition of work
- Mental versus physical work load.

As a follow up to curtailing the effect of stress on seafarers, a revision of ILO Convention No. 109 has been reached and if sufficient numbers of governments ratify the new Convention No. 180, the provision will also be subject to port state control in foreign ports : (ITF Bulletin, 11/1997, 32)

> Agreement was reached on restricting working time to a maximum of 14 hours in any 24-hour period, and to 72 hours in any seven-day period. There must be a minimum of 10 hours rest in any 24-hour period, or 77 hours in any seven-day period. Most importantly the standard of an eight hour day with one day of rest per week has been stipulated.
>
> The restricted hours of work will apply to all seagoing ships (excluding fishing vessels) irrespective of size. Commercial fishing vessels may be included by member states.

There are three fundamental needs required by the crew to be happy at work: it must provide some sort of benefit, that is, wages, job satisfaction, and respect; it must not be too much work, that is, sufficient rest with intervals; it must have a sense of success, that is, to be progressive. The inability to meet any or all of the above leads to stress. Stress is a factor that has both positive and negative effects on humans. Every individual has his/her own optimum level of stress and each person reacts differently to different situations.

Stress is a factor that has both positive and negative effects on humans. Every individual has his/her own optimum level of stress and each person reacts differently to different situations.

The human being reacts to stress in three basic ways: freeze, flight or fight. A withdrawal from reality, reluctance to face up to the situation and self delusion can be symptoms of a person who freezes under stress. Panic and abstention from the scene are the symptoms of a person who is classed under flight, whilst increased muscle performance and misdirected aggression are symptoms of a person who is classed under fight. The human brain has seven channels of information, that is it can attend to seven things at the same time but under stress the brain tends to shed some of this load

Figure 5.1 shows that the performance of an individual increases as the stress increases up to an optimum level of performance and after that as the stress continues to increase the performance tends to fall rapidly.

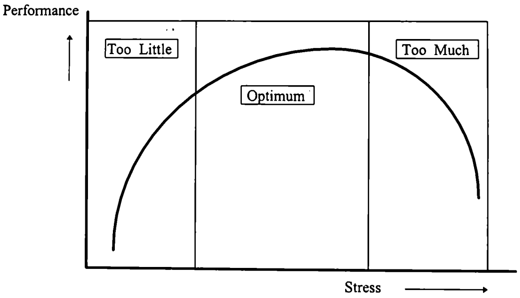


Figure 5.1 Performance against stress
Source: Safety at Sea International, 1997, 28.

Hypostress (too little stress) is due to boredom or inactivity, and has a detrimental effect on performance. As stress increases due to work, the performance increases to the optimum level. As long as the stress factor does not increase above this level the performance of the individual would remain at the optimum . This performance can be sustained as long as the individual is mentally fit just as in physical fitness. The sustenance and endurance of performance would depend on the exercise routine that the brain has been put through and this would also dictate the rate of recovery from stressful situation.

Hyperstress is much more dangerous and harmful because of the limit of the individuals ability to absorb stress is being approached. The graph in figure 5.2 plots the stress against time. The ability of the individual to absorb stress during the day vary and are within his/her stress reserve for recovery. When a highly stressful situation develop, and the reserves are used up, unable to cope the individual collapses. This is one of the reasons why stress levels on board ships are being treated with dispatch because of the catastrophic scenario that could develop that will require professional help.

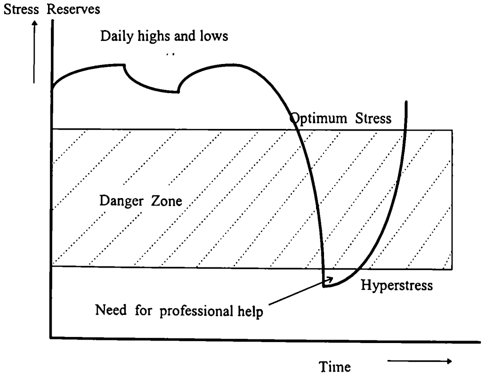


Figure 5.2- Stress reserve against Time.

Source: Safety at sea international, 1997, 29.

Some of the factors that can affect the 'background' stress for an individual are:

- Physical illness or poor health.
- Poor relationships amongst people.
- Uncertainty, could be for continued employment.
- A previous highly stressful experience left untreated.

Some other human factors that have bearing on casualties are experience, morale, motivation, management policies, standards of certification, conditions of service, environment, loyalty, and language. The quality of a ship's crew has a direct bearing on the ship's overall performance which could be extended to the causal effects on casualties. It is not necessarily true that sub-standard ships have sub-standard crews but a sub-standard crew will almost certainly mean a sub-standard ship. That is why the effect of language (communication) among crew should be considered. In the drive to reduce high labour cost on ships especially those of the traditional maritime nations and at the same time ensuring that a ship is properly as well as economically manned is not easy. Shipowners have resorted to using and delegating specific tasks to independent agents. This increasing use of agents and in particular the use of crewing agents has created an unfamiliar relationship between the crew and the owner and so the good old loyal bond between crew and owner is lost, including the sense of identity with the owner's interest.

The decline in the numbers of ships sailing under traditional maritime nations together with the gradual retirement of experienced seafarers, has altered career patterns with changes in responsibilities, career development, depth of training, and in the levels of experience to be found among officers and ratings.

Experience is a component that affect decision making and without it could mean the occurrence of casualty. At that precious moment when a decision is required to avert an incident the individuals exposure to similar situation will be useful. The maritime industry is beginning to see the effect of the loss of experienced seafarers who trained and worked under the old manual systems on the bridge, deck and engine room. The cost of manpower, improved technology and reduction in crew has gradually eroded this effect. Though the use of ARPA, Radar, ECDIS, GPS and the unmanned machinery spaces have reduced the amount of experience required. The industry still depends on experience for a better interface between man and automation. This is where training using the simulator is of paramount importance. This training will impact within a short space of time decades of experience and test the persons reaction and ability. The old wise saying 'there is nothing new under the sun' puts the occurrence of casualties under perspective that it could be avoided if the right and adequate precautions learned from previous cases are taken.

The age of a person involved in a casualty could be taken into account if it is related to his experience on the job. It has been found that complacency could set in because of the monotony of the work at sea and the OOW could be mentally locked into that routine and forget to take action in good time to avert disaster. Age could also be a factor when an incident involves reaction time, in this case younger officers are quick to react to situation than older officers and better risk takers.

The human body is a good indicator of the response to stress such as; (Muirhead & Pourzanjani, 1998)

- Physiological- sweating, heart rate.
- Health- nausea, indigestion, ulcers.
- Behavioural- nervous laughter, appetite.
- Cognitive- concentration, forgetfulness.
- Subjective- anxiety, aggression, depression, moodiness.

Sleep is a very good form of relaxation and stress reducer and so it works the other way round, that is, insufficient sleep could trigger stress. Some of the factors that affect the effect of sleep are;

- Biological clock- circadian rhythms
- Sleep-wake cycle
- Body temperature
- Time of day
- Sleep cycles
- Required quantity of sleep
- Shift work
- Time zone
- Port/sea situation
- Naps
- Sleep disorder- breathing, sleep walking, insomnia.

'Prevention is better than cure' is a cliché that must be fervently upholded at sea, to stop the occurrence of casualties. As part of these preventive measure every crew member should endeavour to maintain the following sleep hygiene;

- Avoid drinks with caffeine
- Avoid napping during the day
- Comfortable room and bed
- Avoid mental stimulation and emotional stress
- Warm milky drink and light reading
- No alcohol.

In a prevailing climate of shipping depression and over-tonnage, owners have resorted to cheap crews thereby encouraging mixed crews. The UK P&I Club investigation shows that fifty-six percent of all the tonnage under its cover had mixed crew (Safety at Sea International, 1996, 27). The danger posed by lack of communication during an emergency could lead to disaster. Also the tension created from multicultural differences is another source of danger.

5.4 *Management ethics*

The temptation for high financial gain has been a major factor for some shipowners not to carry out some of the maintenance and repairs required for safety on board ships.

Table 5.3- Operating cost/financial advantage

Source: IMO-FSI 5/3/1 annex, 1996, 5.

Bulk carrier 30,000dwt 20-year-old USD per day		**Product tanker. 1990. 40,000 dwt. USD/day**
7,500	CEILING (1)	9,500
4,500	GOOD PRACTICE (2)	4,800
3,750	COMMON PRACTICE (3)	4,250
3250	STANDARD (4)	3750
2750	(6) FLOOR (5)	3,100

(1) Ceiling = level of maximum expenditure (influenced by financial revenue earning potential of the ship in the freight market and financial cost of owners).

(2) Good practice = average level of expenditure adopted by majority of shipowners.

(3) Common practice = average level of expenditure adopted by majority of shipowners

(4) Standard practice = minimum level of expenditure to ensure owners compliance with basic standards of safety.

(5) Floor = level of minimum expenditure (still keeping the ship operational)

(6) Shaded area = margin of substandard operation within which the shipowner is able to operate ship subject to non-detection by regulatory authorities (flag states and classification societies acting on behalf of flag states, port states)

It is imperative to point out the financial gain obtained by a shipowner who decides to operate at the floor (5) of the table 5.3 above. With respect to the safety of navigation and prevention of pollution of the marine environment, an owner that decides to work within the shaded area (6) where if not detected could make a substantial saving in running cost

Similarly for a 40,000 dwt product tanker built in 1990 working within the time charter market, the margin of substandard operation equates to USD 650 per day or USD 237,250 per year, equating to a 15 percent saving on annual running costs.

The decision as to where to register a ship is governed by several factors including taxation and administrative convenience, but another point that the shipowner considers is the law of the flag state and whether this will restrict the free choice of nationality of the crew. The percentage of ships operated by its owners is about seventy-three percent and the remainder twenty-seven percent is by professional management company on behalf of the owners. (UK P&I Club)

It is generally known that management companies do not employ on a full time basis crew to man their ships but subcontract the crewing of the ships to employment agencies. And so we have crews that do not display the committed involvement traditionally expected. Fifty-six percent of ships sailing the international route are of mixed crew, but thirty-two percent by nationality of the officers onboard were from the European union states and thirty percent from Eastern European countries. In thirty-two percent of ships, the ratings were mainly from South East Asia with twelve percent from the Far East and seven percent from the rest of Asia. The old traditional way where a shipping company employs youngsters in there teens and puts them through cadet officers training has been lost because of the need to reduce cost in a climate of trust and overtonnage.

For better performance and safety on ships, the increasing use of management tools like policy statements is becoming mandatory for shipowners and includes the ISM-Code and the Vessel Response plans as required under United States OPA 90. The assumption here is that better understanding of responsibilities and systems will lead to better performance and for it to be effective it needs to be active, that is, it must be written down and strictly followed. And every member of the crew must be aware of these plans. There is a common anomaly in the maritime industry whereby the plans are available in written form but for one reason or the other they are not followed because these are not scenarios that occur on regular basis and are easily forgotten.

The benefits of good communications with and the guidance of officers through an effective management policy helps crew efficiency and morale and reduces the distance between operator and employee. Certainly loyalty or the lack of it has an important impact on the performance of the ships' crew.

Management's attitude towards maintenance is a two edged sword, if not done adequately could result in casualty and if over emphasised could drive to bankruptcy and so a good balance is of the essence.

Risk management and loss prevention will have to be addressed by any management that is worth its salt. Risk management involves four distinct phases: planning, organising, motivating and controlling. It is the overall view of all risks and the optimum management of them by minimising the frequency of occurrence and/or the severity of the consequences.

5.5 *Navigation Aids*

The table 5.4 below shows the level of automation and training relative to safety on board ships and the relevant IMO resolutions that apply. It is seen that for bridge operation the level of automation is low whilst it is high for the engine operation and rather unfortunate the level of automation in maintenance does not exist.

Table 5.4- Automation and safety at sea

Safety related processes	***Degree of automation***	***Demands in training***	***Resolutions of IMO***
Bridge Operation	low	on shore	ISM, STCW95
Engine Operation	high	on board	ISM, STCW95
Maintenance	none	skills	ISM

The development of information technology on the bridge of a ship cannot guarantee safety at sea. It is found that the low level of automation on the bridge in addition to the increase in information technology demands a better procedure for the interaction between human and the instruments. The high level of automation in the engine room demands better training of crew in order to maintain safety vis. STCW95. The maintenance system on the ships require an up to date safety management system as demanded by IMO in the ISM-Code. On board the ship administration management tools like the Reliability Centred Maintenance system is overdue for the maritime industry.

The increasing use of automation and the growing demand for safety demands that technology supporting human abilities on board should be exploited to the highest level. Risk management and the identification of potential dangers have largely depended on human capability in the past even on ships with integrated bridge systems. How can navigational risk be analysed by technology to identify the chain of errors in sufficient time to take appropriate preventive action. This question is addressed by the introduction of MarineSoft ANRIS 2000- Automated Navigation Risk Indication System. This is an automatic system for assessing risk in ship navigation taking into account the interaction between good seamanship and the available navaids. It helps the human navigator to quickly recognise danger and effectively avoid it.

Dr. Harro Kucharzewski of MarineSoft, Rostock-Germany said: (1997, 4)

> The first installation onboard the German cruise liner CS "AIDA" has proved that ANRIS 2000 can be easily integrated into ship navigation systems and that the system will efficiently help to promote the safety of ship, passengers and crew by helping the human navigator quickly recognise danger and effectively avoid it.
>
> The system also has an integral data recording system. This accumulates, evaluates and acts on information received as well as reporting and reconstructing casualty scenarios to avoid any external claims relating to navigation. ANRIS achieves most of the relevant requirements and recommendations of the ISM-Code and the STCW95 Convention of the IMO.

In 1983, the IMO adopted Resolution A.528(13) that says, 'Being of the opinion that the practice of weather routeing has proved of benefit to ship operation and safety as well as to their crews and cargoes..., recommends Governments to advise ships entitled to fly the flag of their states of the availability of weather routeing...' This is in light of the number of ships lost due to heavy weather especially bulk carriers. The availability of meteorological satellite pictures, numerical forecasts and other technical data helps a ship master to plan a safe voyage. Heavy weather may be attributed as the reason for a ship lost at sea, in reality the weather may be the final part of other factors like ship structural integrity, type of cargo, load and stowage condition and the engine capability as well as the age of the ship. Structural problem could also be as a result of a combination of weather effect caused by the pounding, slamming and yawing of the ship in bad weather. The effect of wind, heavy precipitation, fog, icebergs and even temperature can cause disaster the use of proper scientific forecasting of weather is imperative.

CHAPTER 6

6. *CONCLUSIONS AND RECOMMENDATIONS*

6.1. *CONCLUSIONS*

Casualties are not solely caused by actions taken by humans but by the interaction brought about by the complex relationship between humans, machine and nature. The potential for a casualty to occur is created when human actions and other inherent failures present within a ship interact in a manner that breaks down the defences already set to prevent these failures. The human being is fallible and the question is how to reduce the frequency of his/her errors and limit their consequences that result in casualties. This is the essence of investigating and reporting on casualties to roll back the sequence of events to enable others to learn from the mistakes.

One of the major faults in the diagnostic and preventive ability of the human race is the refusal to study and come to the understanding that a lot of the unexplained conditions are due to a refusal to accept the authority of a great and mighty God. The human mind has been trained to accept only what it can see and feel and whatever it cannot perceive with the five senses does not matter or exist. The so called 'nature' has laws that govern the earth and the surrounding universe and the moment man trespasses, out of ignorance or whatever, the consequences are always catastrophic. Every casualty investigated has shown that a critical in-depth analysis would reveal the flaw of a love of money being the driving force that controls the decision of man. This statement is made on the premise that maritime transport is governed by trade and trade by the economy of the different parties involved. Safety at sea cost money and the only way to guarantee safety is to obey the laws of God which means taking the interest of human being as priority over maximised profit.

If the maritime industry wants to continue carrying up to ninety-seven percent of world trade it needs to address the casualty rate. This is crippling two of the major sources and assets of the industry, that is, personnel and the physical asset.

The non observance of IMO and other international rules and standards has eroded the competitive advantage of a fair market place. There are advantages gained by unscrupulous ship owners who are in the business only for the short term financial gain, without proper monitoring of the human and technical management of ships' safety. This has created a disadvantage to the shipowners who diligently maintain their ships and obey the rules.

The fall in freight rates, financial pressures and increased competition have led to some shipowners cutting back on maintenance of ships releasing this fund for other sectors. Safety costs money as shown in the following areas:

- in maintaining the ship in a technically sound state of seaworthiness- supplying of spares, stores, regular overhauls of navigational, cargo handling, engine room and other machinery and equipment;
- making sure that life-saving appliances, fire-fighting equipment and other safety items are kept in a state of readiness;
- providing adequate training of seafarers and office staff including regular drills and exercises;
- in establishing and maintaining a well organised and disciplined safety management (SMS) system, combining both ship and shore operations. This includes regular safety inspections, internal audits, management reviews, report and follow-up of accidents, incidents and deficiencies.

The cost advantage of maintaining a ship at a high standard compared to just spending enough only to meet with basic standards of safety can be as much as 15 percent saving on the daily running cost. Savings are also made through Port State Control not detecting defects until during the annual surveys especially if this defect could interrupt the trading of the ship.

A good education of masters and officers was recognised as an effective method of attracting awareness to the dangers of human error, excessive speed in restricted visibility and space, bad habits, social and environmental consequences that culminate in casualties.

6.2. *RECOMMENDATIONS*

As a result of this work the following recommendations were made:

- Major casualty reports should be mandatory for all deep sea ships to carry and to be studied by the masters and officers;
- A greater use of simulators for the training of crew because of the ability to examine casualty scenarios without danger to ship or crew;
- Better qualified teenagers should be employed as deck and engine room cadets so as to raise the standard of officers being produced in view of the technologically improved ships plying the oceans;
- The examinations and certification of officers and ratings should be structured to meet with the provisions of at least STCW95 conventions requirements.
- Not withstanding the requirements of STCW95, officers should be educated up to university degree level. This certainly will encourage the good quality students to apply for jobs within the offshore and shore sector of the industry.
- The explicitness of the division of work tasks on board ships should be improved.
- Communication between the management/master/officer as well as other staff must be improved, to alleviate safety constraints, to increase information distribution and to avoid mistakes.
- The practical implementation of IMO conventions- SOLAS, MARPOL, STCW95, ISM Code should be encouraged.
- The physical and mental being of crew should be improved by allowing them to rest adequately as per IMO convention.
- The division of work tasks on board ship must be defined and improved because the workload on modern ships is moving from a physical to a mental load.
- With reduced crew on ships the physical and mental load have been quite high, and the problem of stress and fatigue should be treated without disdain.

- The flow of communication between management, master and crew must be intensified for better information distribution, avoiding mistakes and for safety.
- Attention should be given to the amount of rest (sleep) the crew have on board in addition to comfortable accommodation so as to reduce stress and fatigue.
- The health and safety of the crew on board should not be neglected. Management should act early to support and rehabilitate the crew's physical and mental well-being.
- Priority should not be placed in producing more rules and regulations but to effectively implementing those already in place.
- The sole reason for investigating a casualty should not be solely to find who is to blame but to be able to gather information that will prevent reoccurrence.
- It is widely acknowledged that eighty percent of accidents are caused by human error but this only confirms that this is because the human element is the controlling factor in the system and not just the weakest link. Investigators should do more to finding the root cause of the accident than concluding by placing the blame on the human element that controls the operation.
- Manufacturers should produce ergonomically compatible and safe equipment for use on board ship. A better understanding of the practical needs and limitations of the end user should be taken into account.
- Emphasis should be placed in designing a good interface between man and machine rather than building a totally unmanned ship. It is well known that automation produces an efficient, safe and reliable system.
- The need for vigilance by the officer on watch of the ship's position and the importance of using all means available for position fixing.
- There is need for good bridge organisation and a well prepared passage plan is imperative. Keeping a good lookout and reacting positively to situations in good time must be emphasised.
- The officer on watch must not be afraid to provide essential navigation information to the master and express concern about the ship's safety.
- When in doubt the officer on watch should not hesitate to call the master or chief engineer as the case may be.

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APPENDIX 1

10.1

THE REPUBLIC OF LIBERIA
MINSTRY OF FINANCE
BUREAU OF MARITIME AFFAIRS

THIS SPACE FOR OFFICIAL USE ONLY

REPORT OF VESSEL CASUALTY OR ACCIDENT

INSTRUCTIONS

1. An original and two copies of this form shall be submitted to the Commissioner or a Deputy Commissioner of Maritime Affairs as soon after the occurrence of the casualty as possible.
2. This form must be completed in full. Entries which do not relate to a particular case should be indicated as not applicable by inserting the initials "N.A."
3. This form should be completed by the Master or person in charge, or, if neither is available, by the owner or his duly authorized agent.
4. Attach crew list to this form. Attach separate Form 109-1 to this report for each person killed or injured and incapacitated in excess of 72 hours as a result of the vessel casualty reported herein.

I. PARTICULARS OF VESSEL

1. Name of Vessel	2. Official Number	3. Year Built	4. Gross Tonnage	5. Net Tonnage

6. Type of Vessel (See Note 1.)	7. Propulsion (See Note 2.)	8. Place Built

9. Name of Owner	10. Name, Address and Telephone of Managing Agent

11.(a) Name of Master or Person in Charge	(b) Citizenship	(c) Date of Birth	(d) License Grade and Date of Issue

II. PARTICULARS OF CASUALTY

12.(a) Date of Casualty	(b) Time (Local or Zone)	(c) Zone Description	(d) Time of Day ☐ Day ☐ Night ☐ Twilight

13. Geographical Location of Casualty (See Note 3.)	14. Geographical Name of Body of Water

15.(a) If Casualty occurred underway, Port of Departure	(b) Date of Departure	(c) Port to Which Bound

16.(a) Nature of Cargo (Describe and give amounts in Long Tons)	(b) Amount Dry Cargo	(c) Amount Bulk Liquid	(d) Amount Deck Cargo

17. Speed in Knots Prior to Casualty	18 True Course Prior to Casualty	19. Draft Forward	20 Draft Aft

21. Atmospheric Conditions at Time of Casualty (Check one or more of the following)
☐ Clear ☐ Partly Cloudy ☐ Overcast ☐ Fog ☐ Rain ☐ Snow ☐ Other (Specify)

22. Distance of Visibility	23. Wind	24. Sea	25. Wind Direction
☐ Under 2 Miles	☐ Light	☐ Smooth to Slight	26 Direction of Sea
☐ 2-5 Miles	☐ Moderate to Fresh	☐ Moderate to Rough	27. Direction of Swell
☐ Over 5 Miles	☐ Storm to Hurricane	☐ High	

28. Navigation Equipment (Check one or more of the following)		29. Communications Equipment (Check one or more of the following)	
☐ Radar	☐ Loran	☐ Radiotelephone	☐ CW (Key)
☐ Inoperative	☐ Inoperative	☐ In Use with Other Vessels	☐ In Use with Other Vessels
☐ Not Used	☐ Not Used	☐ In Use with Shore Stations	☐ In Use with Shore Stations
☐ Used	☐ Used	☐ Not Used	☐ Not Used

30. Auto Alarm Transmitted by your Vessel?	31 Rules of the Road Applicable at Time
☐ Yes ☐ No	☐ International ☐ Other (Specify)

Note 1. Type of Vessel—General Cargo, Oil Tanker, Ore/Oil Carrier, Passenger, Bulk Carrier, Ore Carrier, Tug, etc.
Note 2. Propulsion—Steam Reciprocating, Steam Turbine, Turbo-Electric; Diesel, Diesel-Electric, etc
Note 3. Location—If open sea, Latitude and Longitude; give distance to and name of nearest shore; if near coast give distance and true bearing to charted object; if in port, straits, river, channel, etc, give name.

Source: IMO model course 3.11, 1988, 371.

32. NATURE OF THE CASUALTY (Check one or more of the following. Give pertinent details in Item 33.)			
	COLLISION WITH OTHER VESSEL(S) Give Name and Flag of Other Vessels)		EXPLOSION/FIRE (Other)
			GROUNDING
			FOUNDER (Sinking)
	COLLISION WITH FLOATING OR SUBMERGED OBJECTS		CAPSIZING WITHOUT SINKING
	COLLISION WITH FIXED OBJECTS (Piers, bridges, etc.)		FLOODINGS, SWAMPING, ETC. WITHOUT SINKING
	COLLISION WITH ICE		HEAVY WEATHER DAMAGE
	COLLISION WITH AIDS TO NAVIGATION		CARGO DAMAGE (No vessel damage)
	COLLISION (Other)		MATERIAL FAILURE (Vessel structure)
	EXPLOSION/FIRE (Involving cargo)		MATERIAL FAILURE (Engineering machinery, including main propulsion, auxiliaries, boilers, evaporators, deck machinery, electrical, etc.)
	EXPLOSION/FIRE (Involving vessel's fuel)		
	FIRE (Vessel's structure or equipment)		EQUIPMENT FAILURE
	EXPLOSION (Boiler and associated parts)		CASUALTY NOT NAMED ABOVE
	EXPLOSION (Pressure vessels and compressed gas cylinders)		

33. DESCRIPTION OF CASUALTY (Events and circumstances leading to casualty and present when it occurred. Attach diagram and additional sheets, if necessary)

34. Personnel	Crew	Passengers	Other	Totals	35. Property Losses	Dollars (U.S.A.)
(a) Number on Board					(a) Estimated loss/damage to vessel	$
(b) Number Known Dead					(b) Estimated loss/damage to cargo	$
(c) Number Missing					(c) Estimated loss/damage to other property	$
(d) Number Injured					36. Is Vessel a Total Loss? ☐ Yes ☐ No	

37. Remarks (Indicate assistance rendered by shore stations and vessels; recommendations for corrective safety measures pertinent to this casualty, include explanation of any unsatisfactory lifesaving equipment. Attach additional sheets, if necessary.)

38. Deck Officer on Duty at Time of Casualty		39. Engineer on Duty at Time of Casualty	
Name		Name	
Capacity	License No.	Capacity	License No.

40. Date of Report	41. Submitted by (Print Name)	42. Signature	43. Title

Form RLM-109 (Revised 1/01/70)

APPENDIX 2

10.2

THE REPUBLIC OF LIBERIA
MINISTRY OF FINANCE
BUREAU OF MARITIME AFFAIRS

THIS SPACE FOR OFFICIAL USE ONLY

REPORT OF PERSONAL INJURY OR LOSS OF LIFE

INSTRUCTIONS

1. An original and two signed copies of this form shall be submitted to the Commissioner or a Deputy Commissioner of Maritime Affairs as soon after the occurrence of the casualty as possible.
2. This form must be completed in full. Entries which do not relate to a particular case should be indicated as not applicable by inserting the initials "N.A."
3. This form shall be completed for every loss of life and for every injury which incapacitates the injured for a period in excess of seventy-two hours (3 days).
4. This form should be completed by the Master or person in charge, or, if neither is available, by the owner or his duly authorized agent.

I. PARTICULARS OF VESSEL

1. Name of Vessel
2. Official Number
3. Name, Address and Telephone of Managing Agent
4. Type of Vessel (See Note 1.)
5. Propulsion (See Note 2.)
6. Name of Owner

II. PARTICULARS OF PERSON INJURED, DECEASED OR MISSING (Believed dead)

7 (a) Name of Person
(b) Home Address
(c) Date of Birth
(d) Citizenship
8. Seaman's Book or Passport No
9. Status or Capacity on Vessel
10. Activity Engaged in at Time of Casualty
11. If Crew Member or Shore Worker: ☐ On Watch ☐ Working ☐ Other
12.(a) Name of Immediate Supervisor at Time of Casualty
(b) Supervisor's Capacity or Status on Vessel

II. PARTICULARS OF CASUALTY OR ACCIDENT

13 (a) Date of Casualty
(b) Time (Local or Zone)
(c) Zone Description
(d) Time of Day: ☐ Day ☐ Night ☐ Twilight
14. Geographical Location of Vessel at Time of Casualty (See Note 3.)
15. Geographical Name of Body of Water
16 (a) If Casualty occurred underway, Port of Departure
(b) Date of Departure
(c) Port to Which Bound
17.(a) RESULT OF CASUALTY: ☐ Injury ☐ Death ☐ Missing (Complete INJURY or DEATH entries below, as appropriate)
(b) Nature of Injury
(c) Total Days Incapacitated
(d) Reason for Death
(e) Location of Individual at Death
(f) Date of Death

Note 1. Type of Vessel—General Cargo, Oil Tanker, Ore/Oil Carrier, Passenger, Bulk Carrier, Ore Carrier, Tug, etc.
Note 2. Propulsion—Steam Reciprocating, Steam Turbine, Turbo-Electric; Diesel, Diesel-Electric, etc.
Note 3. Location—If open sea, Latitude and Longitude; give distance to and name of nearest shore; if near coast give distance and true bearing to charted object; if in port, straits, river, channel, etc., give name.

Source: IMO model course 3.11, 1988, 372.

18. DESCRIPTION OF CASUALTY *(Give events leading up to casualty and how it occurred. Attach diagram & additional sheets, if necessary.)*

19. WITNESSES TO ACCIDENT *(At least two, if possible)*

Name	Name
Address	Address
Name	Name
Address	Address

IV. ASSISTANCE AND RECOMMENDATIONS

20 (a) MEDICO *(Medical)* MESSAGE SENT ☐ Yes ☐ No	(b) IF YES, GIVE DATE OF FIRST MESSAGE	(c) IF YES, GIVE TIME OF FIRST MESSAGE *(Local or zone and description)*
21.(a) TREATMENT ADMINISTERED ☐ Yes ☐ No	(b) IF YES, BY WHOM ☐ SHIP'S DOCTOR ☐ OTHER SHIP'S PERSONNEL ☐ OTHER *(Specify)*	

22. BRIEFLY DESCRIBE TREATMENT *(If administered by other than M. D.)*

23 (a) Name of Hospital, if Person was Hospitalized	(b) Address of Hospital

24. Recommendations for Corrective Safety Measures Pertinent to this Casualty

25. Date of Report	26. Submitted by (Print Name)	27. Signature	28. Title

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