MSc Environmental & Occupational Health and Safety Management

Ship's Lifeboats: Analysis of Accident Cause and Effect and its Relationship to Seafarers' Hazard Perception

Photo credit MAIB

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Introduction

Professional mariners will agree the sea represents an inherently hostile environment in which man is ill-suited to survive. However history shows great strides taken by technology to control and reduce the risks. Although the World's oceans remain wild and unpredictable, modern mariners are not confronted by the hazards of disease, poor nutrition and rudimentary navigation endured by their ancestors. Advantages include the ability to immediately request aid and the reasonable expectation of such assistance occurring in most parts of the world. In the event of the total loss of a ship, mariners have recourse to the same piece of lifesaving equipment as seafarers of old - the ship's lifeboat.

In the days of sailing vessels the lifeboat was the ship's workhorse, used for ferrying goods and personnel, as an aid to navigation, a means of propulsion when the wind died, a rescue boat for sailors lost overboard and, most importantly, a means of survival when all else was lost.

Continual use of the lifeboats meant that they were always maintained to a high standard, with crew well practiced in launching and retrieval operations, thereby lessening the chances of accidents occurring.

The greatest stories of the sea would never have been told without the chance of survival offered by the ship's lifeboat. These basic but seaworthy craft carried Captain Bligh on his incredible 4000 nautical mile journey across the Pacific, and provided both means of rescue and shelter for Shackleton and his men after the loss of the *Endurance* in the pack ice.

Modern ship's lifeboats are also designed to preserve life when all other options are exhausted. They may still be used as man-overboard (MoB) rescue boats, although research has highlighted concerns about the suitability of modern lifeboats in this role. The difference between lifeboats of today and their historical counterparts is that, although some cruise ships still use their lifeboats to ferry passengers into small ports, lifeboats are no longer required during the everyday operation of the ship. Reliable ship's engines, electronic navigation and deep-water ports mean that lifeboats have evolved from general workboats into dedicated pieces of safety equipment, designed and built for the specific purpose of saving lives.

It is a tragic irony then that modern ship's lifeboats are responsible for the death and injury of so many seafarers.

Fig 0.1

Photo credit: MAIB

Rescue crews investigate an inverted lifeboat.

CHAPTER ONE

1.0 Project Overview

A brief précis of the project's aims, objectives and hypotheses.

1.1 Hypotheses

Three hypotheses were postulated:

(i) That a correlation exists between lifeboat design as an established accident cause and the severity of injuries occurring;

(ii) That seafarers' perceptions of the hazards presented by lifeboats, and their associated systems, will be graded in the same order as those apparent from incident reports;

(iii) That the perception of seafarers' will be that ship's lifeboats, and their associated systems, are fit for purpose;

1.2 Project Aims

The project aims to build on current understanding of the main causes of lifeboat accidents and to investigate the perceptions of seafarers to the hazards presented by ship's lifeboats.

1.3 Objectives

The objectives of this project were four-fold:

(i) To provide explanations of the contributing factors behind lifeboat accidents, with an emphasis on how design affects these factors;

(ii) To investigate the main causes of lifeboat accidents and the level of hazard each presents to the seafarer;

(iii) To investigate the perceptions of seafarers towards the hazards associated with lifeboats;

(iv) To examine and compare connections between the seafarers' perceptions and the established accident causes from accident investigation reports;

The initial chapters of the project meet the first objective by exploring the issues associated with lifeboat accidents, the components involved, human error, preventive actions, design problems and improvements and changes to legislation. Although these issues are widely understood within the marine industry, it was considered necessary to explain the scale and scope of the history and hazards involved with lifeboat accidents to non-seafarers.

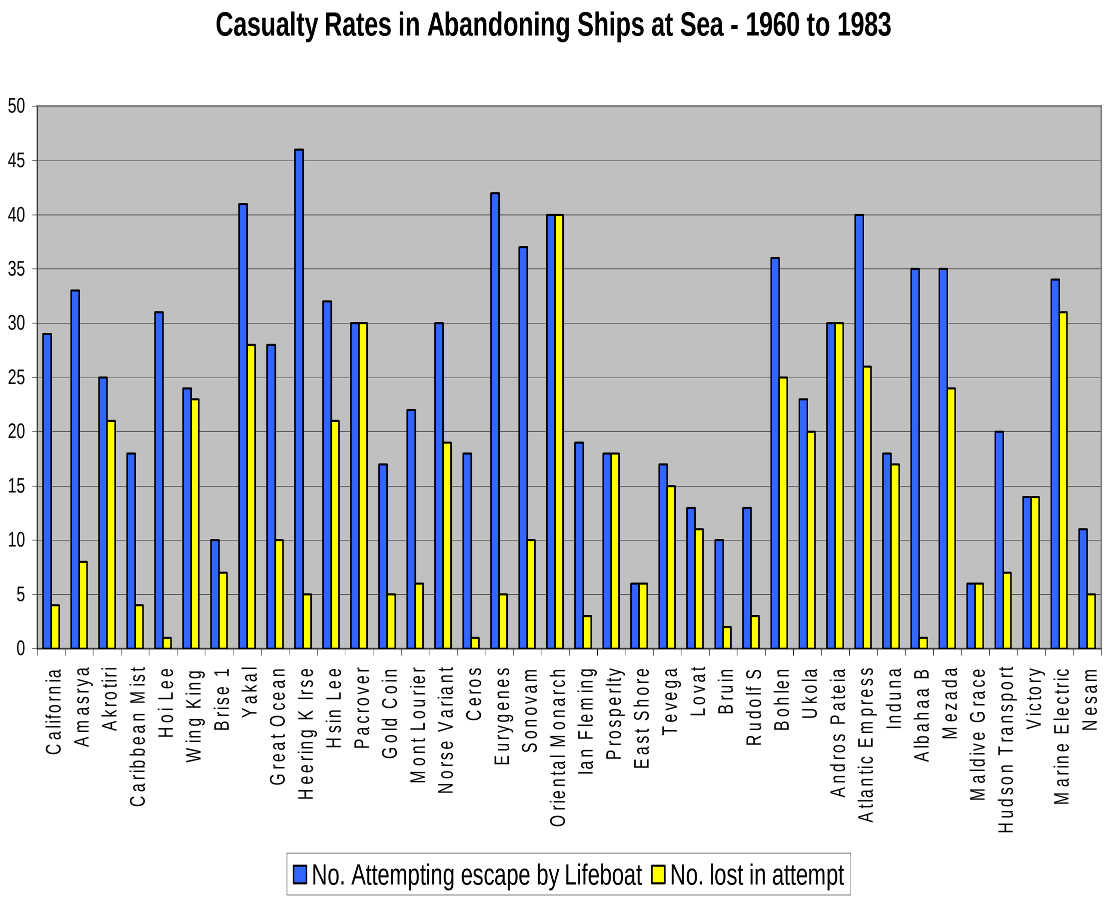
It was expected that the successful completion of the remaining three objectives would allow the desired hypotheses to be tested.

CHAPTER TWO

2.0 Literature Review

A saying exists amongst seafarers that the only time you should get into a lifeboat is when you need to step *up* into it. In other words you should not think about getting off the ship until it has sunk from under you. This light-hearted comment stems from the correct belief that the ship itself is the best lifeboat and that remaining aboard offers the greatest chance of survival.

Fig. 2.0.1[1]



The graph shows the casualty rates for seafarers attempting to abandon ship into lifeboats and clearly illustrates the risk that exists when personnel attempt to evacuate. Note: For reasons of clarity two vessels were not included on the graph: the *Lakonika,* 800 personnel – 128 lost, and the *Wahine,* 744 personnel – 60 lost.

Sometimes remaining with the ship is not possible and seafarers must look to lifeboats or liferafts for salvation. For leisure sailors, or seafarers on smaller ships, the size of lifeboats makes them impractical and they must rely on liferafts.

Although appearing flimsy when compared to a solid lifeboat, liferafts have survived in extreme conditions. Following the stormy 1979 Fastnet yacht race, in which twenty-four yachts were abandoned, several important shortcomings in liferaft design were discovered and improvements made. Although seven of the fifteen fatalities occurred after entering the liferafts, without the chance of survival they offered the death toll would have been even higher.[2]

Caught in Hurricane Allen off Cuba, the crew of the *Island Princess* were forced to abandon ship into their 'Givens' liferaft in 190 knot winds (218mph).[3] All four men survived, quite a feat considering that Hurricane Mitch, rated as the strongest storm in the Caribbean in over a decade [4], with winds reaching 157 knots (180mph), caused the loss of the 282-foot sailing ship *Fantome.*[5]

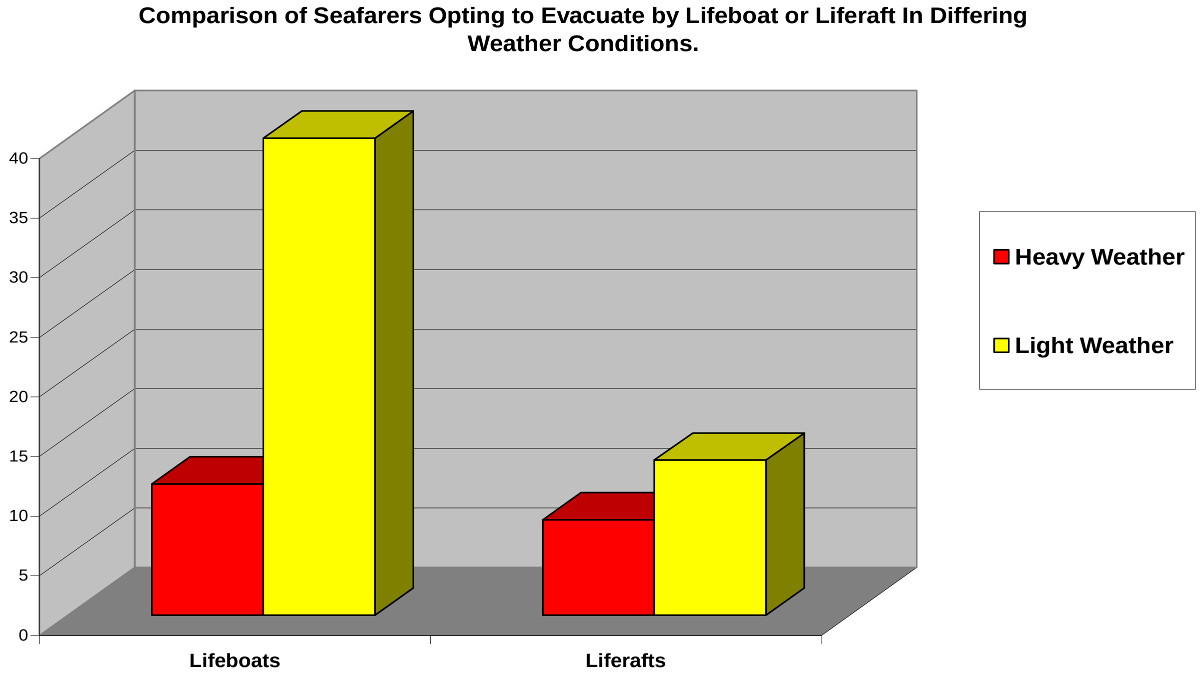
Liferafts are also capable of enduring extended periods at sea. The Robinson family survived for thirty-seven days at sea after their yacht was sunk by whales.[6] Although the Robinson's liferaft eventually disintegrated, leaving them with only their small yacht dinghy, the liferaft of Maurice and Maralyn Bailey carried them safely to land after a staggering 118[*] days at sea.[7] Similarly, Steven Callahan's liferaft enabled him to survive for seventy-six days, setting the record for solo survival at sea.[8]

[*] Although the title of the Bailey's book is '117 Days Adrift' the actual time spent at sea was 118 days. The media misreported the actual time and, to avoid confusion when writing their book, the Bailey's maintained the incorrect numbering in their title.

Although liferafts are used on commercial vessels, lifeboats present a greater chance of survival as they offer several vital improvements over liferafts. Constructed of rigid material, they allow seafarers to avoid the torturous task of continually inflating buoyancy tubes and remove the chance of catastrophic hull failure through careless use of a knife. While liferafts remain at the mercy of the wind and sea, lifeboats contain their own propulsion system, are manoeuvrable, and fully enclosed varieties provide excellent protection from the elements. Fitted with external sprinkler systems and self-contained oxygen supplies, lifeboats make possible escape from burning oil-rigs and tankers, conditions in which liferafts are rendered useless.

However the process of launching lifeboats in rough weather is more hazardous than liferafts and this factor can influence seafarers' behaviour when both lifeboats and liferafts are carried on board.

Fig 2.0.2[9]



Although data for the graph are limited they show that seafarers are less inclined to use lifeboats in heavy weather – the very time when the better sea-keeping qualities of lifeboats are important.

When the *Pamir* was lost in 1957 in eighty-foot seas the crew struggled to escape in the ship's open lifeboats *'…as the boats were launched they were caught by the monstrous waves and sent hurtling hundreds of feet from the ship'* and *'Of twenty-two men in his boat, seventeen were washed overboard…'*[10]

Systems were developed to improve launching procedures; quick release hooks were already appearing prior to 1900, forerunners of those in use today, and 'Clifford's Lowering Gear' and 'Robinson's Disengaging Gear' were considered cutting edge technology in the late 18th Century.[11]

Development of systems to safely launch and recover lifeboats has continued, often prompted by major marine disasters.[12] Valuable research was undertaken into the mechanics of lifeboat operations by Simões Ré and co-workers, primarily using model scale testing. Several investigations on lifeboat evacuation from a fixed installation included investigating safe launching and clearing of lifeboats[13], effects of heavy weather[14] and the presence of ice.[15] Studies on lifeboat performance from vessels included comparisons between conventional davits and flexible booms[16], how pre-planned launch sequences and timings can prevent lifeboats colliding during rapid evacuations of large passenger vessels[17], and the development of new systems to control the speed of descent of lifeboats.[18]

Scale models and computer simulations offer time and cost advantages while providing reproducible results and these technologies have been employed when attempting to understand the causes of lifeboat accidents.[19] However such studies cannot replicate the effects of maintenance on a lifeboat system and quantitative risk assessment is recommended in this area.[20] A report issued by the Health and Safety Executive (HSE) used lifeboats as an example of how to conduct quantitative assessment, although the exercise demonstrated how the number of lifeboats could be reduced, rather than operated safely.[21]

Questions exist over whether simulation based research can address the issue of human factors. One study used human response tests, under benign conditions, as a basis for validating a computer model and for computer extrapolation to more extreme conditions.[22] Although the report expressed confidence in the extrapolation other studies disagree: *'Moreover, whereas computer simulations have their place as evaluative tools, only a live exercise will incorporate realistically the idiosyncrasies of human decision-making under pressure.'* [23] Another study into free-fall lifeboats, including the effect of impact on human occupants, noted that their model represented a *'…well braced occupant adopting the recommended launch posture.'* However the study continued *'The results of these simulations may not represent the response of a "typical" human in an emergency situation.'* [24]

The issue of accurately predicting and modifying human factors is important to lifeboat safety for several reasons. Human error is often cited as a prime cause in accident investigations and was noted in a HSE report as being the most likely cause for the premature release of lifeboats.[25] Often initial design specifications do not place sufficient emphasis on human factors, either because they are considered irrelevant, a matter of common sense, or the design of each piece is conducted in isolation, with little thought to the usability of the whole.[26]

It is vital that design takes into account human factors[27] as the degree of confidence which a person feels in the resources available to him is likely to have a significant effect on his reaction in a critical situation. '*In an emergency situation…humans are likely to be in a state of crisis, which means that the normal repertoire of problem solving is not adequate. The only way to manage work in stressful and dangerous work places is to provide the operators with technical equipment of a standard, which the operators can trust.'* [28]

Finally human factors are fundamental when considering the very usability and survivability of lifeboats. A survey into the anthropometrics of thousands of offshore personnel found that lifeboats could not accommodate the number of people expected. It was discovered that a lifeboat's capacity rating was not based on the size of the typical offshore worker. As a result, fewer personnel could fit into a lifeboat than the capacity rating indicated.[29] Another study looked at the impact on personnel confined within an enclosed lifeboat at sea.[30] The study noted that a full lifeboat of 50-60 personnel '…*may face severe physiological threats…'* from the enclosed environment. Personnel wearing survival suits and large bulky lifejackets had resulted in many craft being downrated in terms of occupancy. Dehydration was a major cause of concern as personnel perspired heavily once the lifeboat was closed up and *'…seasickness was reported as affecting the majority of occupants within 30-60 minutes of launching the [lifeboat]. Those that were not initially seasick were eventually overcome by the pervasive atmosphere in the boats and became seasick'* compromising survival by a *'…reduction in efficiency, reduction in strength, psychological impact, physical and mental impairment and inability to assist in the rescue phase.'*

Research into alternative evacuation systems continues as the marine community becomes increasingly aware of the difficulties involved in evacuating large cruise ships[31], where many passengers are likely to be older and less fit than the average seafarer.[32] Many companies are developing 'marine evacuation systems' (MES) comprising inflatable escape slides or tubes leading to large liferafts.

The UK Maritime and Coastguard Agency (MCA) conducted research which included measuring evacuation times using MES and lifeboats.[33] One case involved a ferry evacuation in Japan where 249 people were evacuated using a MES system in just over 83 minutes, an extremely long time if the ship were on fire. In fact the whole evacuation, from alarm sounding to the last person off took over three hours. Better results have been recorded: on one vessel 277 people were evacuated using a twin-path escape in just over 12 minutes.[34] MES systems are not trouble free; injuries including broken ankles and arms have been reported[35] and one woman died of asphyxia when her body jackknifed within the chute.[36]

Current legislation limits the occupancy of lifeboats to 150 people but there are calls to have this number increased.[37] Simply developing larger lifeboats without a radical rethink of the launch systems is not desirable and designs put forward include the 'Rescube' from Norsafe.[38] Similar to a large vertically hung lifeboat, the 'Rescube' allows passenger access from six deck levels at once and holds 330 people. The 'Rescube' can be launched at a greater angle of heel than conventional davit lifeboats and offers a reduced drop distance compared to free-fall lifeboats. They are also designed to remain attached to the ship and provide a safe haven for passengers.

The potential for a safety zone attached to a ship, but with the option of escape if necessary, would appear to bring this review full circle, and support the view that *'…future large passenger ships should be designed for improved survivability based on the time-honoured principle that "a ship is its own best lifeboat''.* [39]

Fig 2.0.3

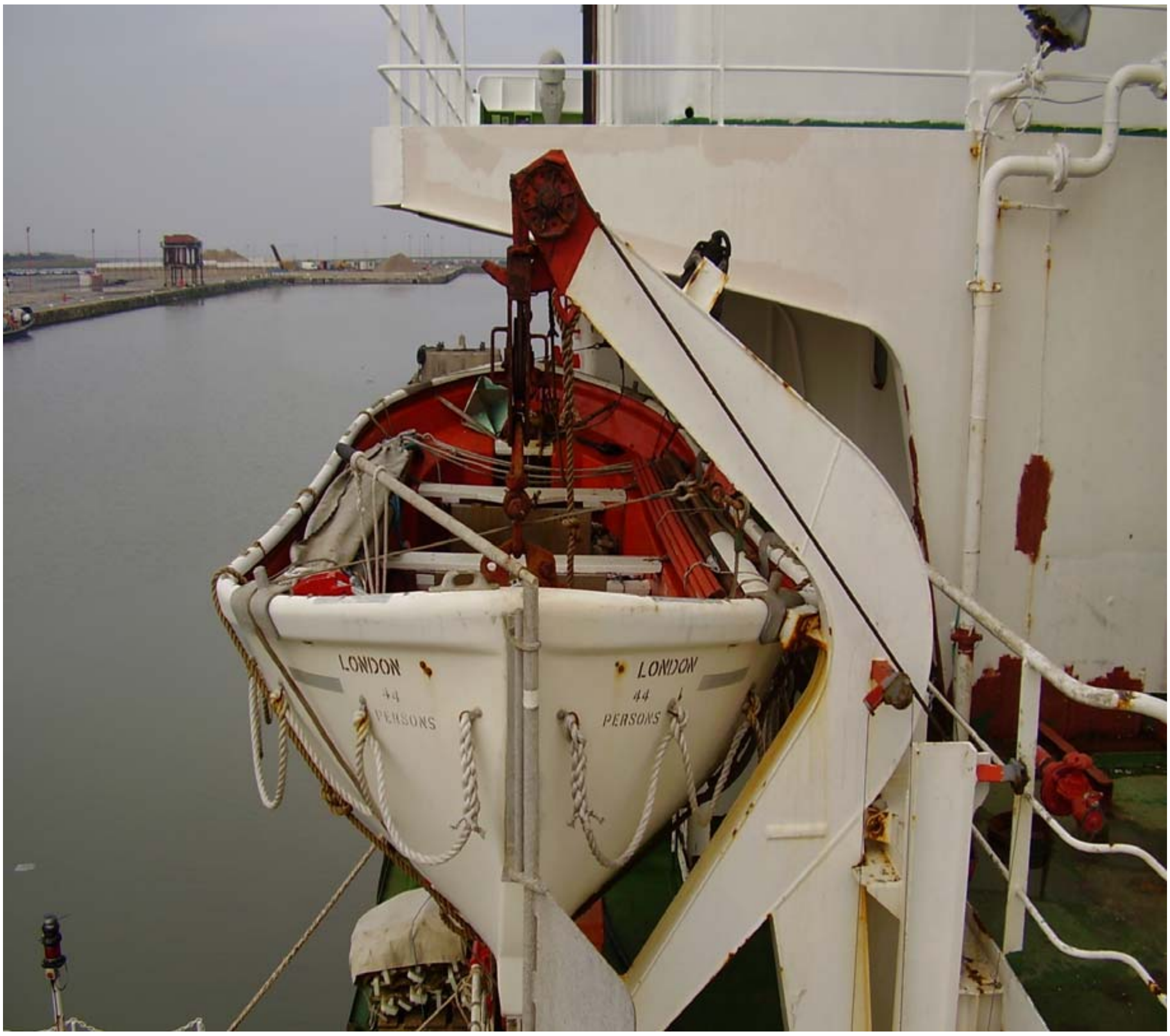


Photo Credit: Author

Open ship's lifeboat which still carries traditional mast, sails and oars as its only form of propulsion.

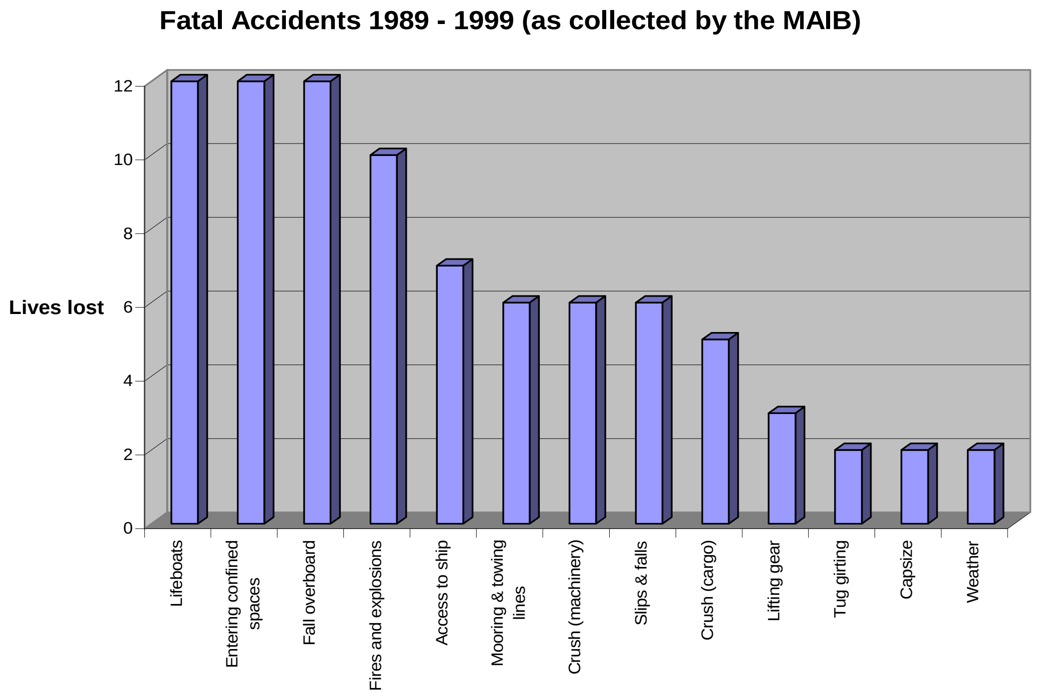
CHAPTER THREE

3.0 Previous Research

In 2001 the Marine Accident Investigation Branch (MAIB), conducted a study into the causes of lifeboat accidents. Its report highlighted the disturbing number of fatalities attributed to ship's lifeboats and their associated systems, revealing that *'Over a ten year period lifeboats and their launching systems have cost the lives of 12 professional seafarers or 16% of the total lives lost on merchant ships.'* [40]

Additionally eighty-seven seafarers were injured. Putting these figures into perspective, the report compared fatalities connected with lifeboats to those arising from other activities.

Fig 3.0.1



The 2001 MAIB report into lifeboat accidents showed lifeboats were one of the three biggest killers of seafarers - equal with Entering Confined Spaces and Falls Overboard.

The report emphasized deficiencies in lifeboat design, maintenance of lifeboat systems and the training standards of seafarers as being the main causes of accidents, and also highlighted a pervasive lack of confidence in the safety of the lifeboats by the seafarers. The study covered incidents that occurred solely within UK territorial waters therefore it only touched on the true scale of accidents worldwide, caused by something that is designed to function as an important piece of safety equipment.

The MAIB concluded with the recommendation that the International Maritime Organisation (IMO) undertake a study on the '…*value, need and desirability of lifeboats…'* and that '*Reported incidents and accidents worldwide should be examined with regard to the specification of lifeboat launching systems.'*

The MAIB was not the only maritime agency to look at issues connected with lifeboats. In 1999 the Australian Maritime Services Board (MSB) submitted a summary of lifeboat accidents covering a seven year period to the IMO.[41] The report contained reference to nine accidents involving lifeboats and highlighted deficiencies in design, training and equipment as being the main causes.

The Norwegian Maritime Directorate issued a safety message containing statistics taken from personal injury reports from 1989 to 2001[42] that showed 1.6% of all accidents occurred in connection with lifeboat drills. The human cost was five fatalities, accounting for 2% of total deaths recorded, and190 injuries; 65 leading to incapacity for further work. In Norway from 1996 to1999 there was an average of twenty-four lifeboat accidents a year – two accidents *every* month.

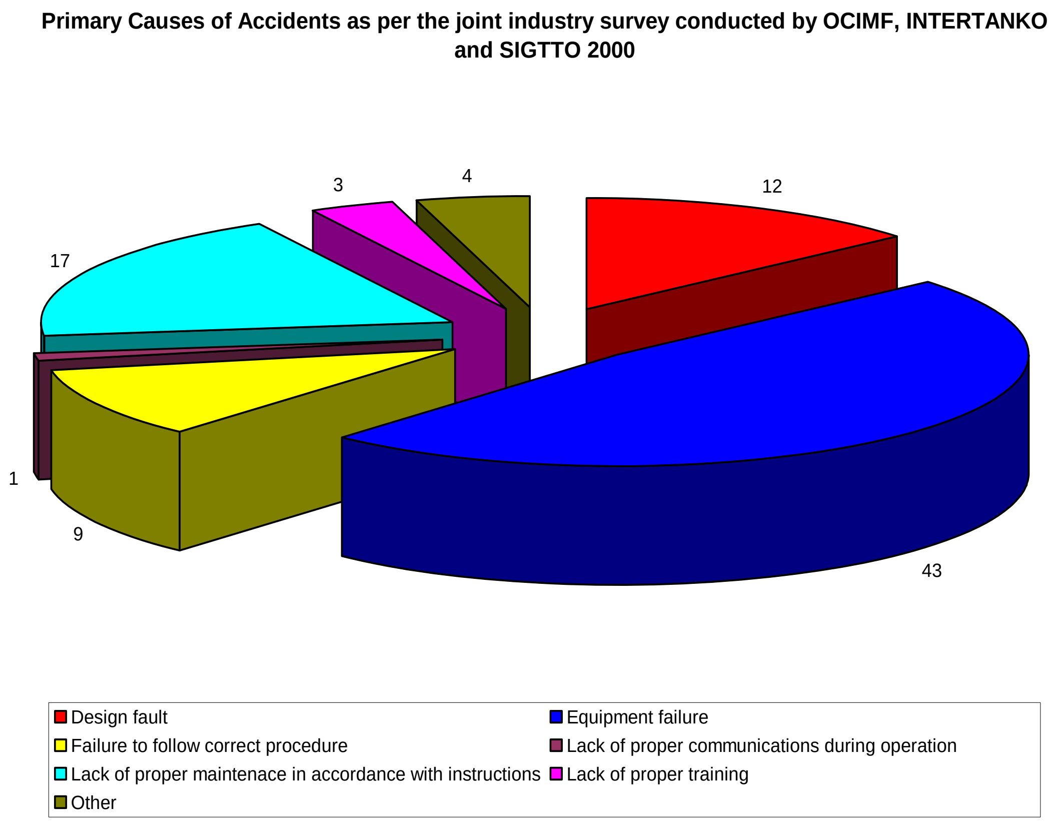
The Norwegians cited the main causes of accidents as being deficient or incorrect maintenance and poor safety procedures. Design was not mentioned except to underline that the systems and release mechanisms were often overly complicated. The report did not suggest any lack of confidence in the lifeboats by the seafarers; however it did mention that lifeboat drills were often regarded as something extraordinary and not as a standard work operation. This attitude is contrary to the very ethos of training drills, which are designed to make extraordinary circumstances appear commonplace through repetition.

Other organisations have also undertaken studies into lifeboat safety. In 1994 the Oil Companies International Marine Forum (OCIMF) published the results of a questionnaire sent to selected Flag State administrations. [43] The survey focused on davit-launched, fire protected, totally enclosed lifeboats and so covered only a small proportion of the designs in use worldwide. Nonetheless ninety-two incidents connected with lifeboats were recorded.

Two thirds of the incidents were found to be associated with equipment failure and design shortcomings. Human factors such as lack of proper training and inadequate maintenance accounted for the rest. It was noted that the majority of accidents occurred during drills and that again, there was a '…*surprising lack of confidence in modern lifeboats.'* This caused reluctance on the part of ship's crews to conduct lifeboat drills, despite these being a vital part of emergency preparedness.

OCIMF were also involved in a further joint survey in 2000 that focused on the complete range of lifeboat designs, providing a wider remit than the 1994 study.[44] The survey reported 20 injuries, 6 being rated as serious, requiring medical treatment before personnel could return to work. It also stated the potential for fatalities was present, and it was only a matter of luck that none had occurred.

Fig 3.0.2



Despite showing design as the third most common cause of lifeboat accidents, the report noted that *'Operational human error does not appear to be a direct cause of many incidents. Human error in design and not adequately specifying launch and recovery equipment standards for practical eventualities is apparent.'*

Thus errors in the initial design of lifeboats were pinpointed as responsible for accidents that might mistakenly be attributed to other factors. Although training was not found to be a significant factor in the incidents reviewed, the report went on to say *'It can be assumed that a deep mistrust of lifeboats has developed on board vessels…'*

The survey also polled seafarers' views on specialist rescue craft as these have similar launch systems to lifeboats. Unfortunately the results on rescue craft were considered inconclusive and were not included. However the use of fast rescue craft (FRC) has increased and, due to the similarities in the launch systems, data on these craft was collected and analysed as part of this project. However to ensure that FRC statistics did not distort the project findings on lifeboats the data was not presented in the final analysis.

To appreciate the nature of the hazard posed by lifeboats, it is important to remember that almost all of the accidents reported occurred during routine maintenance, equipment tests or training drills, *not* in actual emergency situations. These accidents happened when seafarers were not under the increased stresses and pressures created by a real emergency. In fact, since the formation of the MAIB in 1989, there has never been a reported incident of a life saved by the emergency use of lifeboats on a UK registered vessel. The few examples where lifeboats were used in emergencies also resulted in accidents and injuries. Moreover, the majority of accidents occurred within the sheltered waters of marine ports where vessel movement and sea state were not significant factors.

If any other piece of safety equipment caused as many deaths and injuries, *not while in operation but merely when being tested,* it would justifiably be removed from use. However lifeboats, complete with their appalling safety record, are still required by law on most ships.

Lifeboats are not confined just to ships; the offshore industry also uses them to provide escape from marine installations, primarily oil rigs. Incidents from the offshore industry are reported through the HSE and statistics for this project were gathered from them. Allowing for under-reporting[45], it must be accepted that the number of accidents reported by the marine sector represents only a conservative insight into the true hazards involved.[46]

3.1 Seafarer Confidence

The lifeboat studies above, all identified further actions that needed to be taken to prevent more incidents occurring, including simplifying lifeboat design, improved testing and maintenance procedures, and better training. A common concern expressed was the lack of crew confidence in the lifeboat systems.

The MAIB report referred to a case where a ship's Master, confronted with the need to abandon ship, swung out the lifeboats but did not use them. It was concluded that the Master did not have total confidence in the ability of the lifeboats and their systems to evacuate personnel safely. The report continued *'Other shipmasters report that to raise their crew's confidence in the systems, they regularly take an active part in launching a lifeboat. Privately they express a feeling of unease, both at taking part in the operation and at the need for them to do so.'* [47]

The issue of crew confidence was considered serious enough to be discussed by the IMO Sub-committee on Design and Equipment which commented *'…lifeboat drills seem to have become about the most dangerous activity facing* *the modern mariner, and confidence-building changes are overdue if genuine and justified fear is to be reduced.'* [48]

Despite studies highlighting the lack of confidence in lifeboats and their associated systems and the comments of the IMO, there have been no studies to determine whether this lack of confidence is well-placed. Given the number of accidents involving lifeboats some lack of faith could reasonably be expected, but it seems unlikely these statistics are the sole cause of the seafarers' concerns.

Given that the MAIB study identified falls overboard to constitute as great a hazard as lifeboat accidents, it would be reasonable to expect that seafarer confidence in this area would also be low, if accident rates were the only criterion used. However falls overboard have never been subject to the same level of concern as lifeboat accidents and conversations with seafarers show a pragmatic attitude towards being lost overboard that is at odds with the concerns expressed about working with lifeboats.

In emergency situations, seafarers' lives may very well depend on lifeboats, and the degree of faith that they have in the equipment is likely to have a significant effect on their actions in such stressful circumstances. It is self evident that there is a substantial difference between drills conducted in a controlled environment and a real emergency.

If seafarers perceive that lifeboats present a significant hazard when training, then they are unlikely to want to utilise them in an emergency situation, *'But* *seafarers have lost faith in this equipment and are plainly frightened to board the very equipment that is designed to save them.'* [49]

The problem is further illustrated by the following quotes, both from experienced ship's Captains:

'If I, as a captain, ever have to order my ship abandoned I will, in all probability, elect to remain onboard my stricken vessel…because I am frightened of lifeboats.' [50]

'These ''life'' boats seem hardly worthy of the name. Surely the term ''deathboat'' would be more appropriate.' [51]

None of the previous studies examined whether the concerns expressed by seafarers were justified by the actual hazards presented by the lifeboats. The processes involved in launching and recovering lifeboats are complicated and involve a number of individual components, the failure of any one of which can result in a serious incident. This project aimed to re-assess the attitudes of seafarers towards lifeboats and their associated systems, through the circulation of a perception-orientated questionnaire, to determine if the concerns expressed reflected the actual hazards posed by lifeboats.

Fig 3.1.1

Photo Credit: Tim Lee

A fully-enclosed davit-launched lifeboat - a design type currently in use on many ships. Note that in this case the lifeboat can be boarded from the stowed position, rather than needing to be lowered to a separate boarding level.

CHAPTER FOUR

4.0 Research Methods

To test the hypotheses secondary data was collected relating to lifeboat accidents so that the connection between design and severity could be analysed. The maritime investigation branches of thirteen countries were approached for information. Eight countries responded* and data on over 250 incidents was collected. The HSE was also approached for details of accidents involving lifeboats in the off-shore industry and further data was provided by them.

Data was collected on accidents involving all types of ship's lifeboats. However, the project was primarily concerned with accidents involving davit-launched and free-fall lifeboats as these require regular testing and are subject to use during emergency drills.

4.1 Hypothesis One

> *That a correlation exists between lifeboat design as an established accident cause and the severity of injuries occurring.*

It is important to understand which accident causes are the origins of the most serious injuries. It is possible that the most common cause is not the same one

* Although the German Federal Bureau of Maritime Casualty Investigation responded they had no incidents to report. Sweden had three accidents but no documents translated into English. Accident data from seven countries was included in the thesis.

that is killing and seriously harming the majority of seafarers. While it is important to reduce the number of accidents, efforts should first be concentrated on identifying and controlling those aspects of lifeboats that present the most severe hazard to seafarers.

The accident investigation information collected was entered into a statistical database to allow quantification of the data in the fields required. In line with previous studies the data was separated into the three main causes of lifeboat accidents, design, maintenance and training. Each entry was graded by the severity of injuries that resulted to personnel involved, ranging from near miss incidents to multiple fatalities. It was then possible to analyse the connection between accident cause and accident severity.

4.2 Hypothesis Two

> *That seafarers' perceptions of the hazards presented by lifeboats, and their associated systems, will be graded in the same order as those apparent from incident reports.*

It is also important to determine the relationship between the actual hazards represented by lifeboats and the perceptions of the seafarers themselves, so that effective strategies can be developed to influence the attitudes and behaviour of marine personnel.

Secondary accident data was analysed to determine the type of lifeboat component involved in accidents, e.g. winches, davits, falls, browsing and tricing gear. Data was also separated into the various lifeboat operations, e.g.

raising, lowering and general drills. Statistics could then be analysed to determine the ranking of hazardous components and operations. The secondary accident data analysis provided a means of determining which of the individual operations and components involved were most often the causes of accidents.

The project questionnaire polled seafarers for their perceptions on the safety of the same components and operations and the primary data from this was analysed in the same manner. This provided four sets of data, two containing secondary data identifying the actual order of hazards presented by components and operations. The other two sets of data contained primary data demonstrating the order of hazards presented by components and operations perceived to exist by the seafarers. A comparison between the two sets of data from each source provided the means to test hypothesis two.

4.3 Hypothesis Three

> *That the perception of seafarers' will be that ship's lifeboats, and their associated systems, are fit for purpose.*

This hypothesis was tested by the primary data collected in the project questionnaire. The questionnaire established the perceptions of seafarers on whether ship's lifeboats are fit for purpose and the overall safety of lifeboats. The questions also allowed a comparison between the perceptions of seafarers involved in physically conducting the lifeboat drills and those who where only observers.

To provide a rounded test of the hypothesis, further questions on the suitability of lifeboats for use as man over-board rescue boats, the necessity of lifeboats and the level of complexity of lifeboat systems were also analysed. Seafarers were additionally questioned as to whether they considered lifeboats to represent outdated technology in the modern marine industry and whether further research into alternative evacuation methods was desirable.

Fig 4.3.1

Photo credit: MAIB

A lifeboat floats damaged and partially inverted after an accident.

CHAPTER FIVE

5.0 Accident Investigation

An apparent problem when investigating lifeboat accidents lies in establishing the main cause. This allows for a degree of subjectivity in accident investigations that is undesirable.

Lifeboat accidents are often a combination of factors, primarily failures in maintenance, design and training. The difficulty in establishing the primary cause means accidents due to design might be more common than is officially acknowledged as such accidents may be wrongly attributed to failures in other areas.

An example of how this applies to lifeboat safety is the 2004 fatality of a Canadian oilrig worker and the injury of two others. The lifeboat involved dropped 20 metres while being hoisted aboard when the securing hook failed to lock properly. The Norwegian company 'Norsafe', who have been designing lifeboats since 1903, manufactured the hook. Despite the company's worldwide sales the hook in question was not a design accepted by the US Coast Guard, and was stated to be the main cause of the accident.[52]

The US Coast Guard cited problems in design that they considered could have been easily engineered out. Norsafe on the other hand denied design problems and blamed the accident on human error.[53] It is likely that had the incident been investigated by the Norwegian authorities, a different verdict to that presented by the US Coast Guard would have been recorded, and design would not have been identified as the main cause. This case clearly illustrates the difficulties involved in establishing accident causation.

Until there is a clearly established, internationally accepted standard for the design and manufacture of lifeboat systems, accidents will continue to occur. What is worse is that until agreement can be reached as to the primary cause of an accident, it will not be possible for effective lessons to be learnt to prevent a reoccurrence.

As an experienced senior surveyor working with maritime safety inspections and safety assessment commented, *'I have repeatedly warned the industry about the very difficult matter of accident investigation, looking for the ''basic course'' or ''lesson learnt'' for corrective action.'* [54]

Without being able to establish a clear understanding of the root cause of an accident through the investigation process, it is not possible to implement efficient legislation or take effective action towards reducing lifeboat accidents.

To assist non-seafarers with understanding the main identified causes of lifeboat accidents they will be discussed separately in the following chapters.

CHAPTER SIX

6.0 Design and Management Issues

The three main causes of lifeboat accidents can be separated into two categories, design and management. Management encompasses both maintenance and training although, as the following sections show, safe management and lifeboat design are strongly interconnected.

Fig 6.0.1

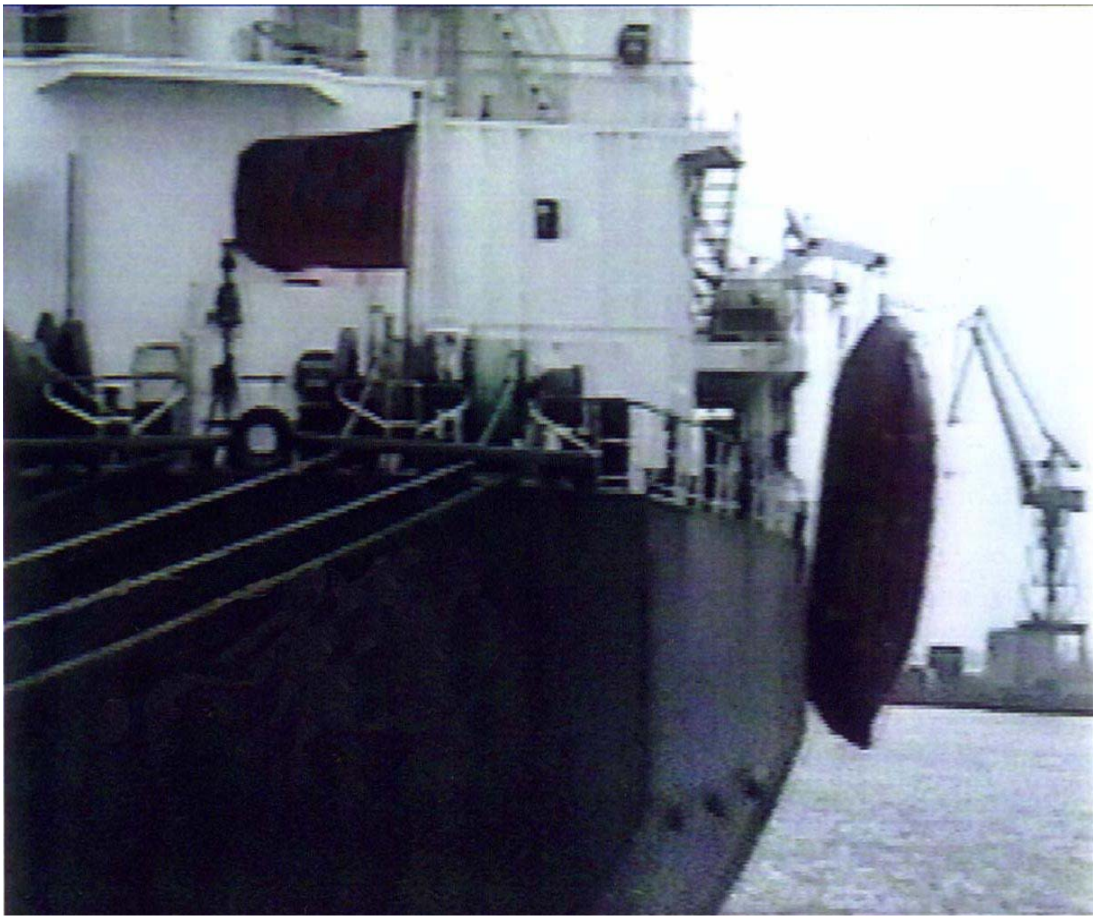


Photo credit MAIB

A lifeboat dangles precariously from a single fall. It is easy to see how an accident of this kind could cause severe injuries to any seafarer onboard the lifeboat at the time.

6.1 Design

When considering design this project was looking at more than just the planning stage of a lifeboat; the manufacturing processes and quality of instructions provided by the manufacturer all form part of the finished product that is presented to the seafarer in a 'fit for purpose' condition. This was emphasized following a lifeboat accident to *Pacmonach 'When considered in isolation, a design aspect may not contain a serious deficiency. However, when all the lifeboat's components are integrated and considered as a whole, they present a risk…'* [55]

Before the issue of lifeboat design can be examined it is necessary to provide a brief description of a typical ship's lifeboat and launching systems. While there are variations of design amongst lifeboats the following diagrams should assist a general understanding of the components involved.

Fig 6.1.1

Photo Credit: Author

Lifeboat secured in stowed position.

Fig 6.1.2

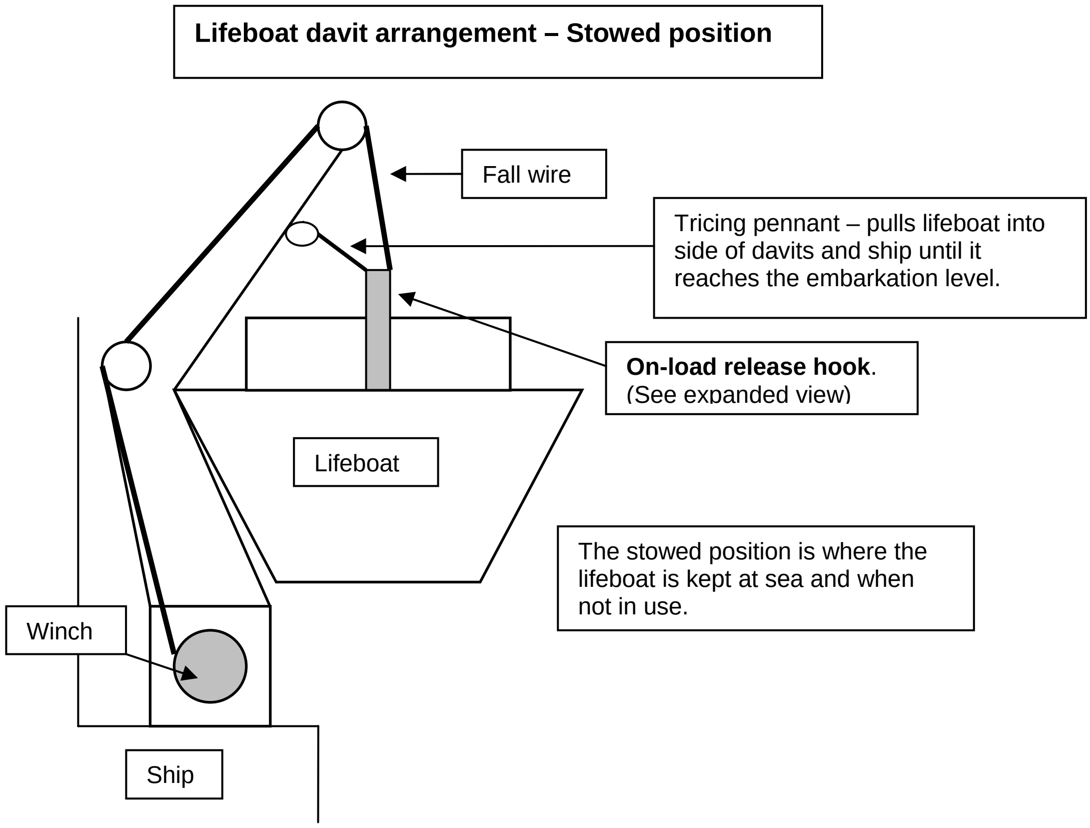
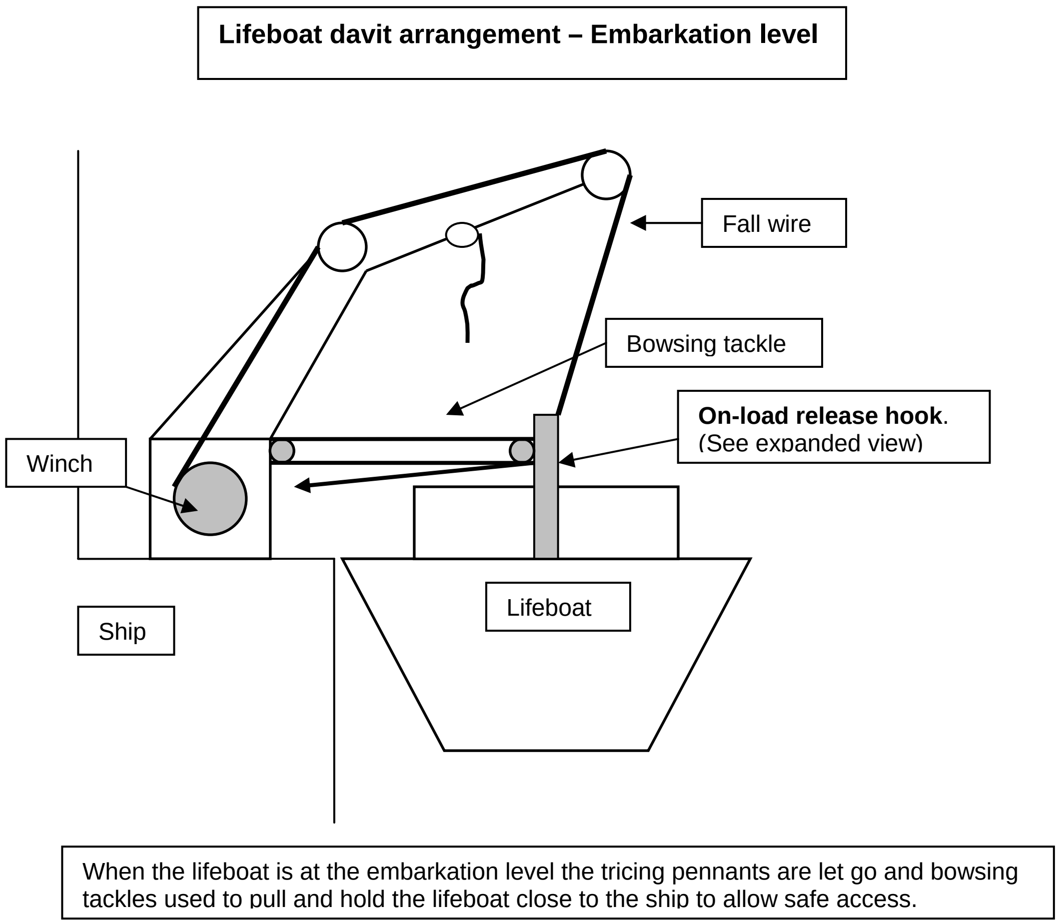


Fig 6.1.3

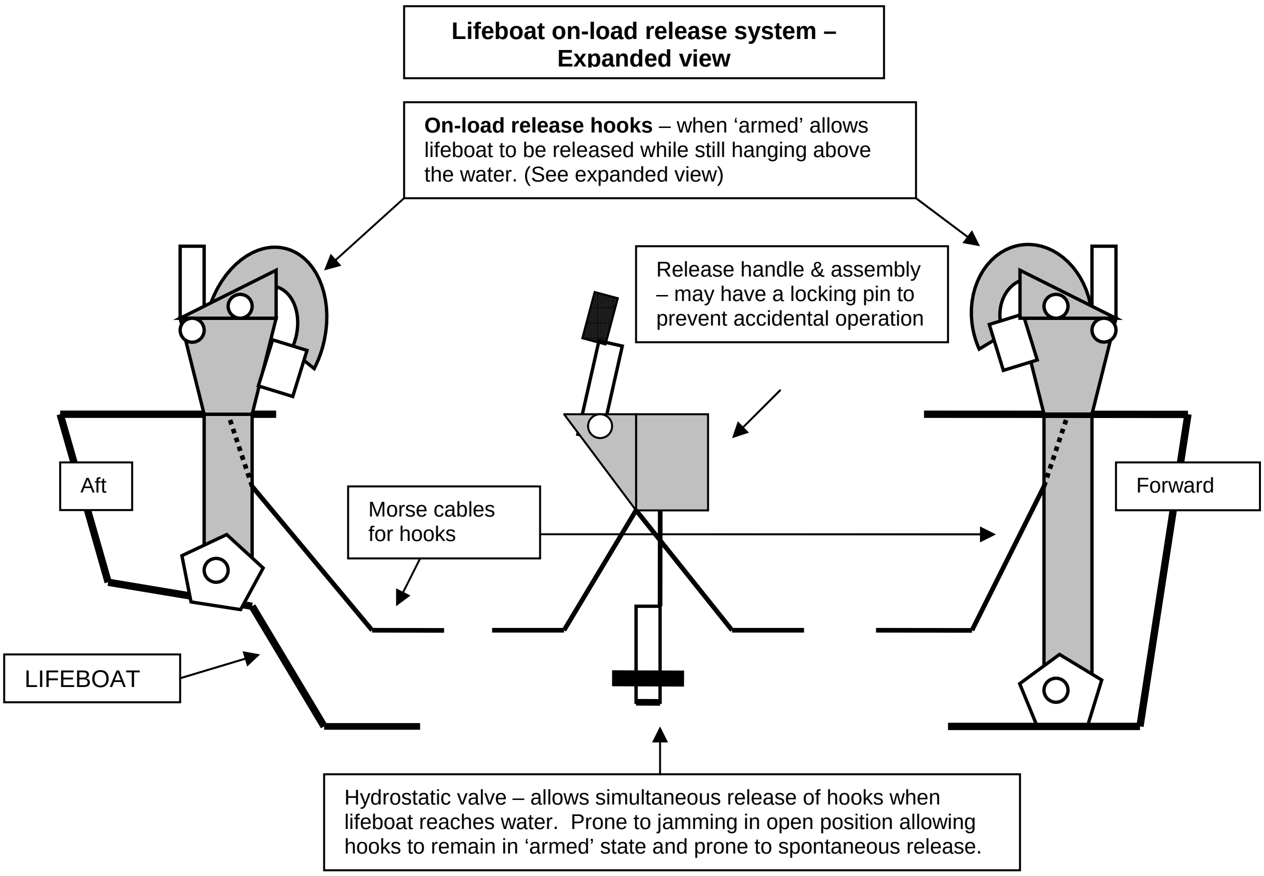


Seafarers are often aware of existing design problems with lifeboat equipment. In a best case scenario this awareness causes them to take additional care when dealing with these deficiencies. One vessel that suffered a lifeboat accident had, prior to the drill being conducted, made a special check of the remote release wires as these were considered '…*notoriously problematical.'* Despite safety checks the release wire fouled on the winch drum causing extensive damage to the lifeboat. The report noted that this was *'…a basic design fault common to just about all lifeboats these days…'* and that *'Crews are now very wary of lifeboats in general.'* The report concluded by asking the question, *'How can something so important be so fundamentally unsafe?'* [56]

In a worst case scenario seafarers aware of problems with design attempt to rectify the problem themselves. Attempts at modifying lifeboat systems are often cited as the cause of accidents. However it can be difficult to recall or correct an identified design flaw with lifeboats that are in use all over the world, so modification of known flaws is likely to continue. For example seafarers, concerned over the number of accidental brake release accidents associated with their design of lifeboat, attached large weights to the remote brake cable. Although this practice was successful in preventing accidental release, the weights were shackled in place meaning that they could not be removed quickly. This could have resulted in the lifeboat being 'hung up' and unable to release from the ship when launched.[57] This demonstrates how a desire to circumvent a known design problem can lead to the creation of unsafe working practices.

Some design problems can be corrected through simple modifications, capable of being performed by the seafarer. Sadly these faults are often only recognised following an accident. One example involved a poorly designed hydrostatic release that jammed in the up position resulting in the system remaining 'armed' and liable to release at any moment. The cure was a simple 180 degree rotation of the hydrostatic release. Unfortunately this was not discovered before it had caused the death of one seafarer and injury of five others.[58]

Fig 6.1.4



A commonly reported design problem involves the use of materials that are unsuitable for the marine environment. This includes hydrostatic interlocks with aluminum casings being secured by stainless steel bolts creating a galvanic reaction, and unpainted non-stainless steel hook arrangements rusting in the corrosive marine environment.[59] Even when appropriate materials are used, the increasing complexity of lifeboat systems makes them prone to failure in marine conditions. Increasing sophistication in design has led to engineering tolerances that, although appropriate in test conditions, quickly cause jamming by salt when used at sea.[60]

On the *Pride of Hampshire* during a lifeboat drill, the No. 2 lifeboat fell into the water, taking with it the forward davit arm and associated rigging. The cause of the accident was the failure, due to stress corrosion, of the aft hook suspension link which had not been heat treated in line with British Standards specifications. Analysis also showed that the welding on the davit arms was of inferior quality, although this did not directly lead to the accident.[61] The implications of the investigation were far reaching as the components involved could have been in use on a number of vessels. The Marine Safety Agency could do little except issue a Marine Guidance Note in an attempt to highlight the problem.[62]

A wide range of accidents and injuries involving lifeboats can be grouped under the cause heading of poor ergonomic design. This includes similarity of appearance of the controls within the lifeboat leading to accidental release of the wrong lever, poor access to vital components, inadequate and confusing markings for on-load release gear, and factors as simple as the design of seats and restraints.

Similarity of design in control appearance is suspected to have been involved in the lifeboat accident on the *Kayax*. [63] The accident occurred through accidental release of the on-load mechanism. Although the investigators were unsure who actually released the boat, they determined on the evidence available that one of the crew aboard the lifeboat must have mistaken the release lever for the engine control. Similar concerns were raised by the investigator of the *Waddens* lifeboat accident. [64] The investigator noted that even if confusion between the release lever and the engine control had not been a factor, the location of the release lever was such that accidental release was a continual possibility.

The *Kayax* report also highlighted the lack of safety harnesses fitted within the lifeboat as leading to increased injury to the seafarers involved. The accident to the *RFA Fort Victoria*[65] also mentions safety harnesses and how poor ergonomic design required a seafarer to release his safety harness to operate the emergency on-load system that releases the lifeboat. While design was not a direct cause of the accident to the *Fort Victoria,* the seafarers aboard suffered spinal injuries, due to the lack of padding and poor ergonomic design of the lifeboat seats, when the lifeboat was released.

When the lifeboat on the *Fort Victoria* was released it fell 1.2m to the water causing injuries to the crew aboard. Interestingly the investigators were of the opinion that the forces involved in causing these injuries would not be encountered during normal operation. However davit lifeboats are designed to be launched in weather conditions up to Beaufort Force 6 and a significant wave height of 3m, and it is very likely that a lifeboat may be subjected to even greater forces if deployed in an emergency. Additionally the lifeboat was rated to carry eighty people, as opposed to the seven on board during the accident, so there is an issue of increased weight and inertia forces at work in a real situation. Moreover ergonomic design in lifeboats is not taking account of the increasing size of seafarers and the requirement to wear bulky survival suits thereby creating the potential for more serious accidents *'This could increase the risk of personnel injury during evacuations and could affect the buoyancy* *and stability of lifeboats*.' [66] Given these factors the importance of safe ergonomic design for lifeboat seats becomes apparent.

As an aside to this accident, davit-launched lifeboats are required to be structurally tested by being dropped from a height of 3m.[67] There is no requirement to test what the effects of this are on the seafarers inside the lifeboat

The adverse effects on seafarers using free-fall lifeboats are even greater. The IMO commented that '*Research suggests that the interior structure and design of free-fall lifeboats is the determining factor leading to injury during launch and raises concern that many crews potentially remain at risk of injury…'* [68]

Recently the SOLAS standards for free-fall lifeboats were brought into question when it was discovered that some lifeboats, despite being built to SOLAS standards, had roofs that were deflecting up to 20cm when the boats hit the water. The deflection allowed water to enter the lifeboats and could have caused head injuries to personnel inside. Part of the problem is SOLAS standards are for the release of lifeboats into calm water only; if lifeboats strike waves at an angle or fall into troughs the forces can be significantly higher.[69]

The accident involving the lifeboat on the *City of Burnie*[70] is an example of poor ergonomic design resulting in unsafe work practices being developed. The accident itself was caused by the overriding of the electrical system, and consequently the safety cut-off switches, when it was discovered that water had damaged the winch controls. Bypassing the cut-offs allowed the lifeboat to be brought up hard against the davits resulting in the fall wires parting and the lifeboat, complete with its eight man crew, falling into the water.

It is exactly this type of accident that the new SOLAS legislation seeks to prevent by removing the requirement for crew to be on board the lifeboat during drills. While such legislation may have prevented the injuries occurring, it would not have prevented the accident itself. Moreover, the design of the davits and fall wires on the *City of Burnie* was such that the fall blocks twisted in use and had to be manually aligned with the slots in the davit heads. As a consequence of this design fault, at least two seafarers *must* be on board the lifeboat at the most hazardous part of the recovery procedure. This example clearly demonstrates how for new legislation to be effective it needs to address the causes of lifeboat accidents at the design stage rather than overly focusing on the human element.

The greatest hazard arising from poor design is the difficulty in determining whether on-load release systems have been properly reset. A recurring theme in lifeboat accidents is that the on-load release gear was not properly reset, but this was not noticed until an accident occurred during a subsequent drill. The reasons for improper resetting of on-load release gear often involved poor maintenance of, or inadequate training in, the systems on board. However these problems are exacerbated by poor designs, making it difficult to check the state of the on-load gear, or which are unsuitable for use in a marine environment.

Fig 6.1.5

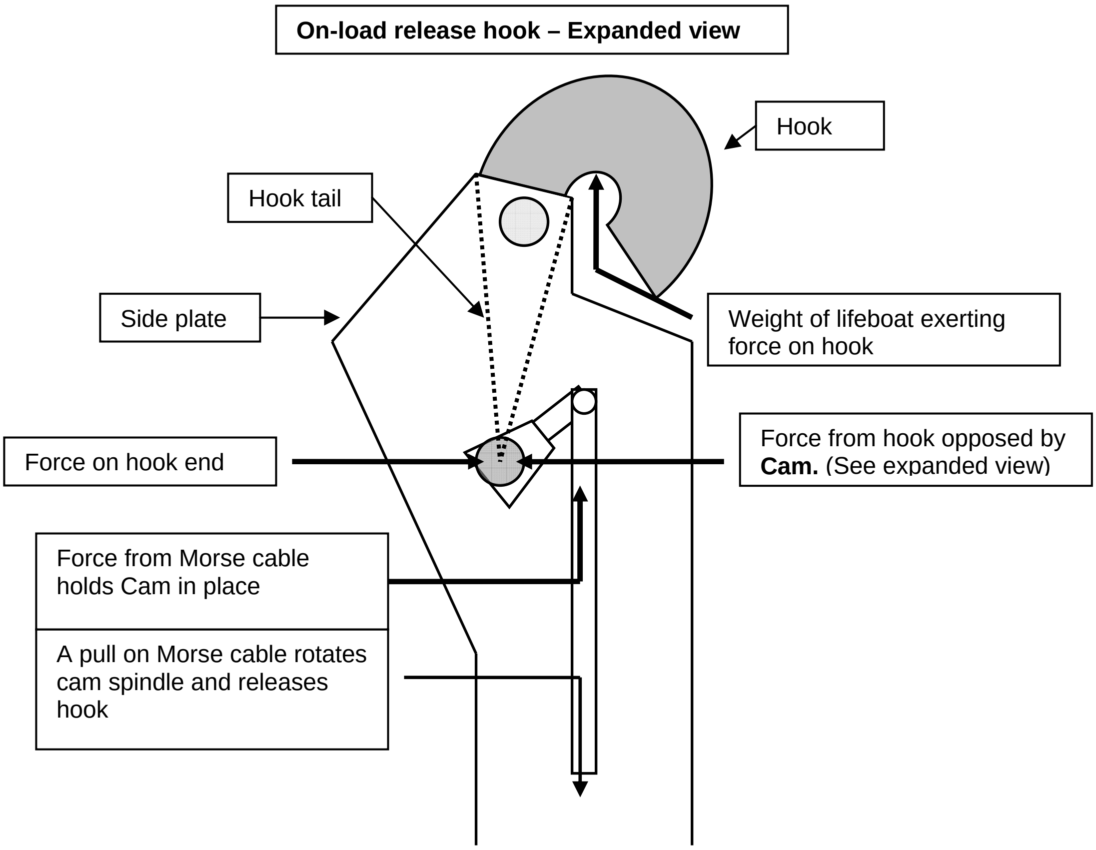
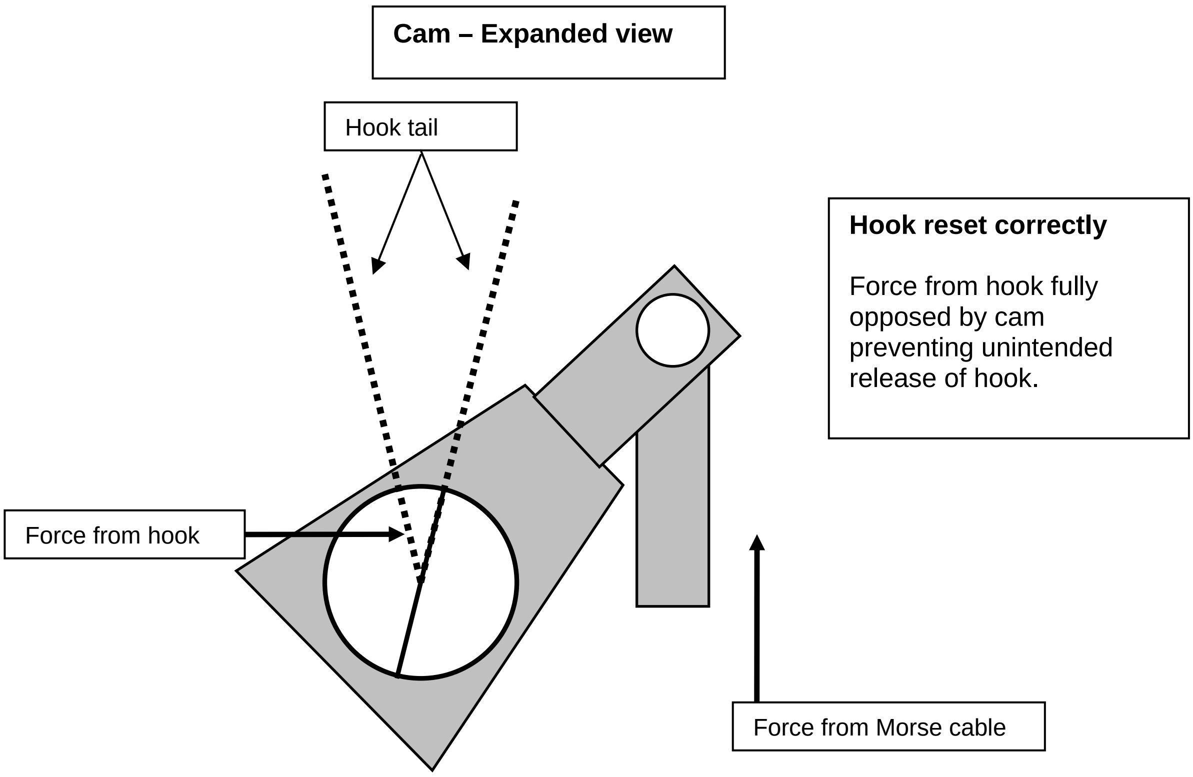
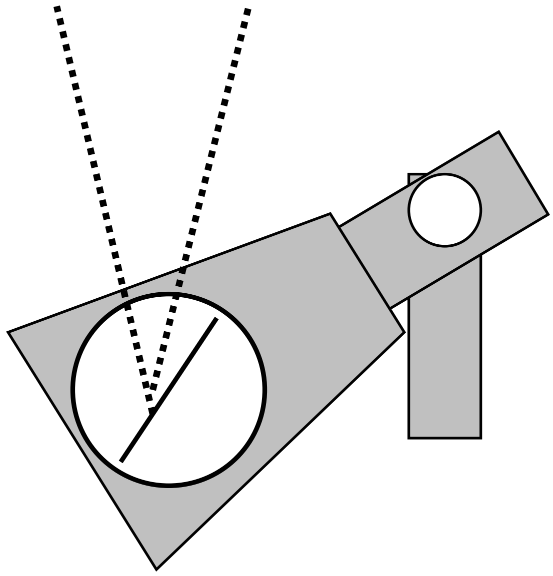


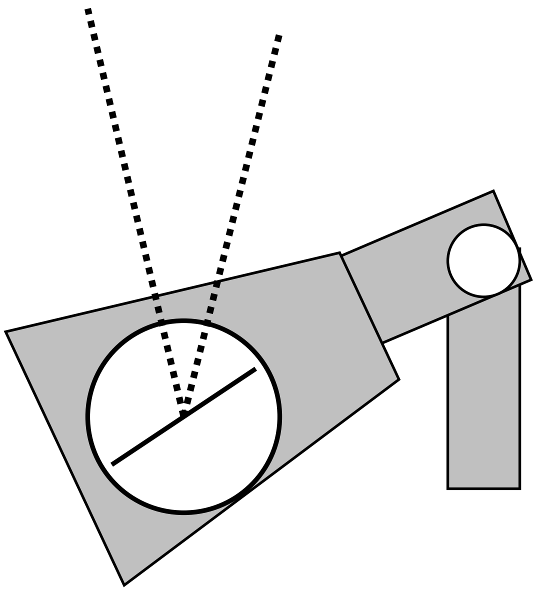
Fig 6.1.6





Hook and cam only partially reset.

Incorrect resetting of the cam can leave the lifeboat in a state where the force of the hook is not fully opposed by the cam. The lifeboat may stay in this unsafe state for some time until additional movement (i.e. a lifeboat drill) results in the unintended release of the hook.



Hook and cam badly reset.

In this situation the force of the hook is barely opposed by the cam and the hook could be subject to spontaneous release at any moment.

A variety of factors may contribute to the hook/cam being incorrectly reset including stiff Morse cables, corrosion of components, salt encrustation and wear of components and design and roughness of the hook and cam surfaces. A lack of clear indicators means that seafarers may be unaware that the hook/cam system is not fully reset.

The *Washington Trader*[71] is an example of a lifeboat accident caused through on-load hooks being reset incorrectly. Although maintenance and training were cited in the investigation as being the main causes, a review of the investigation shows the difficulties that faced the seafarers in clearly determining the state of the on-load gear. Not only was the gear difficult to inspect but the system lacked clear reference markings, so leaving the determination of what *'correctly reset'* meant up to the subjective view of the seafarer. To further complicate matters the design included two panel lights to indicate when the system was safe; each light however could indicate two separate and contrary operating conditions.

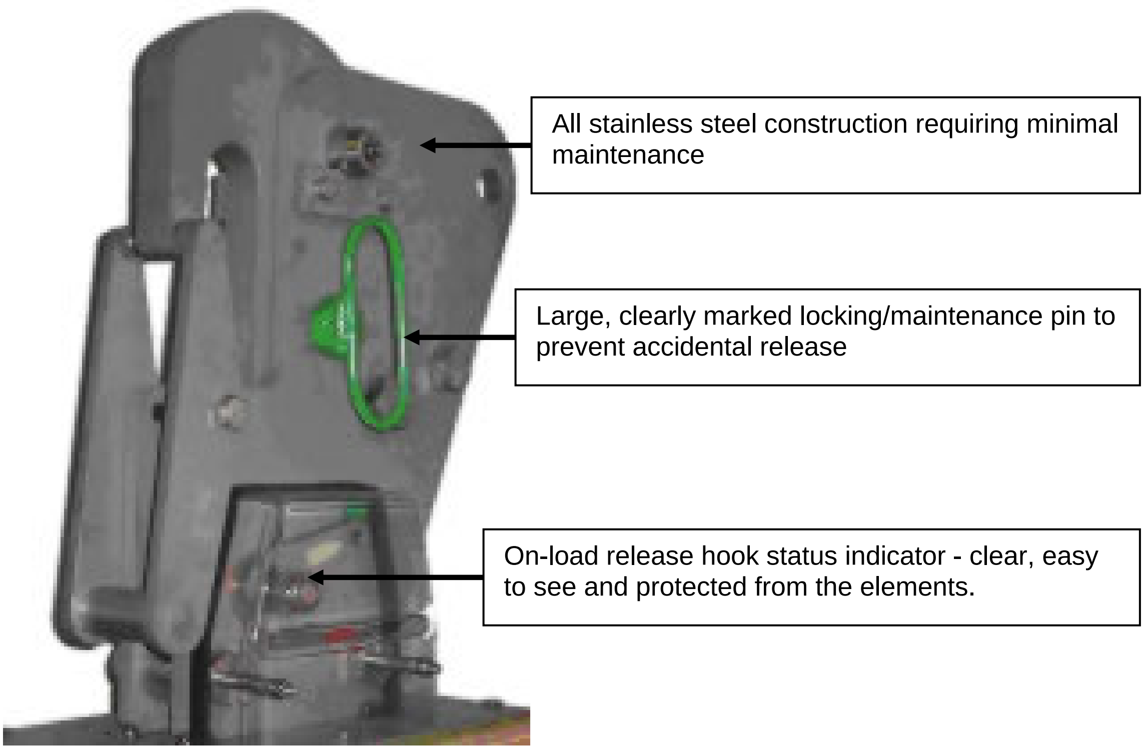
As a single event the *Washington Trader* serves as a clear example of how poor design can be the underlying cause of an accident. However this message is strongly reinforced by the occurrence of a virtually identical accident involving the sister ship to the *Washington Trader*, the *Pachmonach.*[72] Again poor design allowed the on-load release gear to be improperly reset and pass unnoticed until an accident occurred involving multiple fatalities. Disturbingly a subsequent test drop of the *Pachmonach* lifeboat from a height of just 0.5m resulted in the occupants experiencing considerable spinal jarring due to the poor ergonomic design of the lifeboat seating arrangements.

Some lifeboat designers are taking such issues very seriously and improving designs to reduce the chances of accidents occurring. Notable amongst these are Umoe Schat-Harding's new range of KISS (Keep It Simple & Safe) lifeboats that aim to improve the ergonomics and ease with which lifeboats can be operated.

Perhaps the greatest improvements in lifeboat design are reflected in the development of simple and easy to read on-load release hooks. The two leaders in this field are Mad Rock Marine Solutions Inc in Canada, and Survival Craft Inspectorate (SCI) Ltd based in the UK. The SCI *SAFELAUNCH* release hook addresses many of the design issues that have led to accidents in the past, including clear indication of the status of the gear and complete stainless steel construction allowing for minimal maintenance requirements and the ability to withstand the corrosive marine environment. Already in use by shipping companies and training facilities, time will tell if design improvements like this significantly reduce lifeboat accidents.

Fig 6.1.7

SAFELAUNCH on-load release hook.



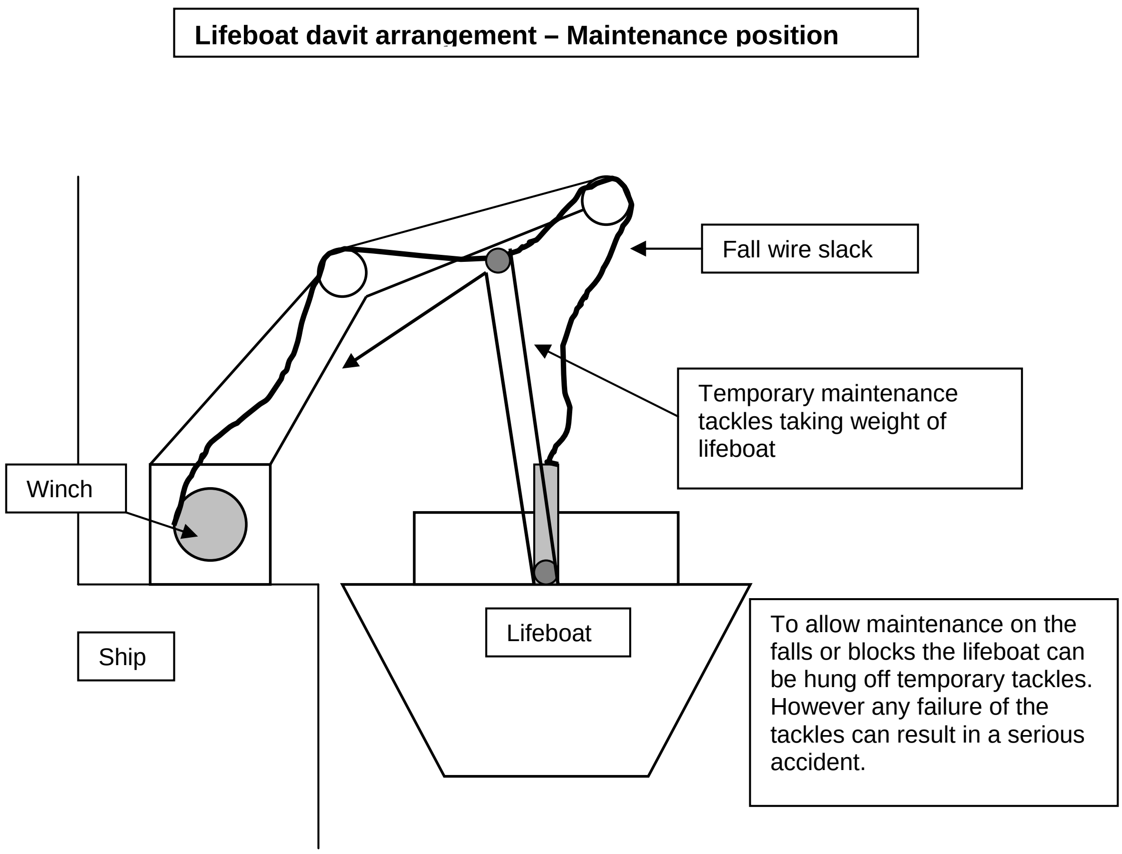
6.2 Maintenance

Another major cause of lifeboat accidents is maintenance. It cannot be denied that maintenance on some vessels is well below the required standard, as evidenced in the case of the *Iran Salam,* where a serious lifeboat accident led to a port safety inspection which discovered a further 54 safety defects. [73]

However the point was made in the previous section that poor maintenance is often blamed for fundamental design flaws. This issue was noted in the Lifeboat Incident Survey in 2000. [74] The report mentioned that '*…if at the design stage the requirement for non-critical maintenance was addressed, the incidents categorised under Lack of Proper Maintenance may not have occurred.'*

For certain aspects of maintenance it is necessary for the lifeboat to be lowered and supported on 'hanging off' tackles in order to allow slack in the falls, i.e. when working on the release hooks. The seafarer undertaking the work may then be required to work in or on the lifeboat which means that the failure of any part usually results in injury or death. Two seafarers were hospitalised when recovery pendants were inadvertently rigged, instead of maintenance tackles, resulting in the lifeboat falling into the water. Lessons learnt from the investigation included *'The casualty would have been prevented if the design of the recovery pendants precluded them being mistaken for, and rigged as, the hang-off* [maintenance] *tackles'* and '*The casualty may not have occurred if the lifesaving equipment maintenance manual contained detailed procedures for supporting the lifeboat from the hang-off pendants.'* [75]

Fig 6.2.1



In the lifeboat accident on the *Ma Cho*[76] the investigation report identified that the maintenance of the on-load release system was poor and had contributed to the accident. However the report also highlighted that the manufacturer's maintenance manuals did not contain information necessary to enable the crew to properly and safely maintain the lifeboat. The report further noted the design of the on-load release hooks were prone to accidental release and had been implicated in a number of other accidents.

The issue of inadequate maintenance manuals recurs within accident investigations. Common problems include manuals which are overly complex and not able to be understood without specific training, are generic to a brand of lifeboat with information regarding the specific design on a ship either absent or buried within unnecessary details, lack important maintenance information or are not available in the working language of the ship.

An example of confusion in deciphering maintenance manuals leading to a series of accidents concerns the wrong type of lubricating oil being used on one-way clutches on lifeboat winches. In the accident on *P&OSL Calais* the lifeboat went into free fall after being lifted, as oil used on the winch brake had the wrong viscosity.[77] Manuals for the vessel covered several models of winches and seafarers were required to extract the information specific to their lifeboat system. Although the manuals identified the correct oil to be used the information was presented in a general-purpose table covering a wide range of applications and lubricants. Because of the general nature of the information it was easy for the seafarers to select an incorrect lubricant.

So easy was it for this misunderstanding to occur that other vessels had previously suffered similar accidents after using incorrect lubrication on the same design of lifeboat winches. Accidents on *Arcadia*, *Pride of Dover* and *Pride of Burgundy* were almost identical to *P&OSL Calais*.[78] The MAIB has several other accidents on file concerning winch failures suspected to be linked to the use of inappropriate lubrication.

The fatal accident on the *Iolcos Grace*[79] is another example of on-load release hooks opening prematurely. The report stated that a lack of understanding of the operating principles of on-load hooks was the prime cause, but also noted that while the system for releasing and resetting the hooks was included in the lifeboat manuals there were no instructions covering when the hooks should be reset or how the boat should be secured to the davit falls.

The report also noted the information in the lifeboat manual was unclear and difficult to comprehend. For example Item 7 in the manual states *'To be adjusted lowering speed by remote control wire before the boat launch to the sea surface and to be waterborned slowly.'* Although this does not relate directly to maintenance it raises the question - if the above is an example of the standard of basic instructions for launching, how incomprehensible must the technical details for maintenance be to the average seafarer?

A similar example is the *Alianthos* [80] where an accident occurred to the port lifeboat when the on-load hooks failed during a drill. The investigation report noted the instructions were unintelligible with reference numbers for the system missing, a single diagram showing the system in both the tripped and reset modes, and confusing diagrams which showed parts of the system that were below deck level and therefore not visible to the operator. The report concluded the operating instructions for the on-load release system were '…*effectively useless to the crew*…' and *'The on-load release hooks…could not be fully reset using the operating mechanism in the prescribed fashion.'*

These accidents demonstrate the need for maintenance manuals provided to ships to be clearly written, type specific and available in several languages. In 2001 the International Association of Classification Societies (IACS) [81] issued guidance on development of technical manuals to address what they termed '*Poorly produced manuals with ambiguous* content'. The IACS paper noted that technical manuals '…*represent a critical factor in maritime* safety…' and *'Instructions on how to operate and maintain equipment should be an integral part of the delivery* [by manufacturers].'

A plea for legislation to force change was made to the IMO by Japan in 2003. The submission contained proposals to standardize operating manuals so crews could conduct operations and maintenance effectively to reduce the number of accidents.[82]

In answer to problems identified with lifeboat maintenance the IMO have included in new SOLAS legislation, coming into force in 2006, a requirement that periodic servicing and maintenance may no longer be undertaken by the ship's crews but must be conducted by the manufacturer's representatives. Although this step may prevent some lifeboat accidents, it places a large logistical and financial burden on the shipowner, rather than addressing the primary issue of inadequate operating manuals.

Design of critical components can also mean that preventive maintenance is impossible. In one such example a ship was lowering a lifeboat for routine planned maintenance when one of the davit sheaves disintegrated allowing the fall wire to become trapped and damaged. The sheave was designed with no lubrication points and marketed as being maintenance free, which plainly it was not.[83]

This is not to deny that poor maintenance is a very real factor in lifeboat accidents, but rather to highlight the important connection between good initial design and ongoing maintenance requirements.

Fig 6.2.2

Photo credit MAIB

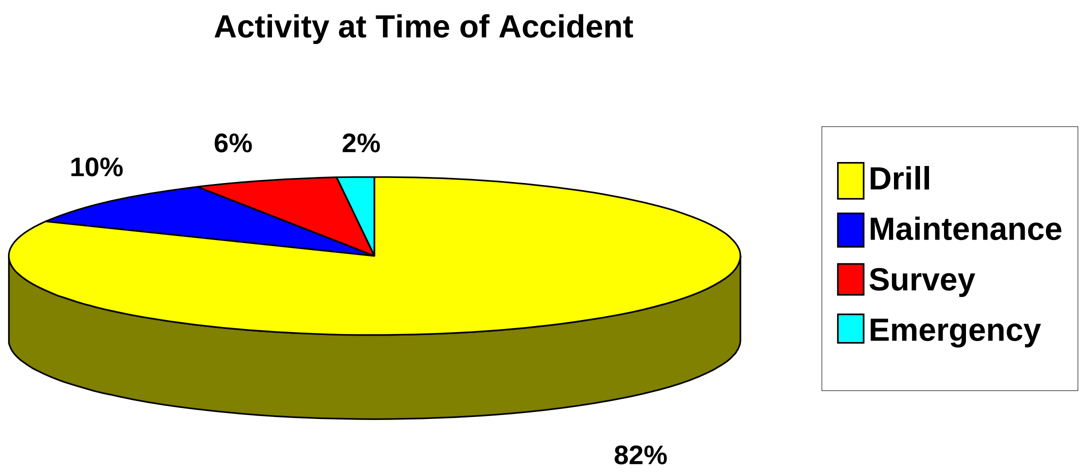
Ship's lifeboat hung-off on maintenance tackles

6.3 Training

The issue of training and competence arises as, at least in part, a contributing factor in almost every lifeboat accident report. Of course the issue of safety training extends beyond that just relating to lifeboats, but an analysis of lifeboat accidents highlights the same global training issues that are found in other marine accidents and serves as an exemplar of the greater picture.

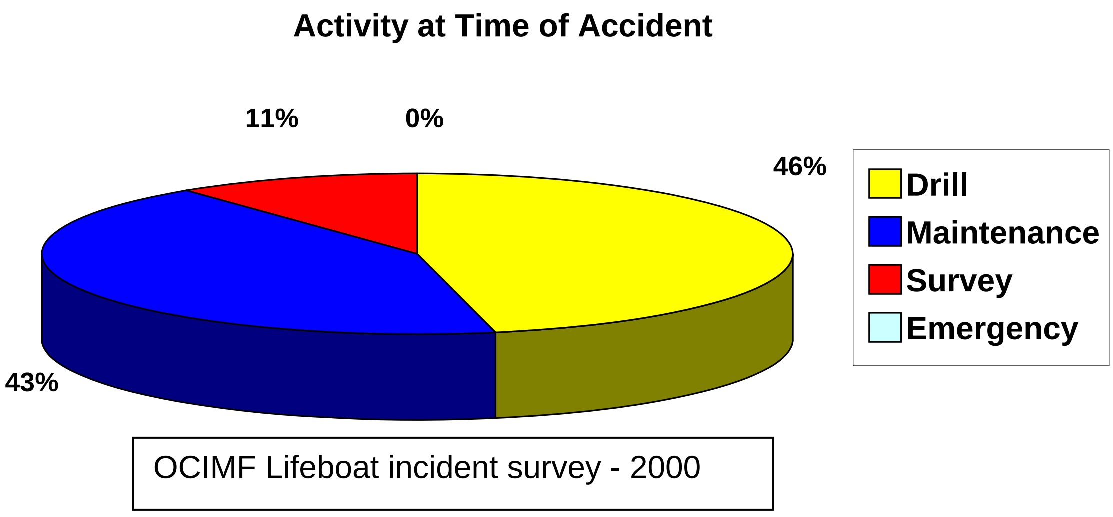
One of the most disturbing factors about lifeboat statistics emerging from previous studies is that the majority of accidents occurred during training drills.

Fig 6.3.1 [84]



OCIMF Results of a survey into lifeboat safety -1994

Fig 6.3.2 [85]



Comparing the graphs it appears that accidents during training drills had significantly reduced over the six-year period. However it was not possible to draw any conclusions about whether this was due to improved training techniques or to other factors.

When discussing training it must be remembered that lifeboats are designed essentially as a single use piece of equipment, intended to be deployed only for escape and not intended for retrieval and re-use. Recovery and re-stowing of lifeboats is confined almost exclusively to training drills. This creates major hazards when lifeboats are designated for use in MoB recovery, '*The main disadvantage of an enclosed boat is that it is a boat designed for abandoning ship and nothing else. A ship equipped with just enclosed boats is in a poor position to deal effectively with a man overboard situation.'* [86]

It is difficult to understand why training is a factor in so many accidents as, unlike most shore businesses, all seafarers must undergo a detailed training programme before they can qualify to work at sea. This initial training is reinforced by that conducted on ships and further supplemented by additional shoreside training should seafarers intend advancing their careers. There are very clear and detailed legal training requirements for seafarers including training on the use of lifeboats,[87] although Flag State implementation of this legislation can vary considerably.

However if standards of training on merchant vessels are variable it is reasonable to expect that standards amongst the armed services are of the highest level. It was therefore interesting to note that one identified cause of the lifeboat accident on *HMNZS Endeavour* [88] was incorrect drills due to insufficient training. Given that within the armed forces considerable emphasis is placed on training and preparing for emergency situations, the fact that training can be got so wrong even by the Navy points to a fundamental flaw in the way lifeboat training drills are conducted. It is worth noting that the investigation also determined that the accident was caused by a '…*design or manufacturing error* [that] *would have been in existence on both lifeboats since they entered service with the RNZN.'*

Although training is often cited as being the cause of lifeboat accidents, like maintenance a review of investigation reports often identifies underlying and contributing design problems. This issue was highlighted by the Australian Maritime Safety Authority which commented '*These factors* [lack of familiarity] *were exacerbated in many cases by the design and instructions provided by the manufacturers of such critical equipment as ''on-load'' releases.'* [89]

As with maintenance, poor quality instruction manuals contribute to the difficulties in training seafarers in safely using lifeboats. Often this is simply the instructions not being in the working language of the crew, as was a contributing factor in the lifeboat accident on *Gulser Ana* where the instructions were deemed '…*of little value…'* to the crew.[90]

Similarly the accident investigation of *Maersk Pomor* noted an overall lack of knowledge of the lifeboat systems, and that labelling and instructions for the release gear, although clear, were not in the language of the crew.[91] In the lifeboat accident on *Galateia,* although pictorial and explicit warning notices had been issued, these had not been supplied to the ship by the manufacturer.[92]

The issue of clear instructions in the crew's working language is of particular importance when dealing with equipment likely to be used in an emergency situation. The Association of Maritime Training Institutions in Asia Pacific (AMETIAP) spent a large part of 2004 looking at how maritime training could be improved. Although they acknowledged that training institutions have done a good job, they noted that there is a big difference between simulated drills in a controlled situation and a real emergency. AMETIAP commented that '*It is largely true that people panic in their own language*…' and that effective training needs to address this fact.[93]

This issue is evident in situations where lifeboats have been launched in real emergencies. Following a collision with another vessel, the *Ogrady* prepared to launch its port lifeboat when the on-load release hooks were inadvertently opened. The boat fell 15m into the sea, capsizing and causing the death of two seafarers. Although panic was not specifically mentioned, given the recent collision and subsequent heavy listing of *Ogrady* it can be assumed the crew were working under unusually stressful conditions. In such extreme situations the provision of clear, unambiguous signage and safety instructions are vital, but none of the lifeboat instructions on *Ogrady* were comprehensible to the Chinese crew.[94]

A more extreme case involved *European Highway* where an accident during a lifeboat drill led to another accident when launching the FRC to assist the seafarers in the water, *and* a further near miss when recovering the FRC. Again lack of instructions and training were cited as contributory causes.[95] It is worth noting that there remains an intense debate amongst mariners over the safety and value of FRC[96], and even the IMO itself agreed with a statement put forward from Finland that '…*fast rescue boats should not, as a rule, be regarded as means of rescue.'* [97]

Although seafarers are still required to conduct a full lifeboat drill every three months, the new SOLAS legislation will no longer require personnel to be in the lifeboat while the drill is conducted. While this will undoubtedly reduce injuries, some training establishments have raised the issue of the reduced practical experience that seafarers will receive in handling lifeboats.[98] If the only time seafarers experience practical lifeboat work is at training colleges, will they be properly prepared for real emergencies at sea?

Several companies are taking steps to address the problem of crew training, notably *Seagull AS* who have developed interactive computer based training programmes.[99] The programmes have been developed in conjunction with lifeboat designers and manufacturers and cover the specific equipment found on each vessel. Liberal use of interactive diagrams and pictures simplifies the training and makes it applicable across a variety of languages and learning abilities.

Finally, for training to be effective in an emergency situation the seafarers must above all be confident in their ability to safely deploy lifeboats in the controlled atmosphere of a drill situation. If, as has been shown in the early sections of this paper, seafarers lack confidence and trust in the systems they are required to employ, then training problems will continue to feature as a cause in accidents.

Fig 6.3.3

Photo credit: Author

The lifeboat training facility at Warsash Maritime Centre, Southampton.

6.4 Summary

The importance of the interconnection and interaction between design, maintenance and training needs to be brought to the forefront of lifeboat research to ensure efforts to reduce accidents are focused on the problem as a whole. As the Nautical Institute states,

'*Notwithstanding the maintenance issues, indicative to a great degree of one's perception of safety, we should equally focus on the design of a release gear and the quality of training that the seafarers receive. It is most unlikely that any of these three can be successfully addressed if viewed isolated from the others.*' [100]

Fig 6.4.1

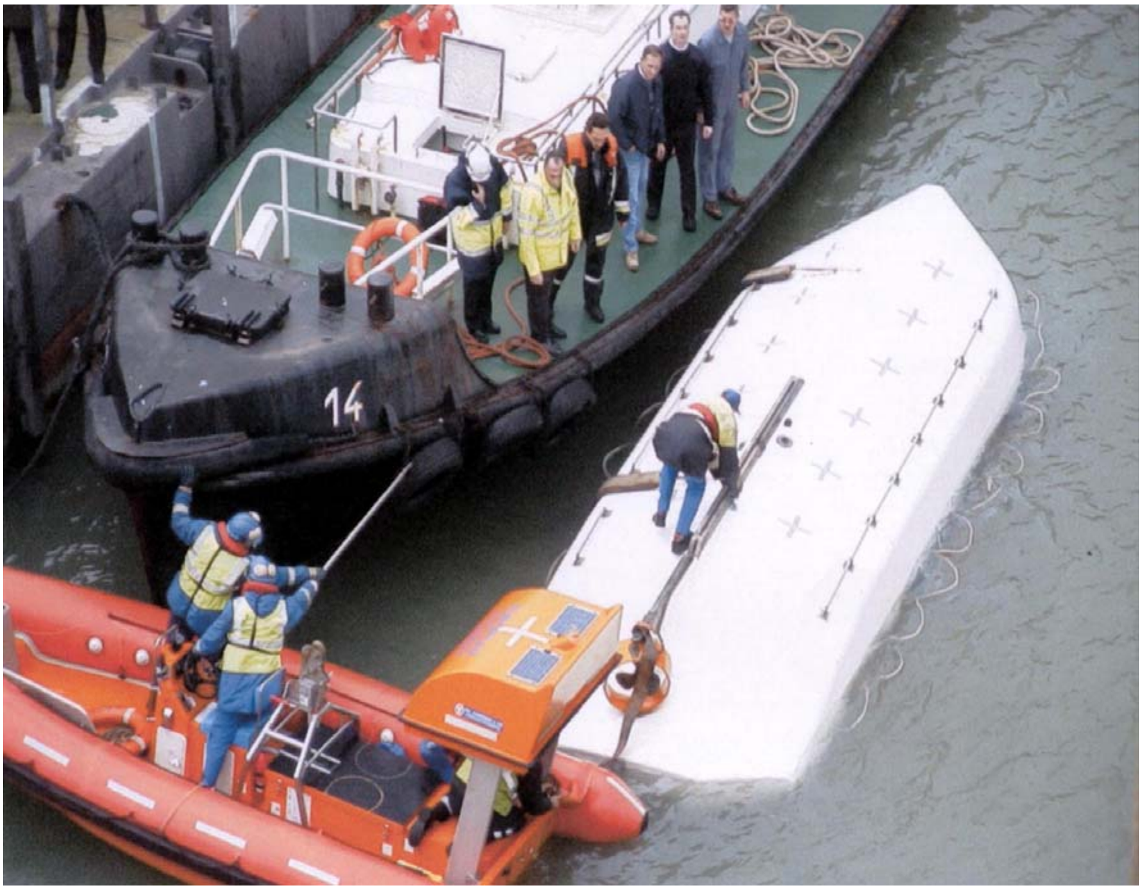


Photo Credit: MAIB

Rescue workers attach lifting gear to recover an inverted lifeboat

CHAPTER SEVEN

7.0 Project Questionnaire

The project questionnaire[†] collected primary data required to establish the perceptions of seafarers towards the overall safety of ship's lifeboats and the safety of individual activities and components of the lifeboat launch/recovery systems. The scope of the questionnaire was limited to the marine industry with a sample sent to company personnel departments for forwarding on to the ships. Because of this it was not possible to state what the circulation or return ratio was of the questionnaire.

It was realised early in the development of the questionnaire that perceptions would probably be different for each group of seafarers', dependent on the amount of contact they had with the ships lifeboats. Crew involved in the launching and recovery of the lifeboats were likely to have views of these operations contrasting with those for crew members more removed from the process.

This reasoning was supported by a research project that was started after this one. In 2005 the Lloyd's Register Research Unit (LRRU), a section of the Seafarers International Research Centre at Cardiff University, began a major project to determine the perceptions of seafarers towards safety and risk. The project proposal identified that previous research in other industries has shown '…*that members of staff operating at different levels within an organisation can have varying perceptions as to what is important in relation to safety.'* The

[†] Appendix II

LRRU project continued '*A lack of awareness of such difficulties can result in the misdirection of management-led safety interventions which can in turn lead to antipathy and mistrust amongst the workforce.'* [101]

The LRRU project intends to poll seafarer's perceptions via a series of questionnaires over several years and one module will focus on perceptions of risk towards ships lifeboats.

To accurately assess the perceptions of all seafarers the questionnaire for this project was developed in four sections.

7.1 Section One

The first part of Section One gathered information on the rank or position of the seafarers and the time spent at sea in a professional capacity. It asked for details of the type(s) of lifeboats on the vessel and whether the seafarer had been involved in any previous lifeboat accidents. The rest of Section One was devoted to gaining the perceptions of all participants towards lifeboat usage in general as well as specific equipment and operations.

7.2 Section Two

Section Two asked for an overall opinion of lifeboat safety. The question was repeated twice, one to be answered by members of the lifeboat launch party and the other by all other seafarers. These questions were intended to investigate the difference in hazard perception between personnel actively involved in lifeboat operations and those removed from the process.

7.3 Section Three

Section Three was to be answered only by seafarers involved with the launching and recovery of the lifeboats. The questions assessed perceptions concerning the equipment identified in previous studies as being most commonly associated with accidents.

7.4 Section Four

The questions in Section Four were to be answered only by seafarers involved in lifeboat maintenance. The questions centred on the most commonly identified maintenance issues in previous studies.

7.5 Circulation

A draft questionnaire was presented for comment to a selection of seafarers and the paper modified to include their suggestions. The final questionnaire was then sent to the Personnel Departments of various shipping companies with a written invitation for their seafarers to take part. Participating companies are listed in Appendix I.

An indication of the degree of concern about lifeboats was reflected in the response from companies approached to take part in the study. This small project accumulated over 700 returns and it was apparent that the limiting factor on the scale of the project was not the number of responses obtainable from the marine industry, but rather the time available to the researcher to process the data. Given additional time and resources the scope of this project could have been significantly larger and provided more statistically significant data to the marine community.

CHAPTER EIGHT

8.0 Data Collection

Data for this project consisted of primary and secondary data collected from different sources. Primary data was obtained from the project's perception oriented questionnaire, and secondary data came from accident investigation reports. Testing the hypotheses required the primary and secondary data to be analyzed both separately and in conjunction.

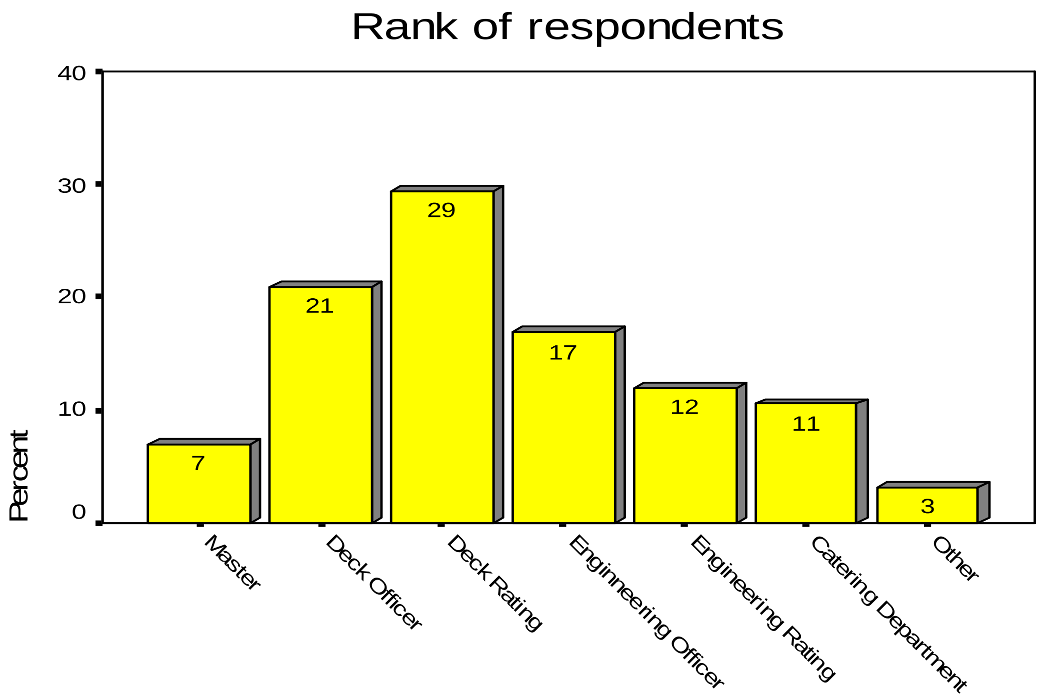
This chapter covers the background information that was gathered. Data presented here was not intended to be used in the testing of the project hypotheses, but was gathered to provide background information on the investigation reports and questionnaire respondents. It illustrates the scope and source of the information that was used in the testing of the project hypotheses.

8.1 Data Collection - Primary Data

The primary data consisted of the 768 replies received from the circulated questionnaire.

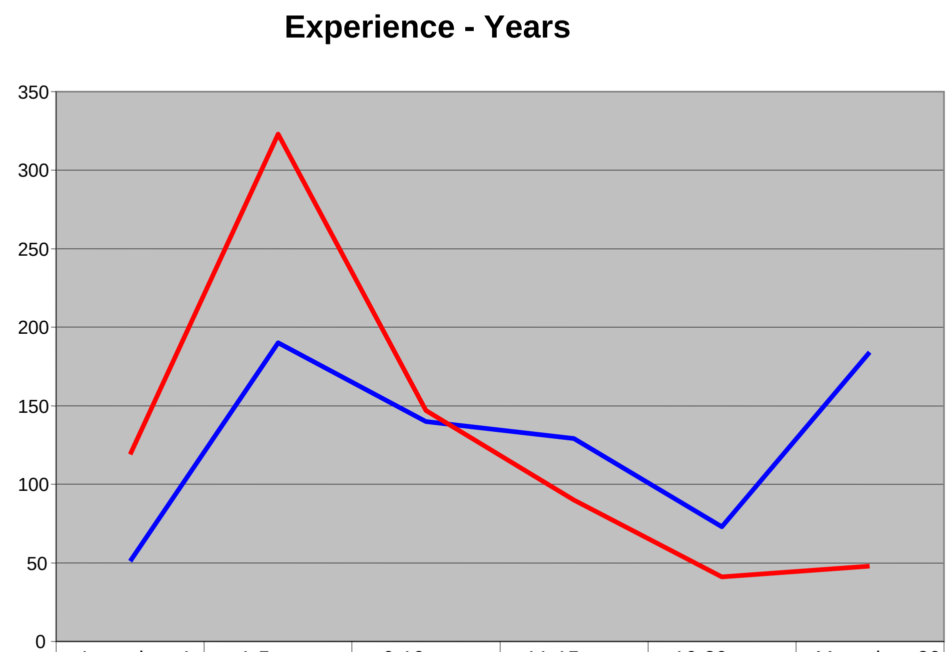
This section looks at the personal data on the respondents.

Fig 8.1.1



Question No. 1: The greatest response was from deck ratings but given that most vessels carry a proportionally larger compliment of deck rating than other ranks this was to be expected. The 'Other' category was almost entirely composed of trainee cadets.

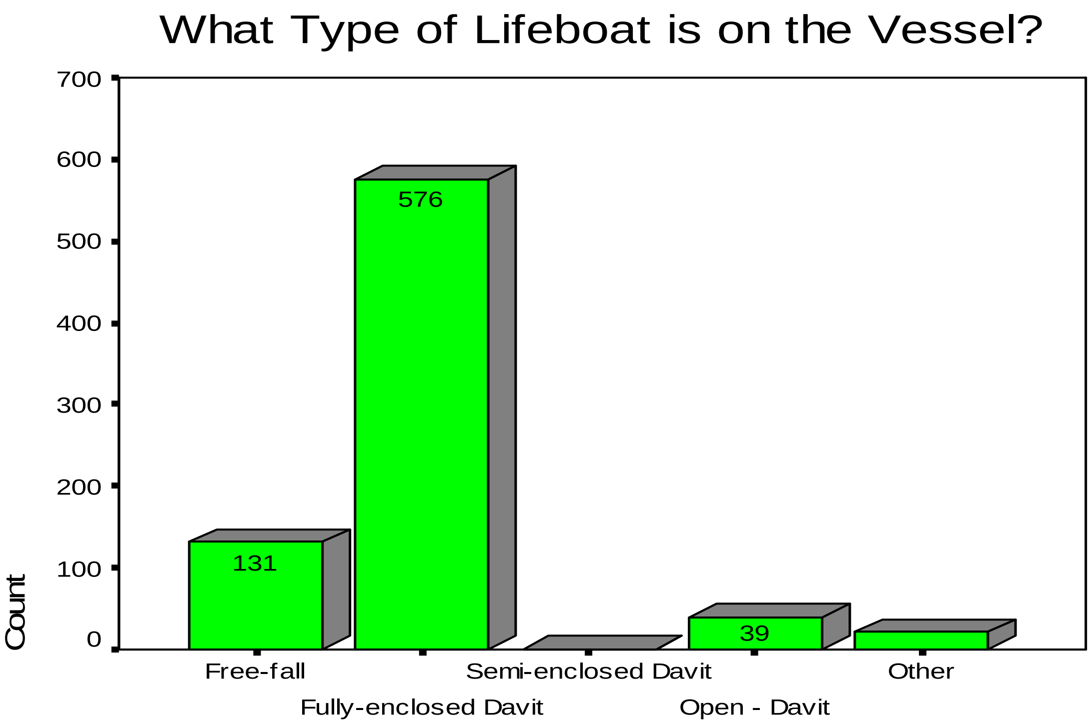
Fig 8.1.2



	Less than 1	1-5 years	6-10 years	11-15 years	16-20 years	More than 20
At sea	51	190	140	129	73	184
With company	119	323	147	90	41	48

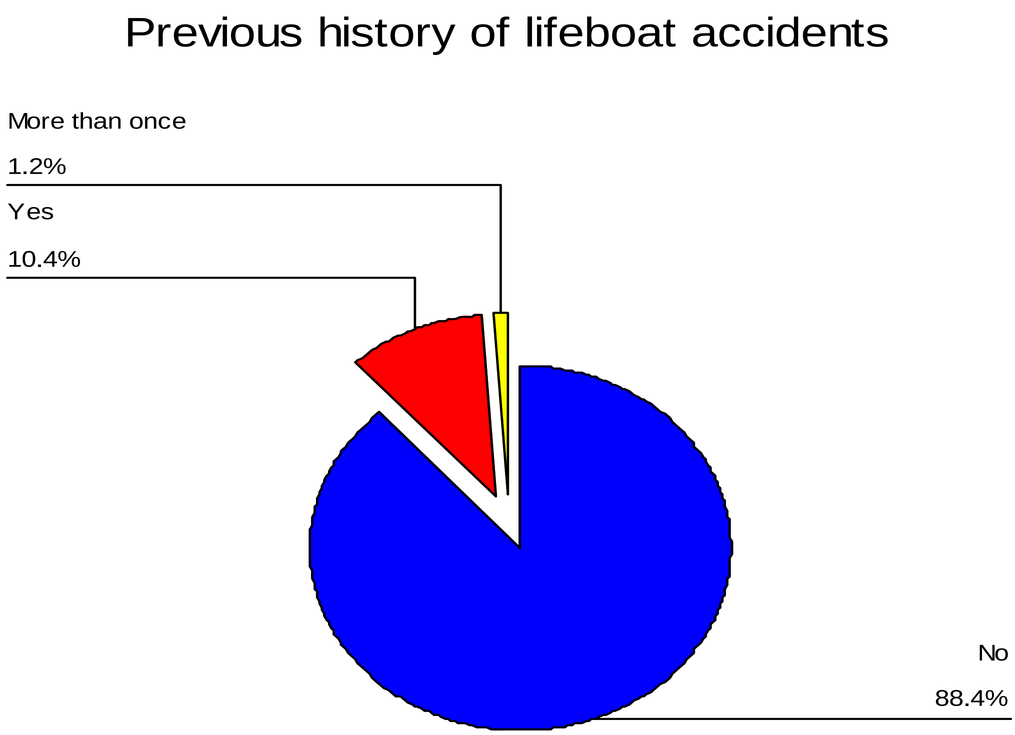
Questions No. 2 & 3: This graph represents the experience level of the respondents. The questionnaire asked for both the amount of time that each respondent had been at sea in a professional capacity and the amount of time with their current company. The graph shows that the majority of seafarers did not stay with one company for their whole career. It may therefore be assumed that they were likely to have come into contact with several different makes and/or designs of lifeboats in the course of their careers at sea.

Fig 8.1.3



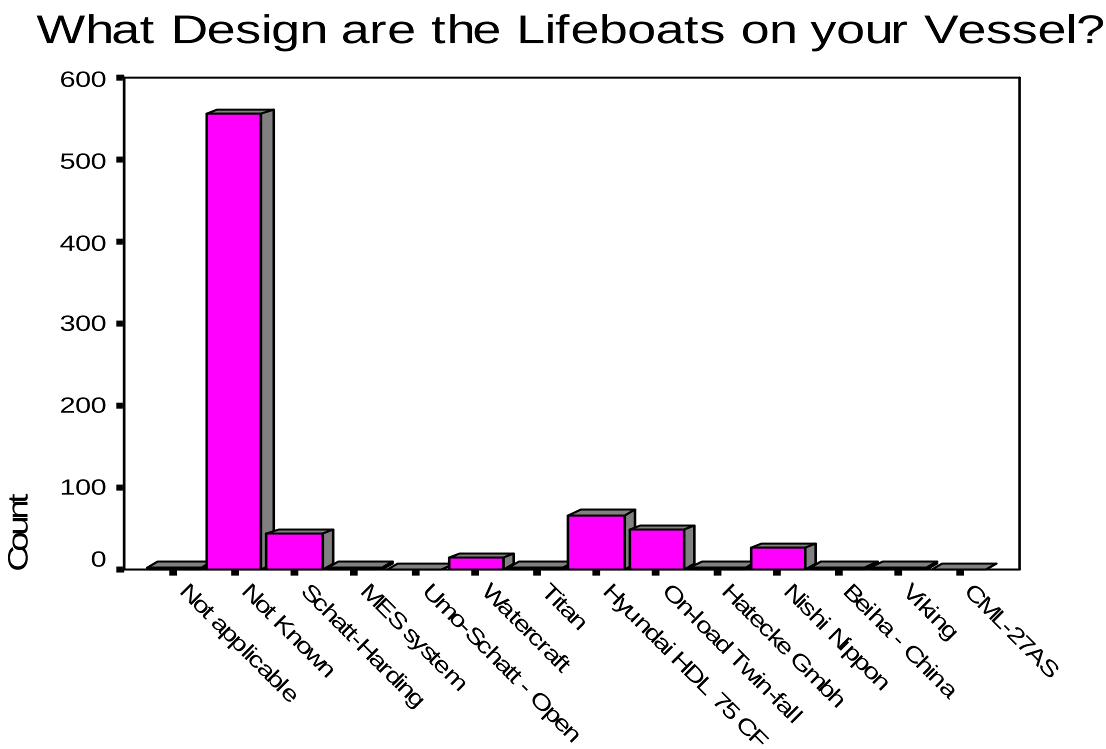
Question No. 4: The majority of responses involved fully-enclosed davit launched lifeboats. As the project was predominantly concerned with davit launched lifeboats this demonstrated that the data collected was consistent with the project.

Fig 8.1.4



Question No. 5: Respondents were queried as to whether they had ever been personally involved in any lifeboat accidents in the past. Where involvement in more than one incident was reported, participants were requested to specify the number of occurrences. The most commonly reported figure was two - although one unlucky respondent reported involvement in no less than five separate accidents involving lifeboats.

Fig 8.1.5



Project question No. 6: The intention of this question was to determine the design of lifeboat (s) that were on the vessel or off-shore installation of each respondent. Unfortunately the question was not clearly worded. The majority of respondents confused this question with question four and gave incorrect answers, e.g. respondents answered 'fully-enclosed davit launched' rather than giving the actual name of the design. Where an incorrect response was received it was entered in the 'Not Known' field.

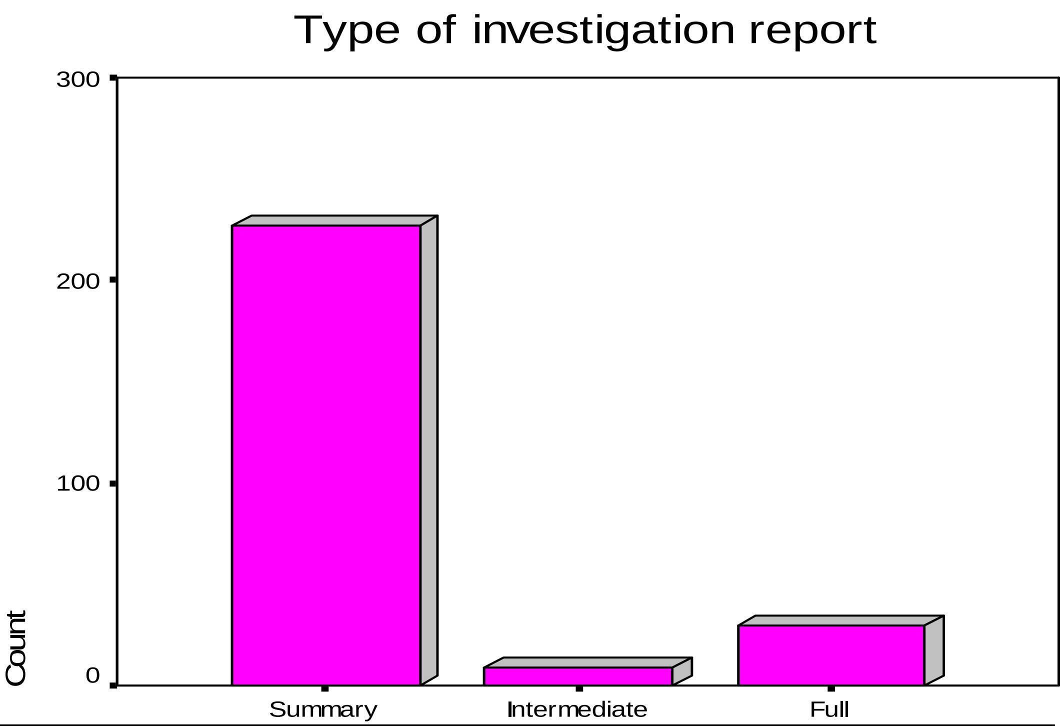
Given the large amount of confusion caused by this question, the data collected could not be regarded as reliable and no conclusions were drawn from it.

8.2 Data Collection - Secondary Data

Secondary data consisted of 266 marine and off-shore industry accident investigation reports gathered from seven countries. This section looks at the details of the accident reports that were used in the analysis. A full summary of all investigation reports analyzed is contained in Appendix III.

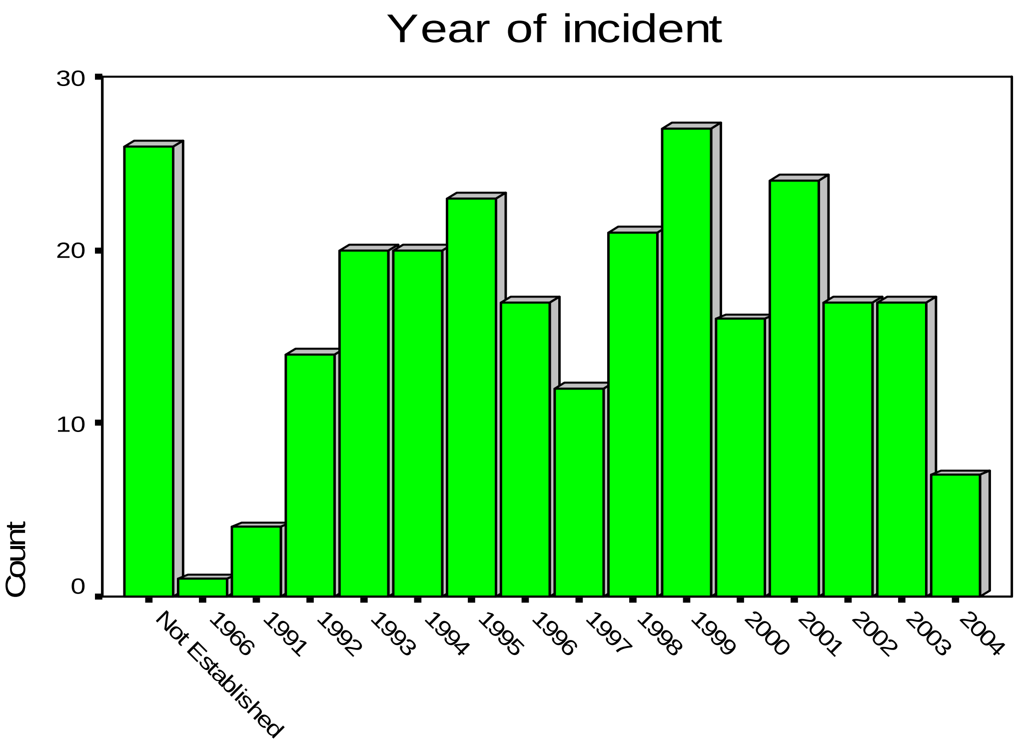
The reports were first separated into three categories dependent on the amount of detail each contained.

Fig 8.2.1



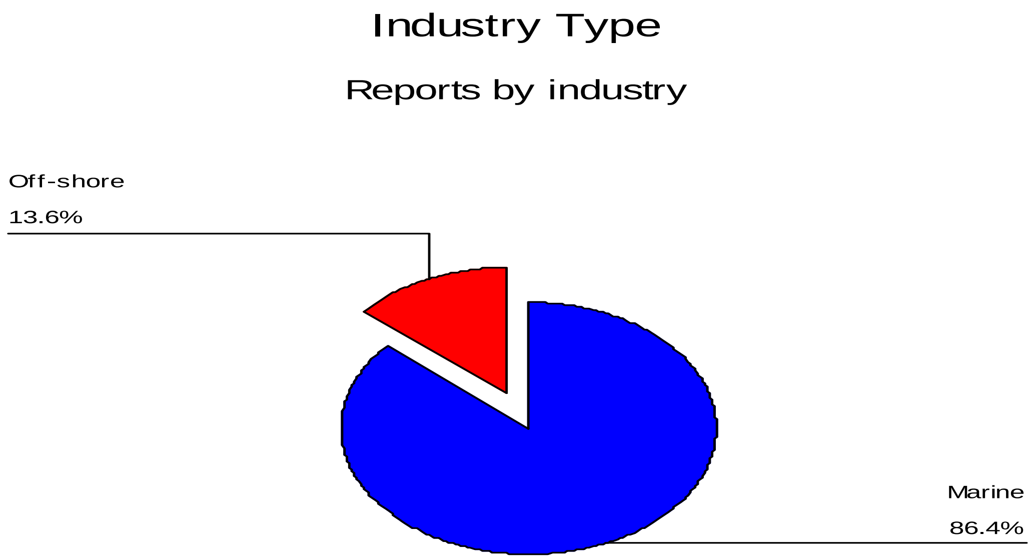
Summary reports: basic accident details with minimal investigation results
Intermediate reports: basic accident details complete with investigation results
Full reports: detailed investigations and analysis of accident cause

Fig 8.2.2



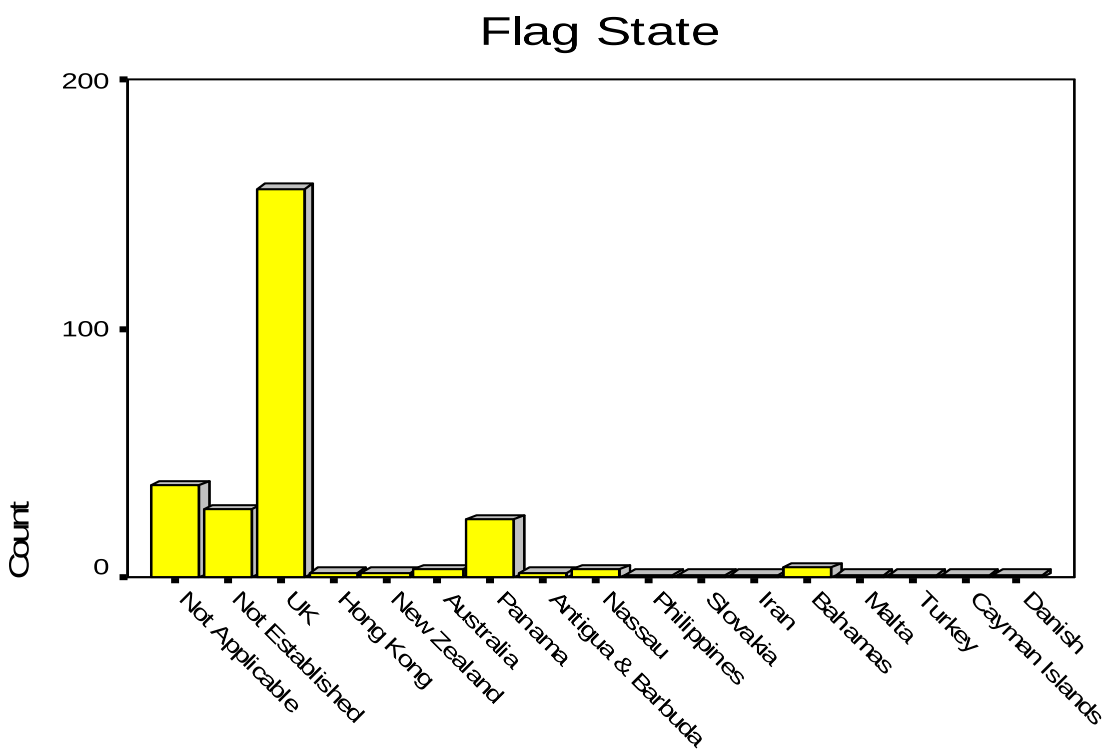
The reports analyzed coved a forty year period; although the majority of cases were from the last fifteen years. The lower incidence of reports in 2004 should not be interpreted as indicative of a reduction in accidents. There were further investigations underway into lifeboat accidents which were unpublished at the time of this paper.

Fig 8.2.3



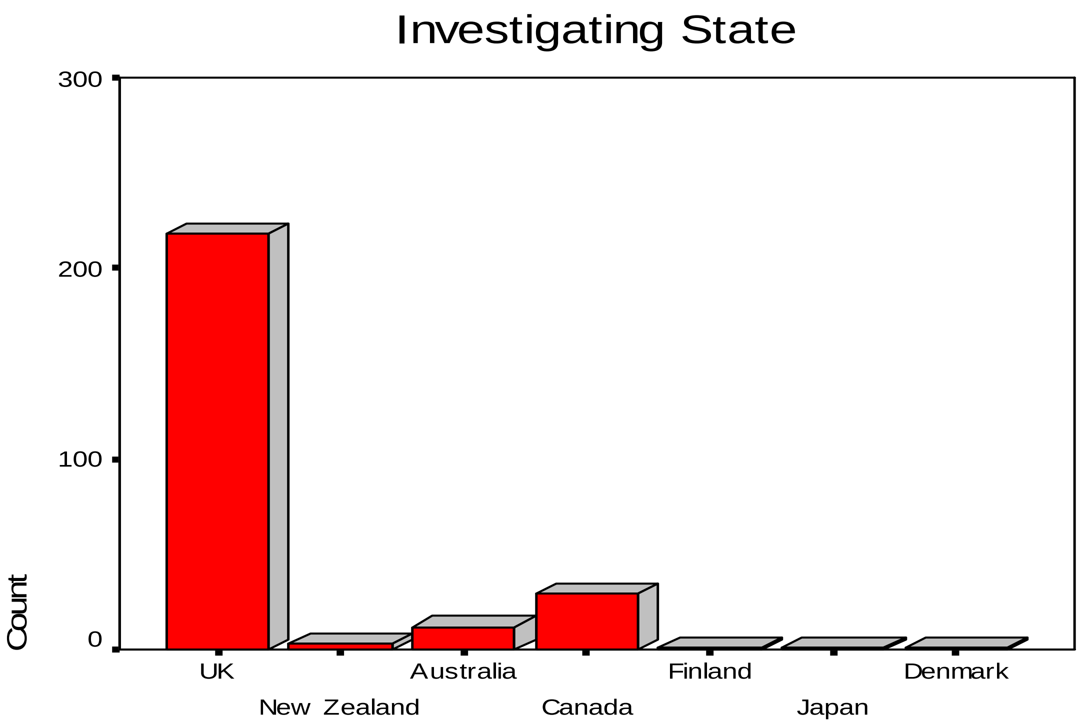
The majority of accident reports were from the marine industry. This would be expected given the number of merchant vessels compared to the number of off-shore installations. It was also more common for merchant vessels to carry davit-launched lifeboats which required more training drills to be conducted than the free-fall type commonly found off-shore. It can be assumed that the more often a lifeboat was required to be operated, the greater the probability of an accident occurring.

Fig 8.2.4



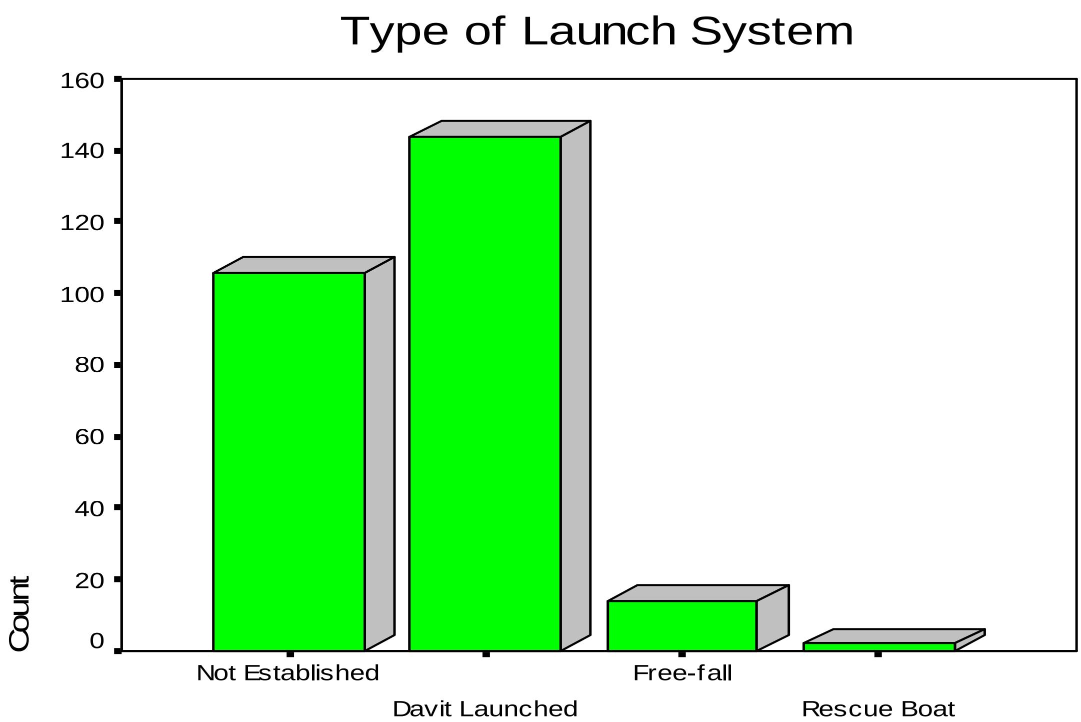
The Flag State is the state under which a vessel is registered. This was not applicable to off-shore installations. Although the chart appears to indicate that the majority of accidents occurred on UK flagged vessels this assumption could not be drawn. This study benefited immensely from assistance from the MAIB and that meant that the majority of the data came from the UK. The data could equally be taken as an indicator of a healthy reporting culture amongst UK vessels.

Fig 8.2.5



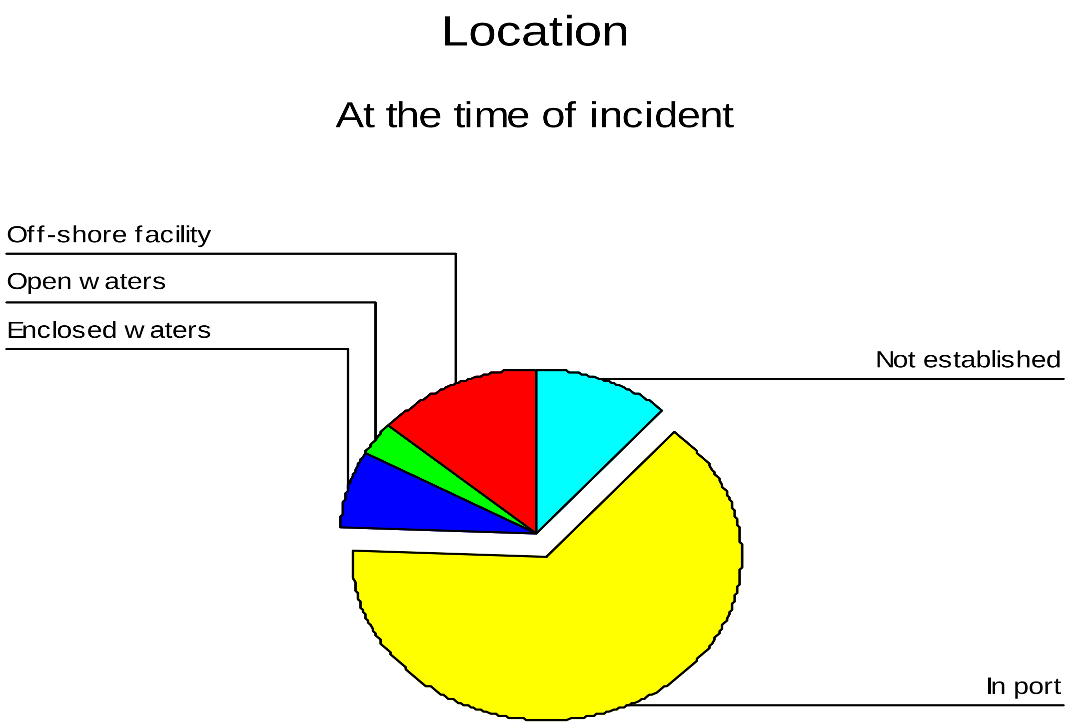
The graph shows the seven states from which investigation reports were received.

Fig 8.2.6



Often the type of lifeboat launch system could not be identified from the investigation reports. Where identification was possible the majority of reports involved davit launched lifeboats. This was consistent with the seafarer's responses to project question No. 4, which queried the type of lifeboats on their vessels.

Fig 8.2.7



The majority of lifeboat accidents/incidents occurred when the vessel was a stable platform in the sheltered waters of a port facility. Even allowing for the fact that the majority of drills are conducted in port, this is a disturbing statistic. Lifeboats are required to provide a means of evacuation on the high seas, where vessel moment, poor visibility, darkness and panic could easily be additional safety hazards. If the majority of accidents occurred in calm waters, what chance do seafarers have of effecting a successful and safe evacuation in adverse conditions?

CHAPTER NINE

9.0 Data Analysis

With the exception of the general data discussed above all data collected was analyzed to test the project's hypotheses.

9.1 Hypothesis One

That a correlation exists between lifeboat design as an established accident cause and the severity of injuries occurring.

The intention of this hypothesis was to discern which failure of the three accident causes investigated, design, training or maintenance, was the cause of the highest severity of injury. The hypothesis put postulated that failures in design were most likely to result in serious injuries. To test the hypothesis, two sets of statistical values were created from the secondary data.

9.2 Hypothesis One - Established Cause

Entering the secondary data into a database enabled the causes of accidents as identified by the investigation reports to be collated. The main cause of accident from each investigation report was recorded.

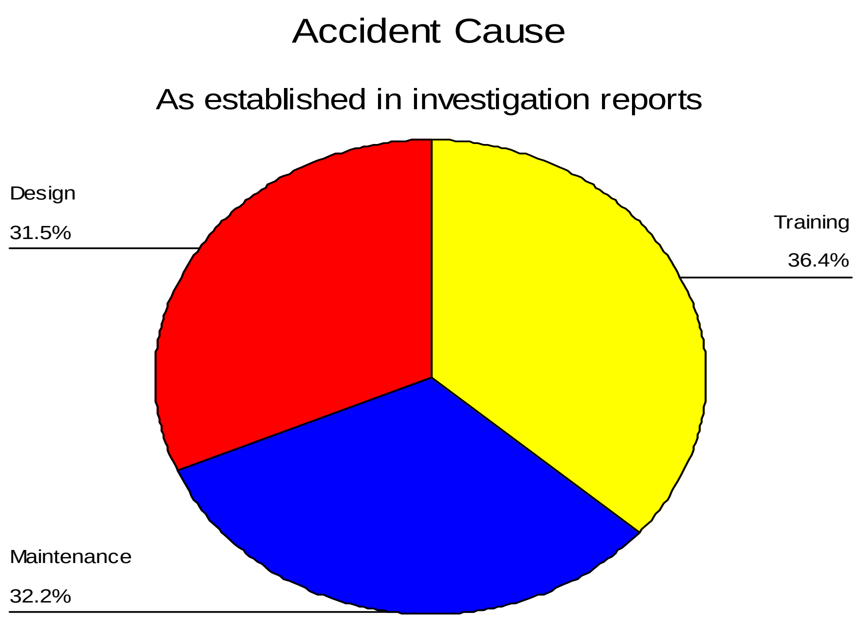
Table 9.2.1

Accident Cause Frequency

Cause	Frequency	Percent
Not Identified	79	29.7
Training	52	19.5
Maintenance	46	17.3
Design	45	16.9
Other	44	16.5
Total	*266*	*100.0*

It was not always possible to clearly allocate the cause to training, maintenance or design. This was due to a number of factors the most common being a lack of information in the summary-level investigation reports. Where the cause was not identified this was entered as such; where the established cause was other than training, maintenance or design, 'Other' was entered. With these variances removed the three primary causes of interest could be displayed.

Fig 9.2.2



9.3 Hypothesis One - Accident Severity

The second set of statistics required was severity ratings for the injuries suffered in each accident. Eight levels of severity were selected ranging from 'near miss' to 'multiple fatalities'.

Table 9.3.1

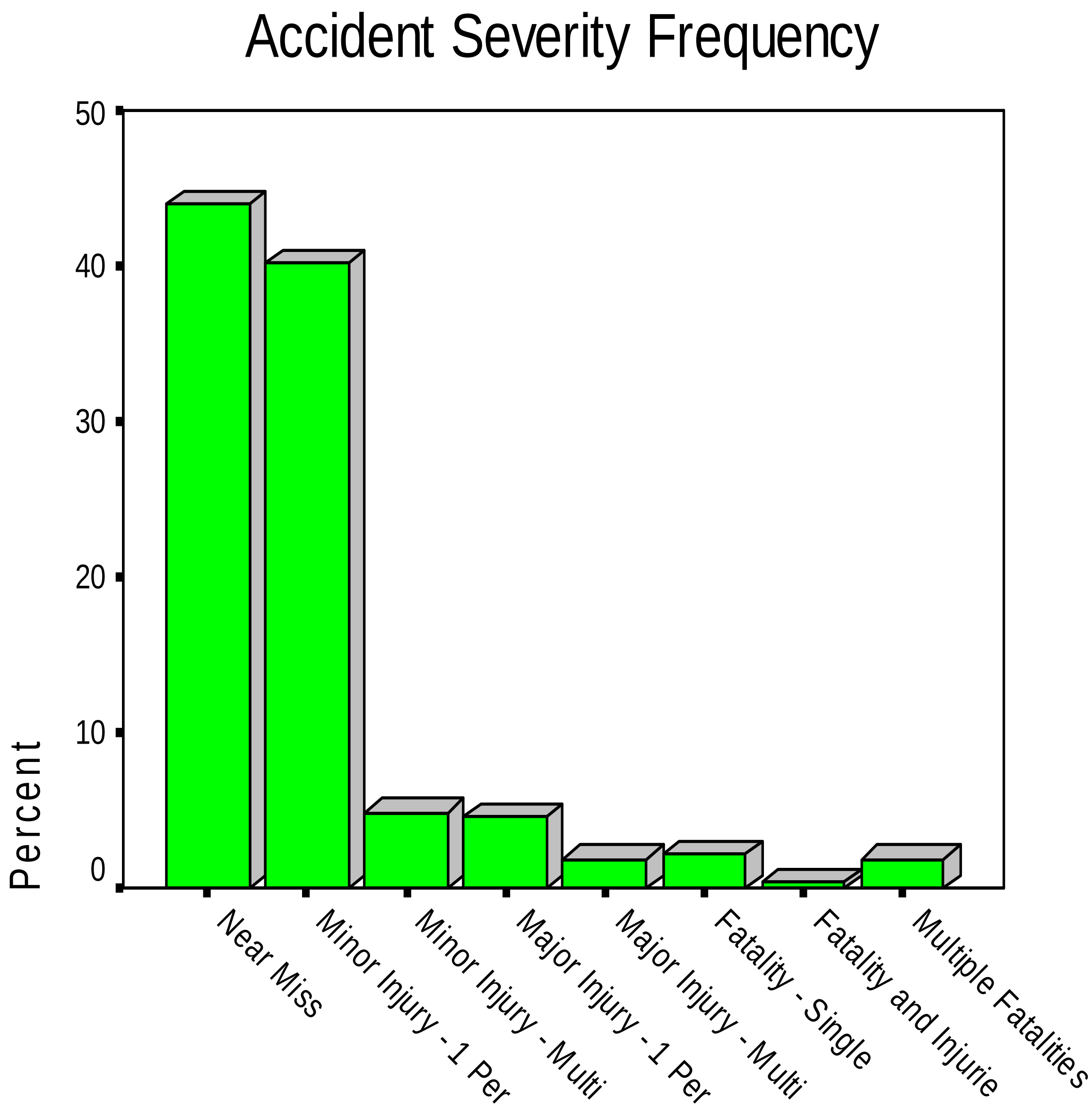
Accident Severity Frequency

Severity	Frequency	Percent
Near Miss	117	44.0
Minor Injury (1 Person)	107	40.2
Minor Injury (Multiple People)	13	4.9
Major Injury (1 Person)	12	4.5
Major Injury (Multiple People)	5	1.9
Fatality (Single)	6	2.3
Fatality and Injury	1	0.4
Multiple Fatalities	5	1.9
Total	*266*	*100.0*

The project was focused on the hazards presented to seafarers from lifeboats and therefore only concerned with injuries to personnel, not damage to ships or lifeboats. Although many of the recorded accidents resulted in fabric damage, where an accident did not result in personal injury this was recorded as a near miss.

The results are presented in graphical format for clarity.

Fig 9.3.2



Once the cause and severity were assigned, the results were cross-tabulated to show the correlation.

Table 9.3.3

Accident Severity Frequency – All Causes

Severity of Accident	Not Established	Training	Maintenance	Design	Other
Near Miss	42	9	26	26	14
Minor Injury (1 Person)	26	32	12	8	29
Minor Injury (Multiple People)	5	2	3	3	0
Major Injury (1 Person)	4	3	2	3	0
Major Injury (Multiple People)	0	2	1	2	0
Fatality (Single)	2	1	2	0	1
Fatality and Injury	0	1	0	0	0
Multiple Fatalities	0	2	0	3	0
Total	*79*	*52*	*46*	*45*	*44*

As the project was primarily concerned with injuries occurring from design, maintenance and training, the results were simplified for analysis by removing the 'Not Established' and 'Other' data.

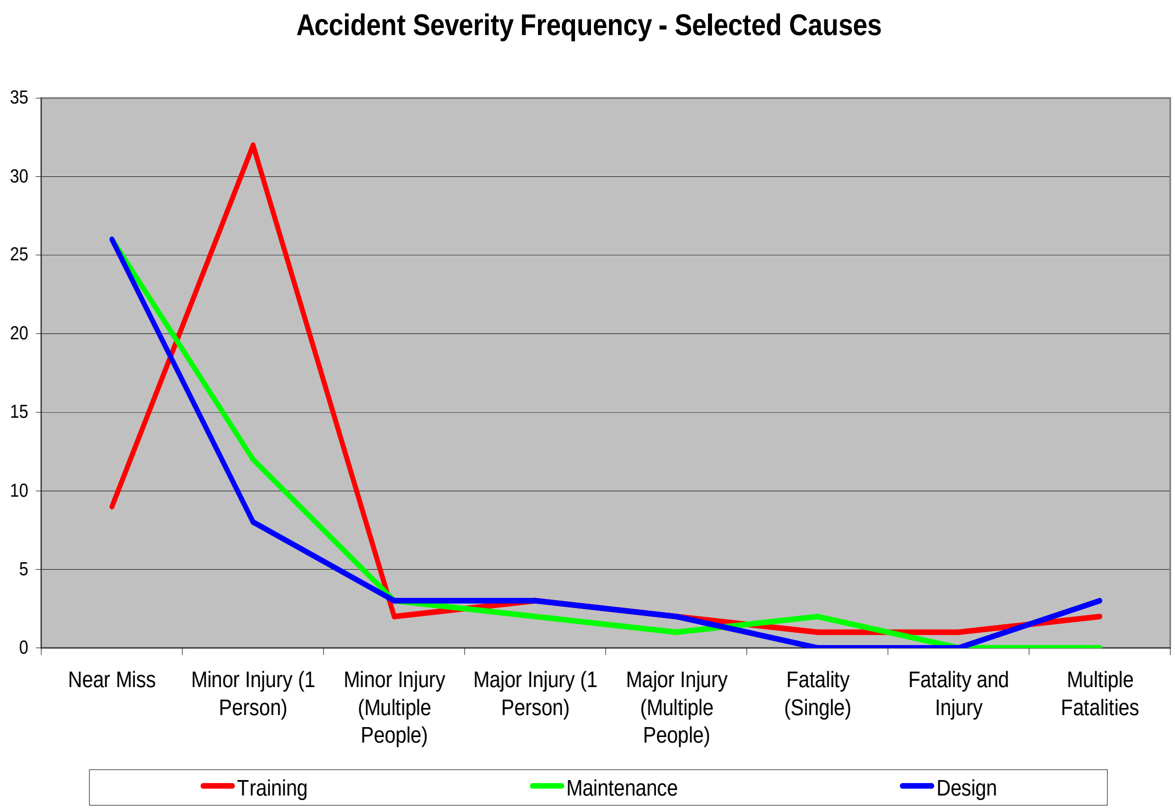
Table 9.3.4

Accident Severity Frequency – Selected Causes

Severity of Accident	Training	Maintenance	Design
Near Miss	9	26	26
Minor Injury (1 Person)	32	12	8
Minor Injury (Multiple People)	2	3	3
Major Injury (1 Person)	3	2	3
Major Injury (Multiple People)	2	1	2
Fatality (Single)	1	2	0
Fatality and Injury	1	0	0
Multiple Fatalities	2	0	3
Total	*52*	*46*	*45*

The results are shown in graphical format for clarity.

Fig 9.3.5



9.4 Hypothesis One – Final Conclusion

The hypothesis was intended to test the relationship between accident cause and severity of injuries that resulted. The data clearly showed the majority of minor injuries were caused by failures in training. However as the severity of the injuries increased the analysis showed a statistically insignificant difference between the severity of injuries caused by training, maintenance and design. Given these results it was not possible to state with any degree of confidence which of the three areas was the primary cause of major injuries. Therefore hypothesis one was regarded as being unproven.

Fig 9.4.1

Photo credit: Tim Lee

Fully enclosed davit-launched ship's lifeboat

CHAPTER TEN

10.0 Hypothesis Two

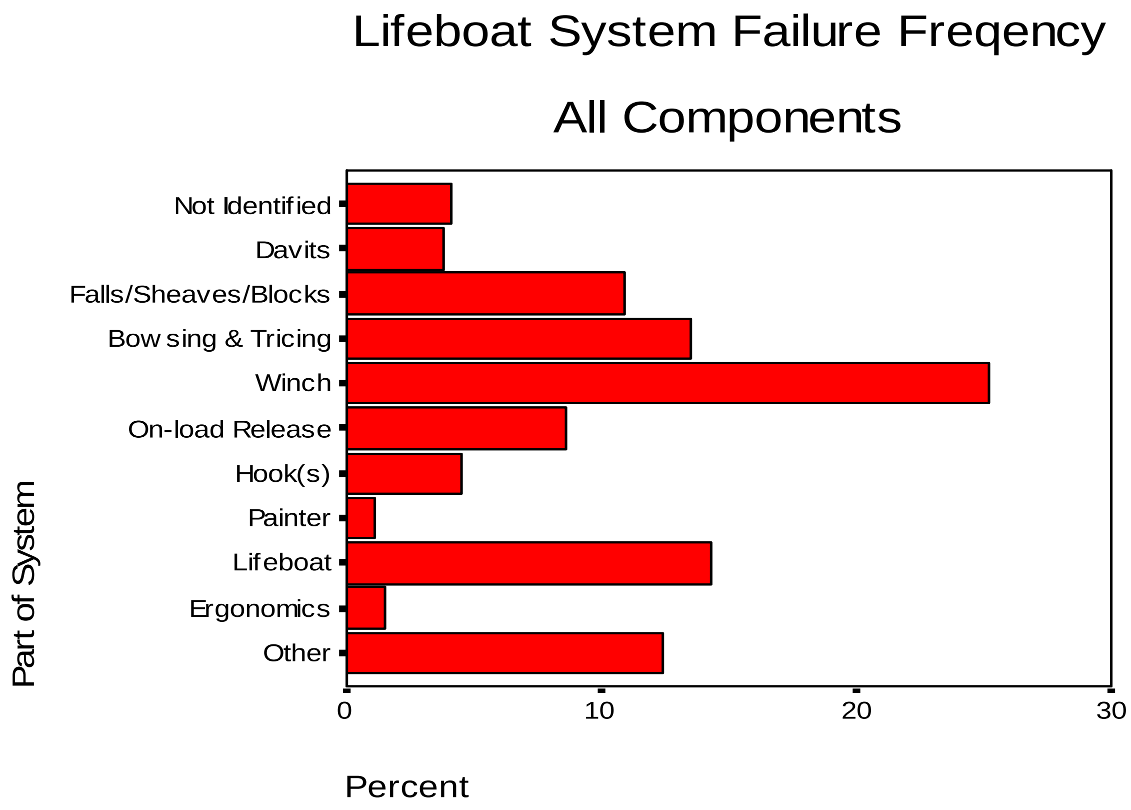
> *That seafarers' perceptions of the hazards presented by lifeboats, and their associated systems, will be graded in the same order as those apparent from incident reports.*

The intention of this hypothesis was to grade and compare the most hazardous lifeboat components and operations, identified in investigation reports, with the seafarer's perceptions of the same hazards.

This section was split into two parts, firstly to address component hazards and secondly to analyze specific operational hazards. All data are shown as percentages; to allow for the disparity in the number of investigation reports compared to questionnaire responses.

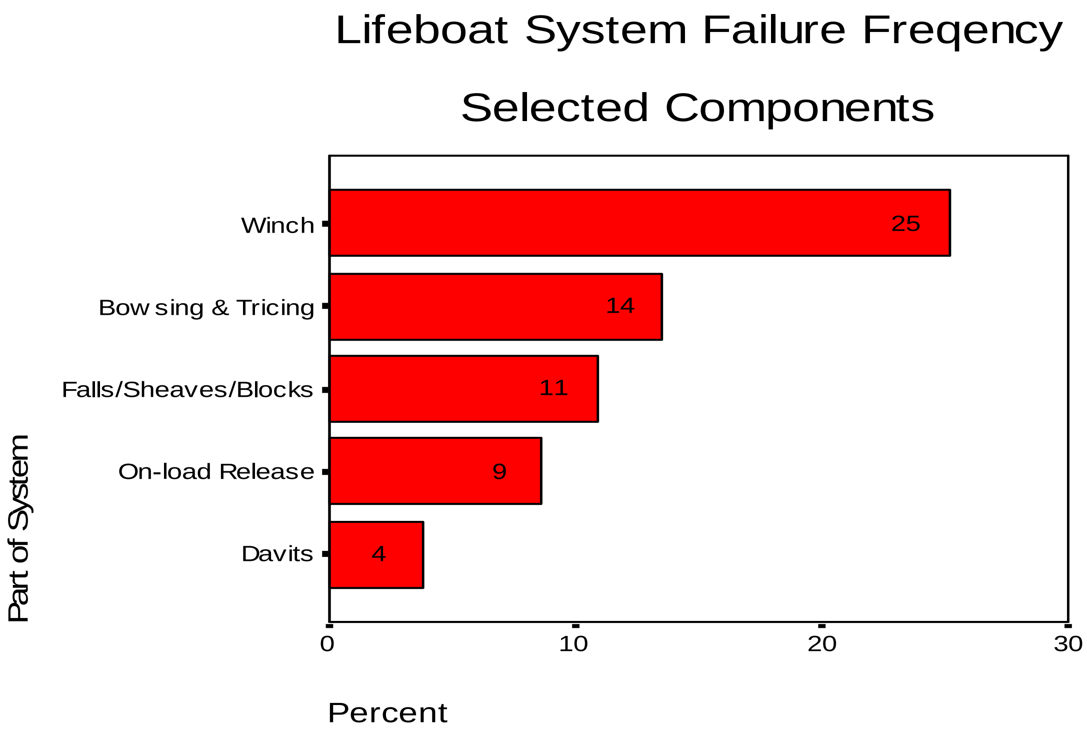
10.1 Hypothesis Two - Lifeboat Components

Fig 10.1.1



Lifeboat systems are made up of many components, any one of which may cause an accident through failure. The investigation reports identified a wide range of accidents caused by component failure. However given the limited scope of this project, and the need to keep the questionnaire within reasonable boundaries, the decision was made to focus on five major components. The graph for the selected components is abstracted from Figure 10.1.1 and shown below for clarity (Figure 10.1.2)

Fig 10.1.2



Once the main component hazards were identified from the investigation reports, a similar grading was established from the project questionnaire data.

Question No. 14

14. Please indicate how safe you consider each item to be (each number may be used multiple times). Rating system: 0 = Not Applicable, 1 = Very Safe, 2 = Safe, 3 = No Opinion, 4 = Unsafe, 5 = Very Unsafe	
On-Load release hooks	
Winch mechanisms	
Bowsing and tricing systems	
Falls, sheaves and blocks	
Davit arrangements	

The question gave the option of 'Not Applicable' as not all components are necessarily on all designs of lifeboats.

The responses to each section of the component question are shown in full for clarity.

Fig 10.1.3

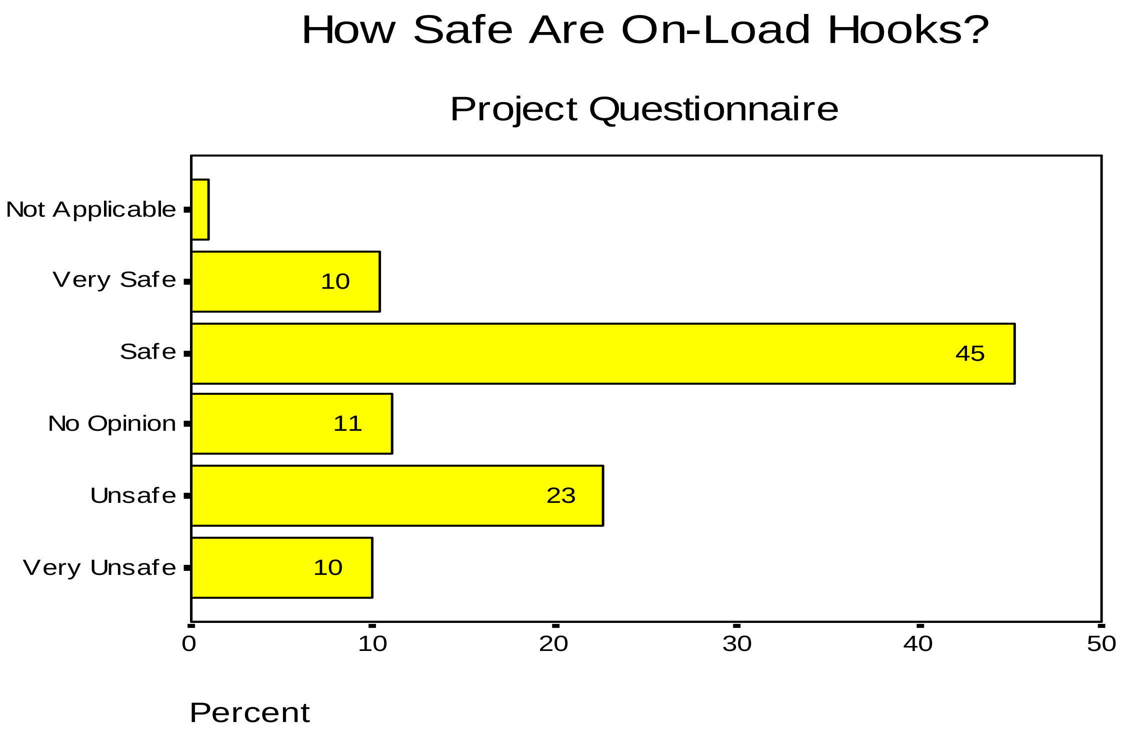


Fig 10.1.4

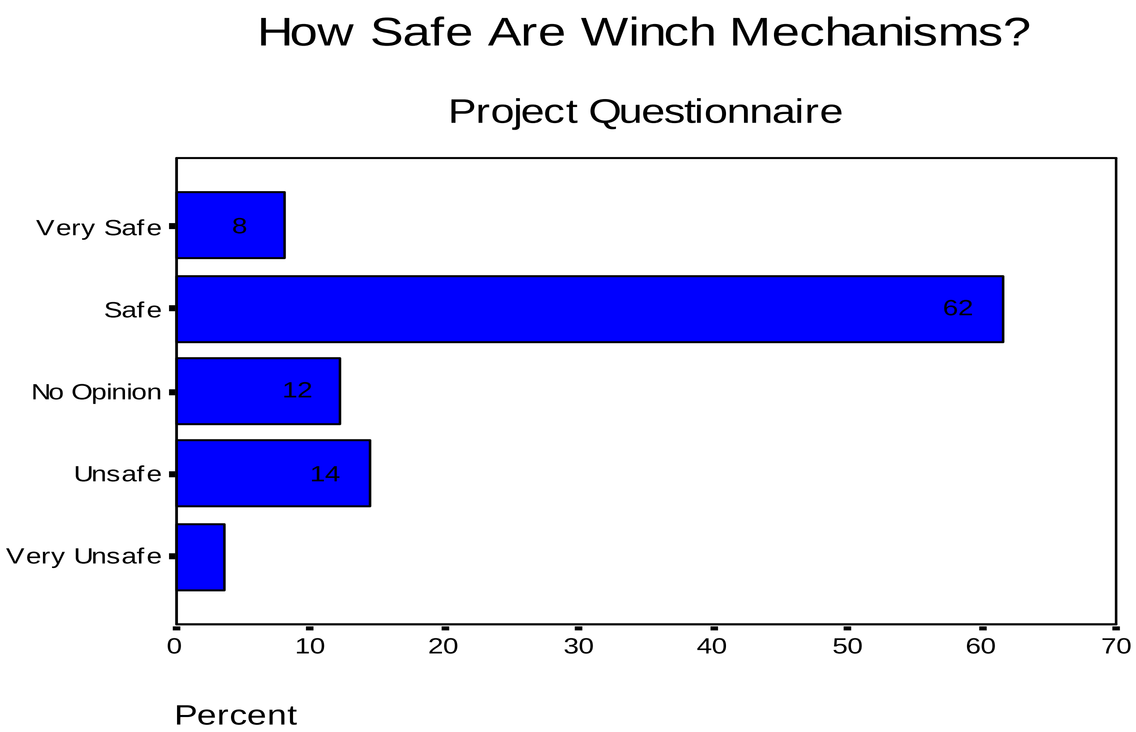


Fig 10.1.5

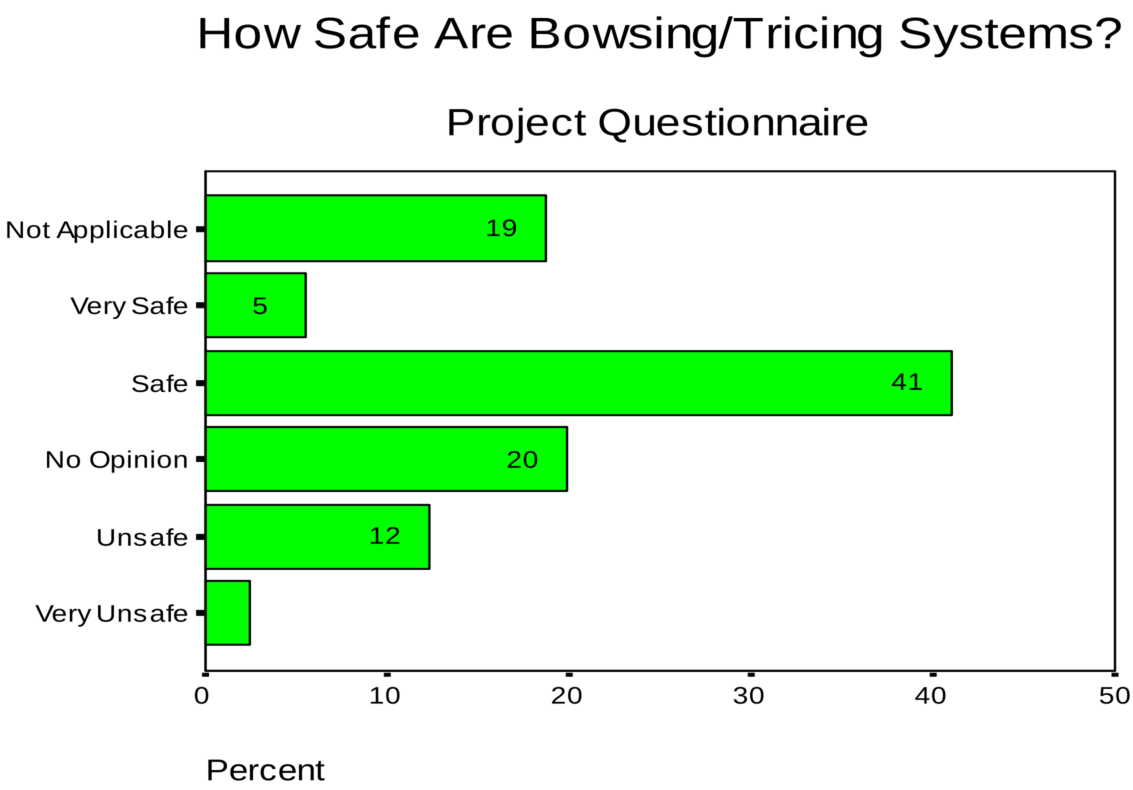


Fig 10.1.6

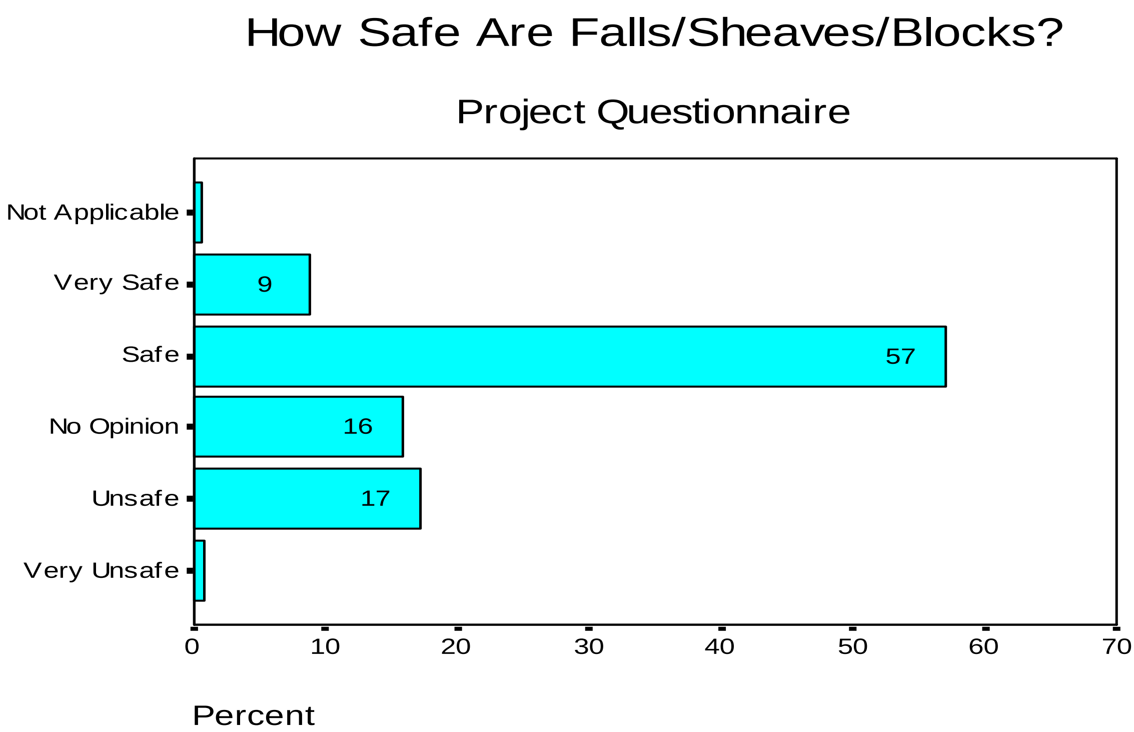
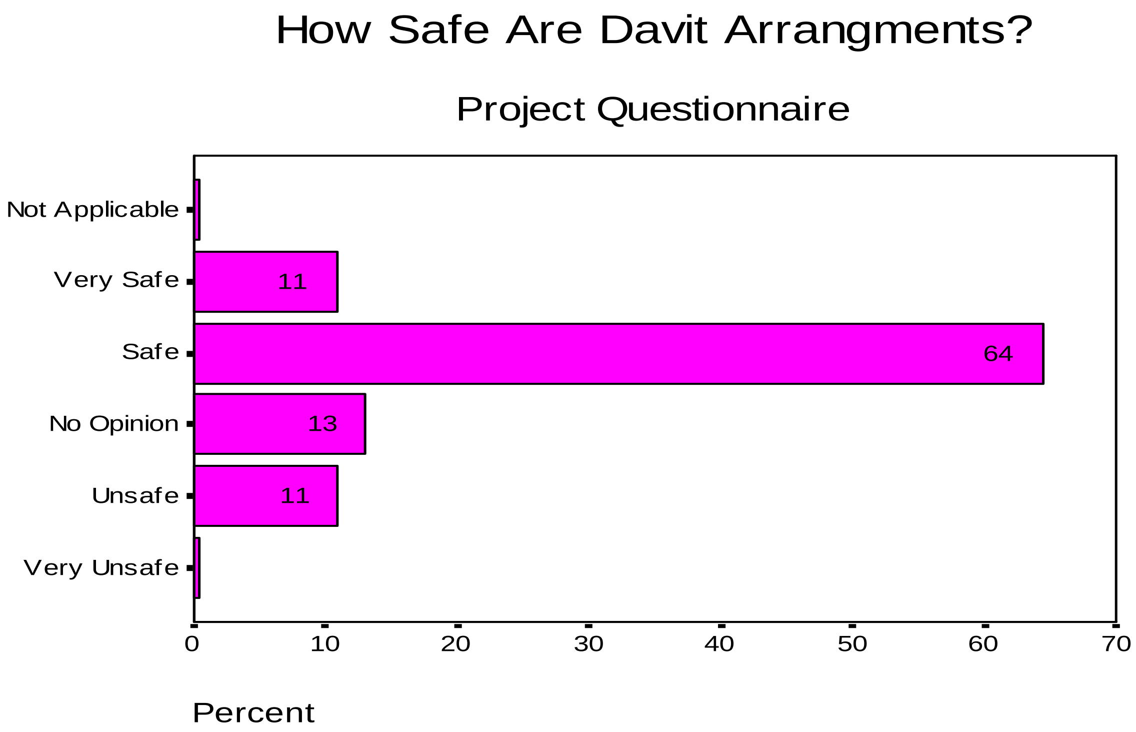


Fig 10.1.7



The responses showed that the general perception towards lifeboat component hazard levels was positive. However, the hypothesis intended to compare seafarers' hazard judgements against the established hazard levels. Therefore the project was primarily interested in responses in the 'Unsafe' and 'Very Unsafe' categories. The percentages of responses in these categories were added to give the total seafarers' hazard perception rating.

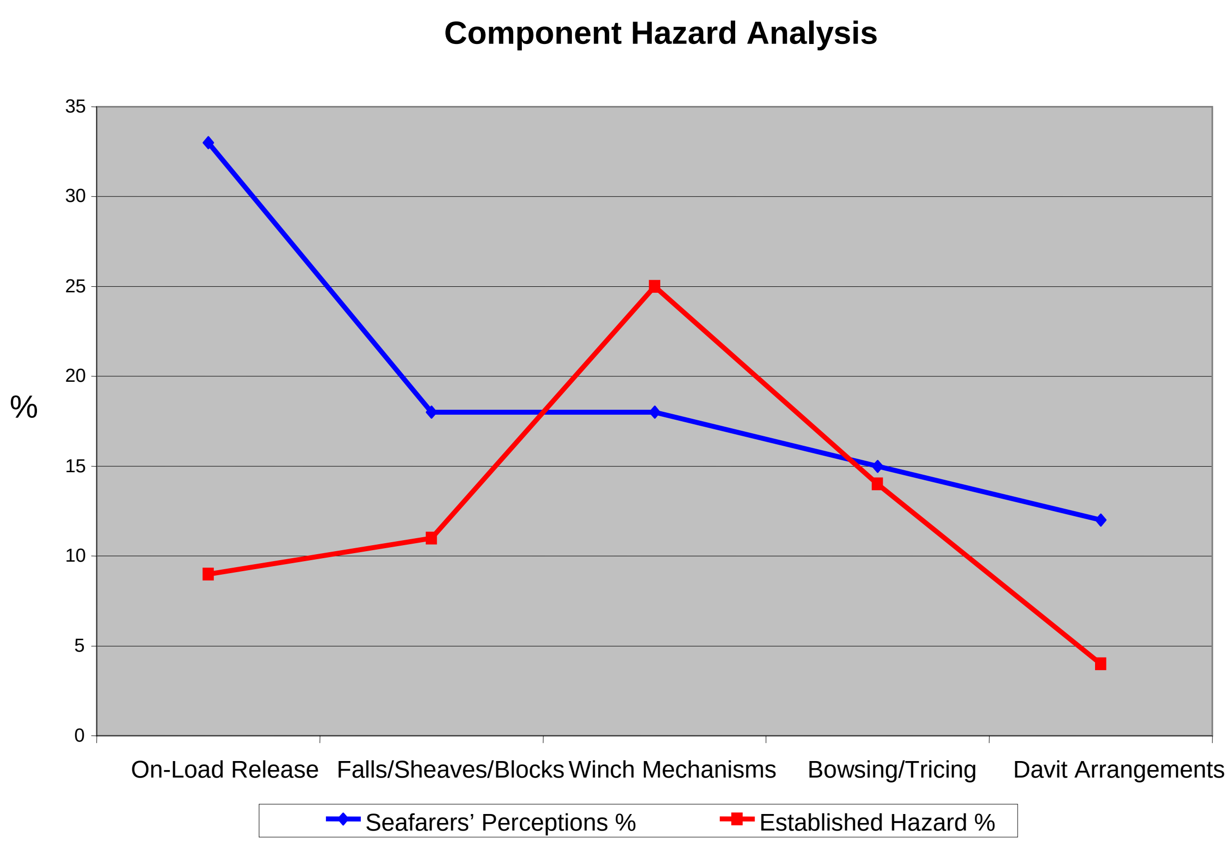
Table 10.1.8

Component Hazard Perception Analysis

Component	% Hazard Perception Rating
On-Load Release Hooks	33%
Falls / Sheaves / Blocks	18%
Winch Mechanisms	18%
Bowsing / Tricing	15%
Davit Arrangements	12%

These figures were then compared to the data collected from the investigation reports in order to test the hypothesis.

Fig 10.1.9



10.2 Hypothesis Two - Component Conclusion

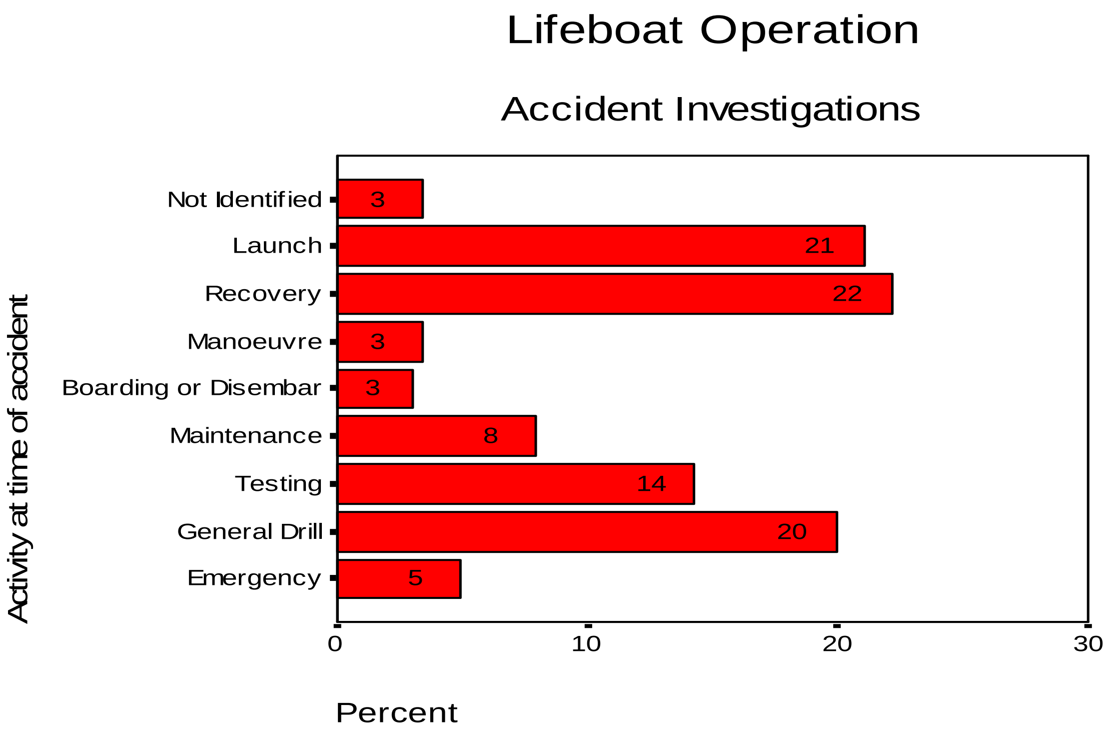
The analysis clearly showed the seafarers' perceptions of the hazards presented by lifeboat components did not match the actual hazards identified from the investigation reports. The greatest disparity was with the on-load release hooks which were considered by seafarers to pose a significantly greater hazard than they actually did. Conversely the seafarers' judgement of the relatively minor hazard posed by winch systems was at odds with the number of accidents caused by this component.

The hypothesis postulated that the identified hazards and the seafarers' perceptions would be graded the same. The analysis results concur with the hypothesis for Davit Arrangements, Bowsing and Tricing; and Falls, Sheaves and Blocks. A discrepancy exists between Winch Mechanisms and, most interestingly, On-Load Release Hooks. Given the differences between the established component hazards and the seafarers' perceptions it was concluded that, insofar as lifeboat components were concerned, hypothesis two must be considered unproven.

10.3 Hypothesis Two - Lifeboat Operations

This section of hypothesis two looked at the hazards present in lifeboat operations. The same methods were used as in Section 10.1.

Fig 10.3.1



Investigation reports identified a wide range of operational activities at the time of the accidents. Again however, given the limited scope of this project, and the need to keep the questionnaire within reasonable boundaries, the decision was made to focus on four major operations.

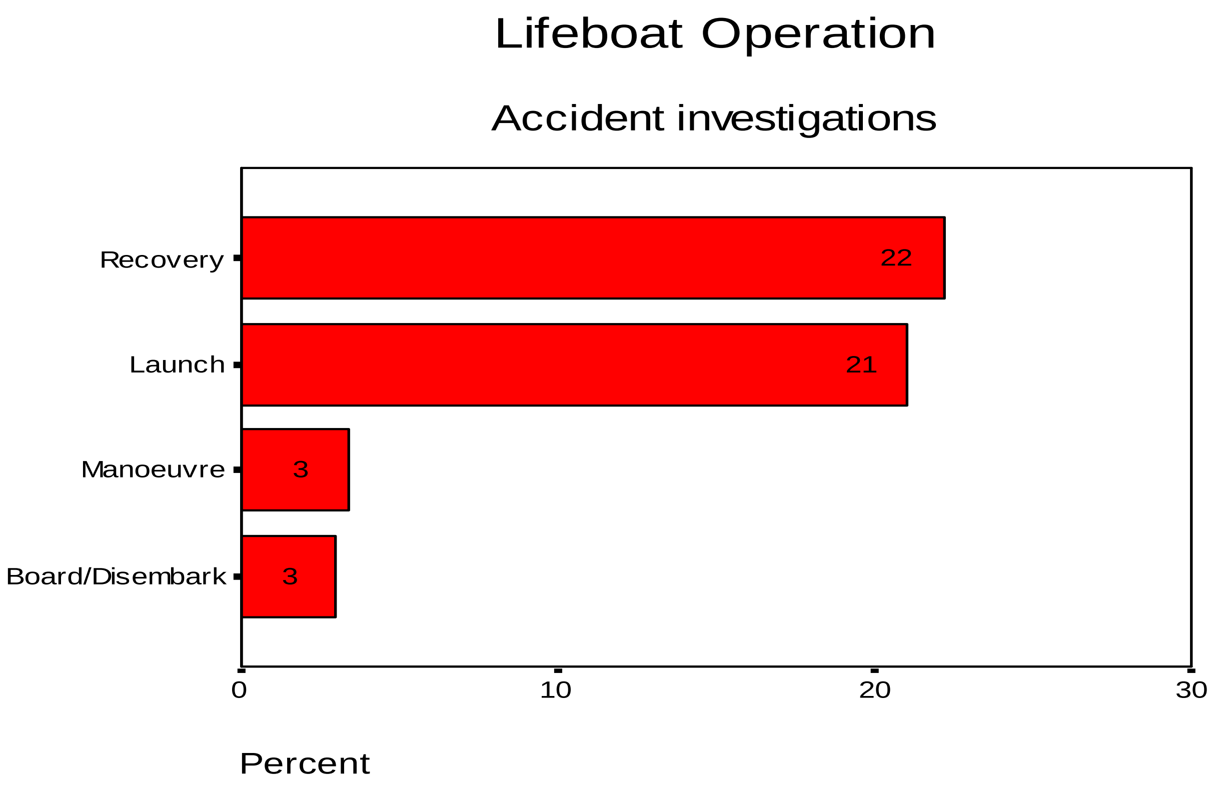
Seafarers were not asked for their perceptions concerning lifeboat testing and emergencies as those situations were felt to be out of the seafarers' control and beyond the normal scope of shipboard activities. In retrospect, given the high incidence of accidents involving lifeboat testing, this would have been an interesting area to have included.

The issue of maintenance was considered too large to enable a balanced record of views to be gained from the necessarily small project questionnaire. Although maintenance questions were asked, they were aimed more at testing hypothesis three.

Although general drills featured as a major accident cause, secondary data was only put into this section when it was not possible to determine the exact operation at the time of the incident. Data relating to general drills was considered too vague to be analyzed in this section and was addressed as part of hypothesis three.

Given the above factors the four operational activities chosen were recovery, launch, manoeuvre and boarding/disembarking. The graph for these operations was abstracted from Figure 10.3.1 and shown below for greater clarity.

Fig 10.3.2



The project questionnaire data was analysed with the four operational hazards selected from the investigation reports.

Question No. 13.

Q13. Please indicate how safe you consider each exercise to be (each number may be used multiple times). **Rating system: 0 = Not Applicable, 1 = Very Safe, 2 = Safe, 3 = No Opinion, 4 = Unsafe, 5 = Very Unsafe**	
Launching lifeboats	
Recovering lifeboats	
Bowsing and tricing of lifeboats	
Boarding and exiting of lifeboats	
Manoeuvring of lifeboats	

The question gave the option of 'Not Applicable' as, in the case of free-fall lifeboats, not all operations are conducted on each vessel or off-shore installation. Although the question polled seafarers for their perceptions towards bowsing and tricing operations, no significant secondary data could be gained from the investigation reports and a comparison could not be made. Therefore the bowsing and tricing section of Question 13 were not included in the analysis.

Responses to each section of the operational question are shown in full for clarity.

Fig 10.3.3

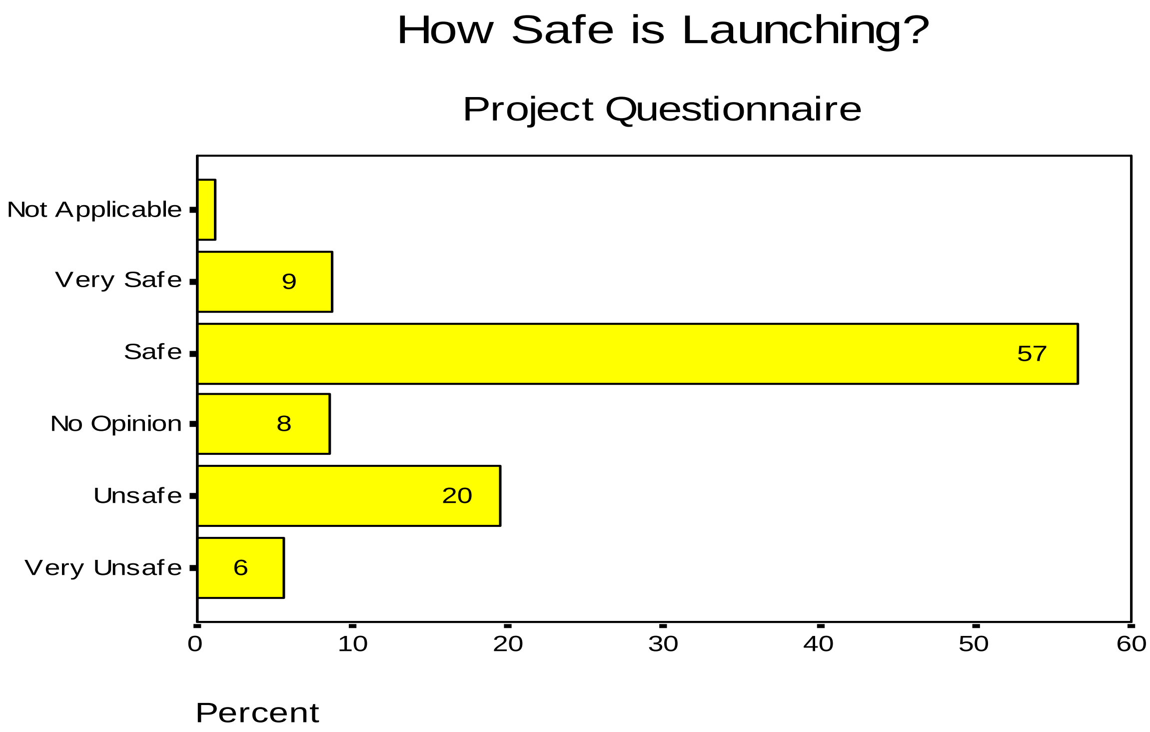


Fig 10.3.4

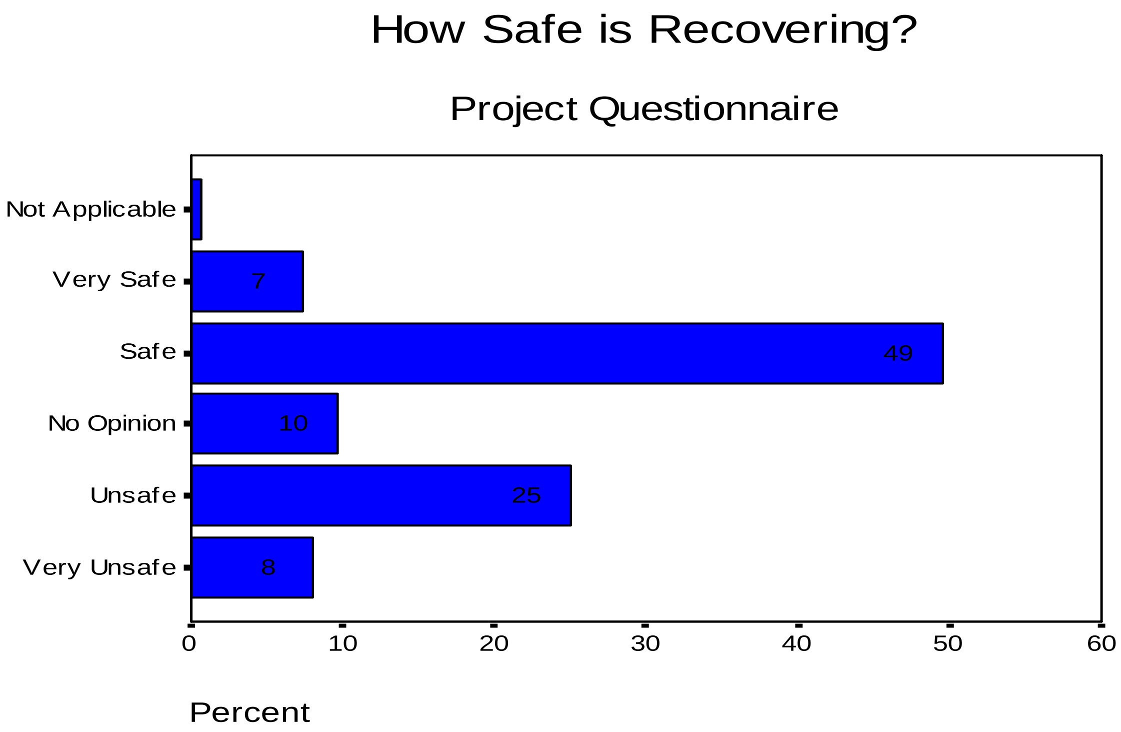


Fig 10.3.5

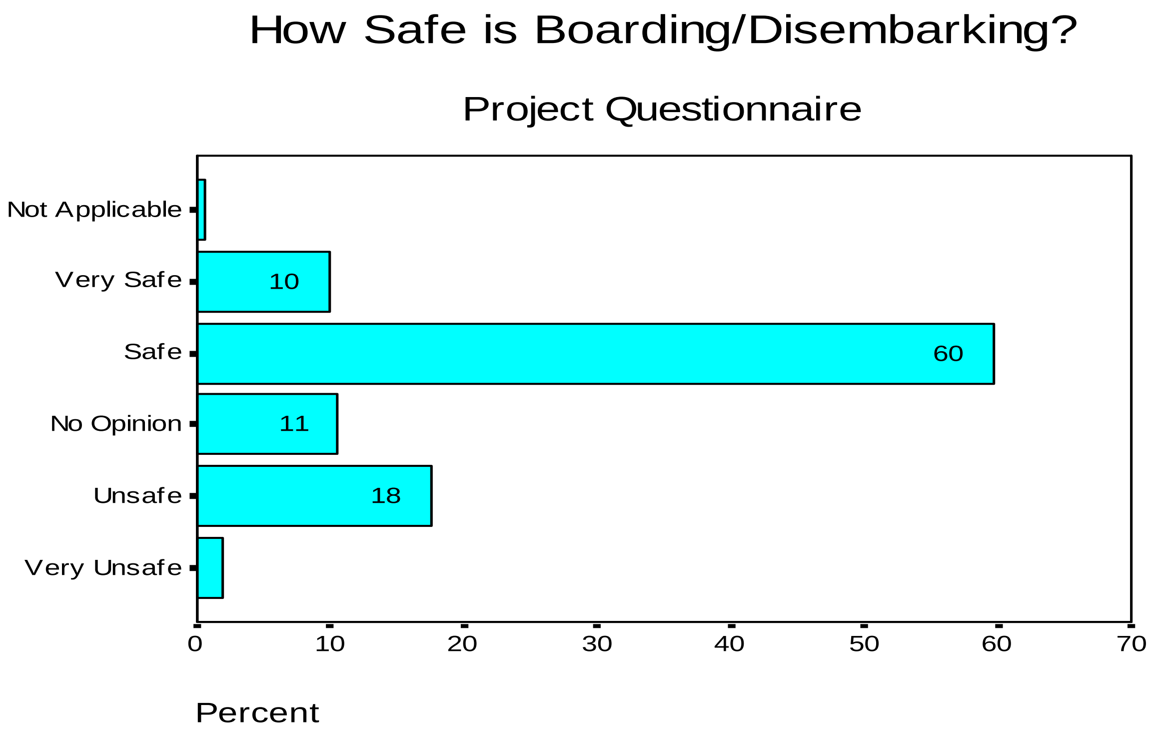
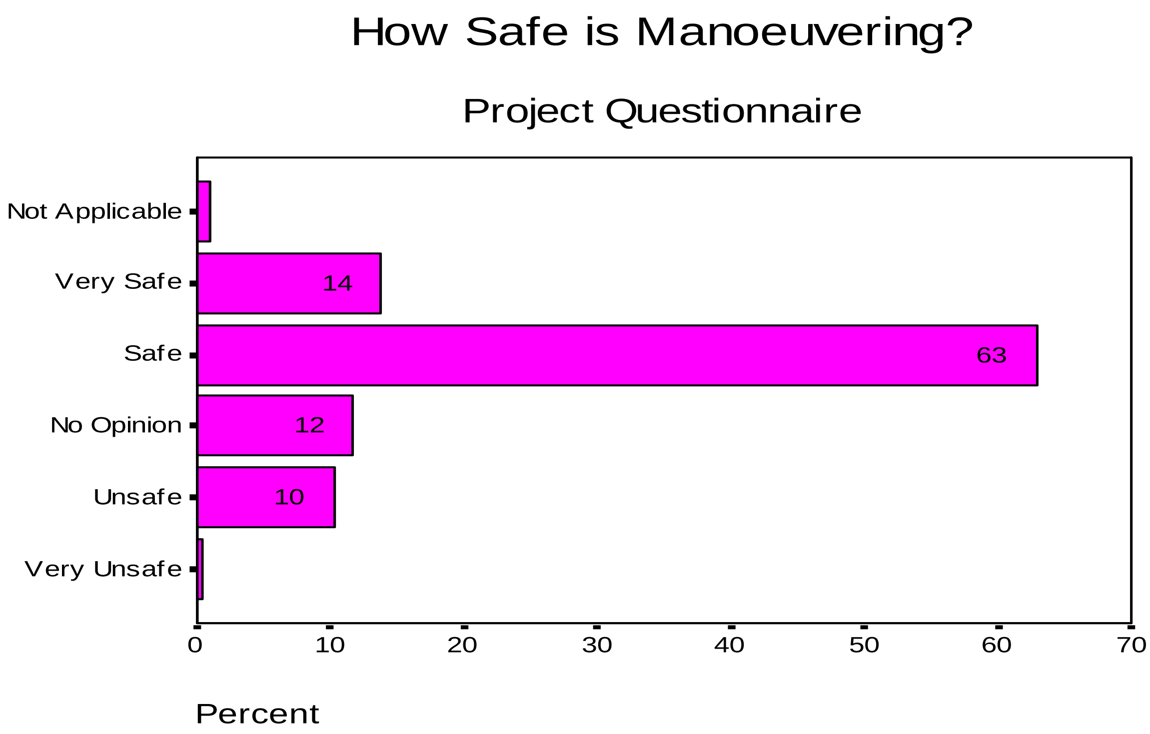


Fig 10.3.6



The responses showed the general feeling about lifeboat operational hazard levels was positive. However, the hypothesis intended to compare seafarers' hazard perceptions against the established hazard levels. Therefore the project was primarily interested in the responses from the 'Unsafe' and 'Very Unsafe' categories. The percentages of responses in these categories were added to give the total seafarers' hazard perception ratings.

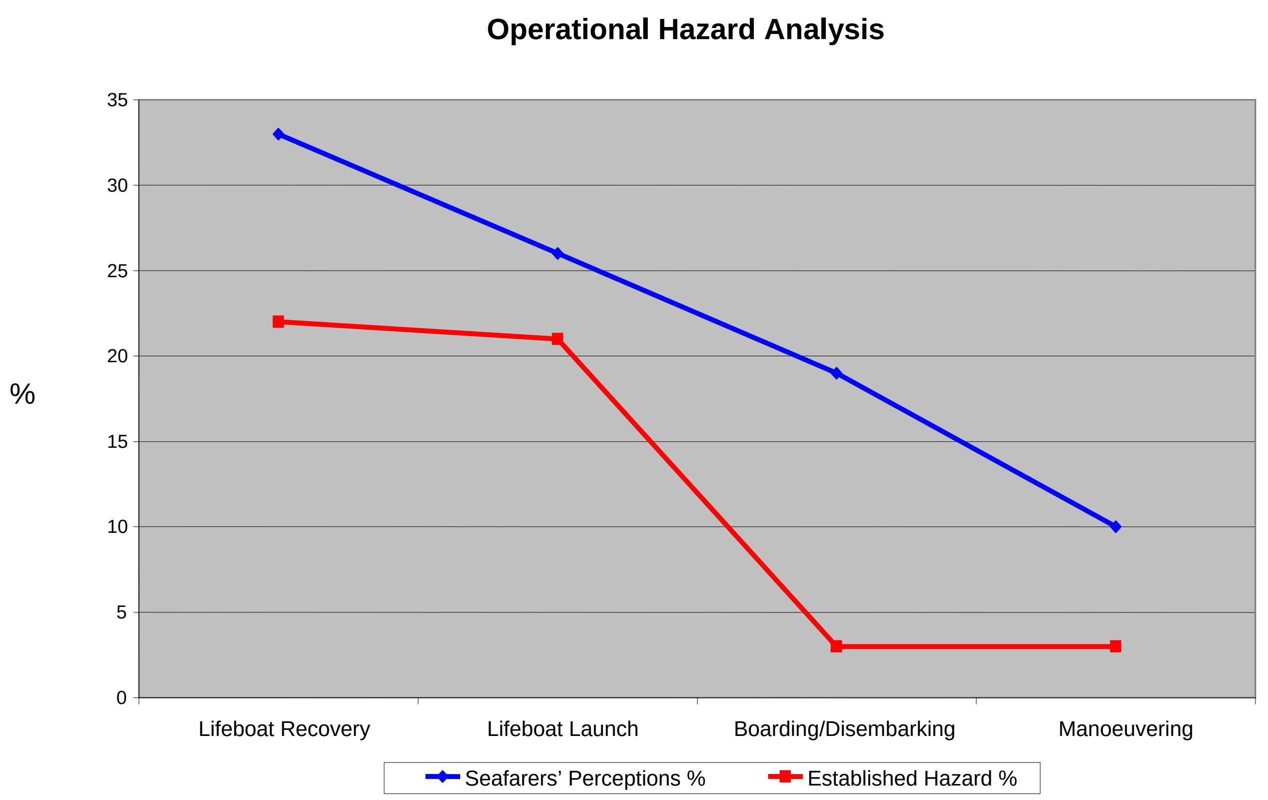
Table 10.3.7

Operational Hazard Perception Analysis

Operation	% Hazard Perception Rating
Lifeboat Recovery	33%
Lifeboat Launching	26%
Lifeboat Boarding/Disembarking	19%
Lifeboat Manoeuvring	10%

These figures were compared to the data collected from the investigation reports in order to test the hypothesis.

Fig 10.3.8



10.4 Hypothesis Two - Operational Conclusion

The analysis showed the seafarers' view of the hazards presented by lifeboat operations were graded in the same order as the actual hazards identified from investigation reports. Despite the similarity in grading, the seafarers' perceptions of the hazards involved were consistently higher than the established hazard levels. This was particularly noticeable for recovery of lifeboats and boarding/ disembarking from lifeboats. Given the large number of accidents that have occurred during lifeboat recovery it was understandable that hazard perception in this area would tend to be high. It was not so easy to understand the disparity in judgement about a relatively small hazard like boarding and disembarking.

Given the similarities between the established operational hazards and the seafarer's perceptions it was concluded that, insofar as lifeboat operations were concerned, hypothesis two was proven.

10.5 Hypothesis Two – Final Conclusions

Hypothesis two was intended to test if the feelings of seafarers towards the hazards presented by lifeboats were compatible with the actual hazard levels determined from accident investigation reports. The first section analyzed component hazards. The results showed the seafarers' judgements did not agree with the actual hazard levels present. The second section looked at operational hazards, where the seafarers' perceptions and the actual hazard levels were compatible.

Given the different results from the two sections it was concluded that the testing of hypothesis two was inconclusive.

What has been established is that the seafarers' perceptions of the hazards presented by lifeboats, with the exception of winch systems, are consistently greater than the actual hazards themselves.

CHAPTER ELEVEN

11.0 Hypothesis Three

That the perception of seafarers' will be that ship's lifeboats, and their associated systems, are fit for purpose.

This hypothesis utilized primary data from the project questionnaire to establish the feelings of seafarers regarding whether ship's lifeboats were fit for purpose. Questions were asked on the suitability of lifeboats for use as man-overboard rescue boats, the necessity of lifeboats and the level of complexity of lifeboat systems. Seafarers were questioned as to whether they considered lifeboats to represent outdated technology in the modern marine industry and whether further research into alternative evacuation methods was desirable.

Respondent's answers relating to the safety of general lifeboat drills by seafarers involved in actually conducting the drills, and those who only participated, were also analyzed.

11.1 Hypothesis Three - Necessity of Lifeboats

The following four questions tested the seafarer's perceptions of the usefulness and need for ship's lifeboats.

Question No. 7

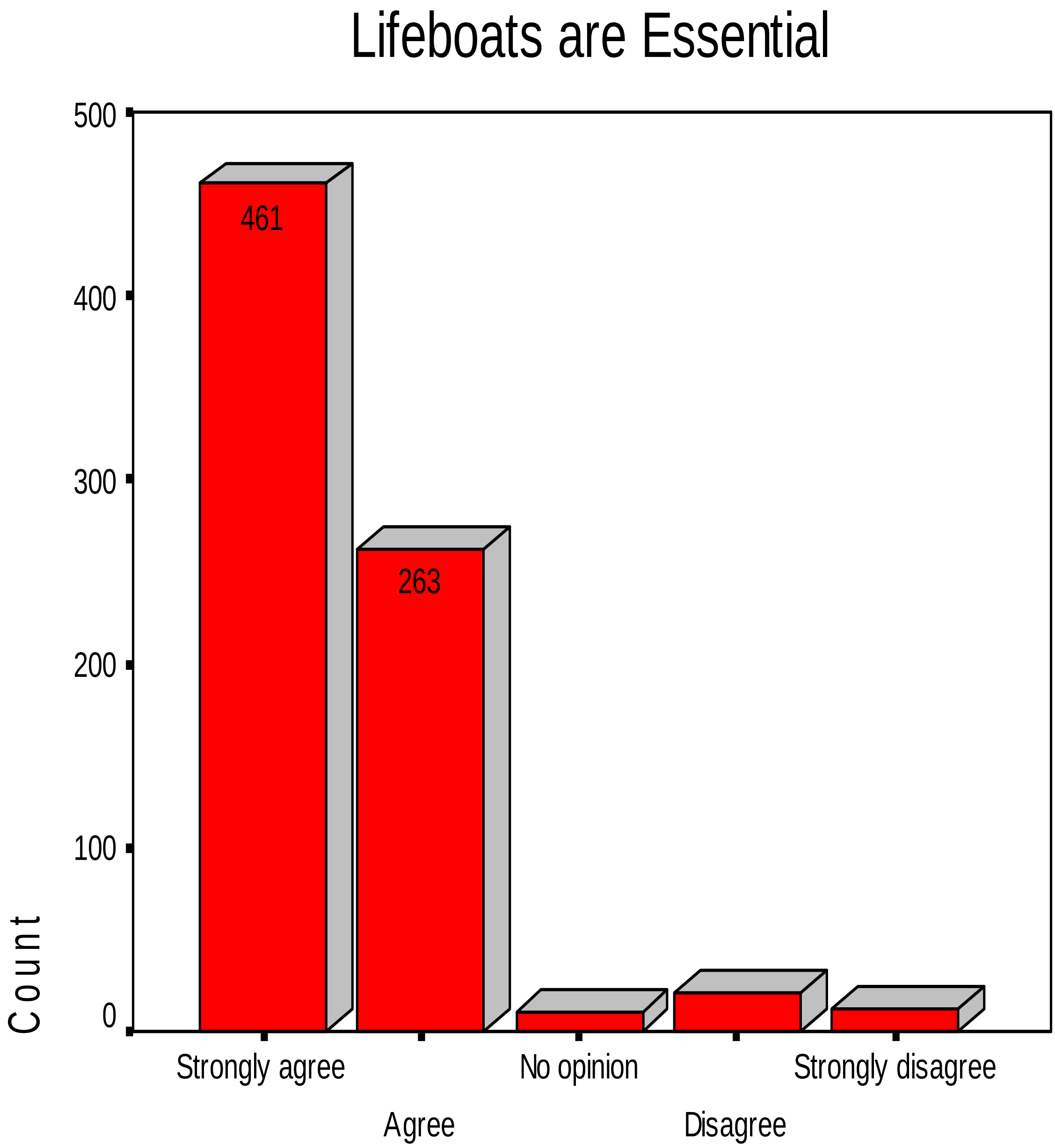
Please indicate whether you agree or disagree with the following statement for question 7.

Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q7. Lifeboats are an essential piece of evacuation equipment.

1		**2**		**3**		**4**		**5**	

Fig 11.1.1



Question No. 8.

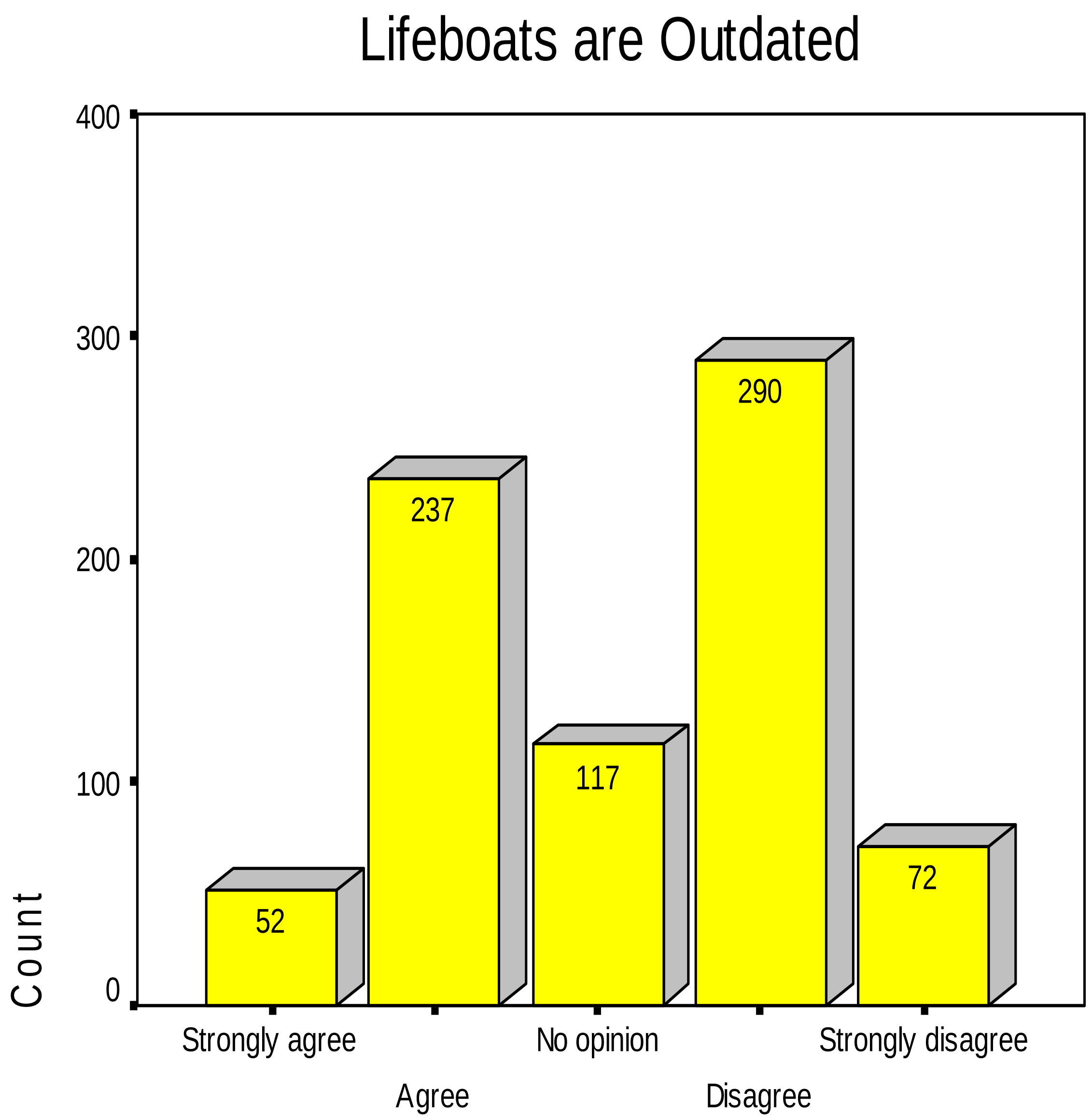
Please indicate whether you agree or disagree with the following statement for question 8.

Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q8. Lifeboat systems are outdated.

1		**2**		**3**		**4**		**5**	

Fig 11.1.2



Question No. 9.

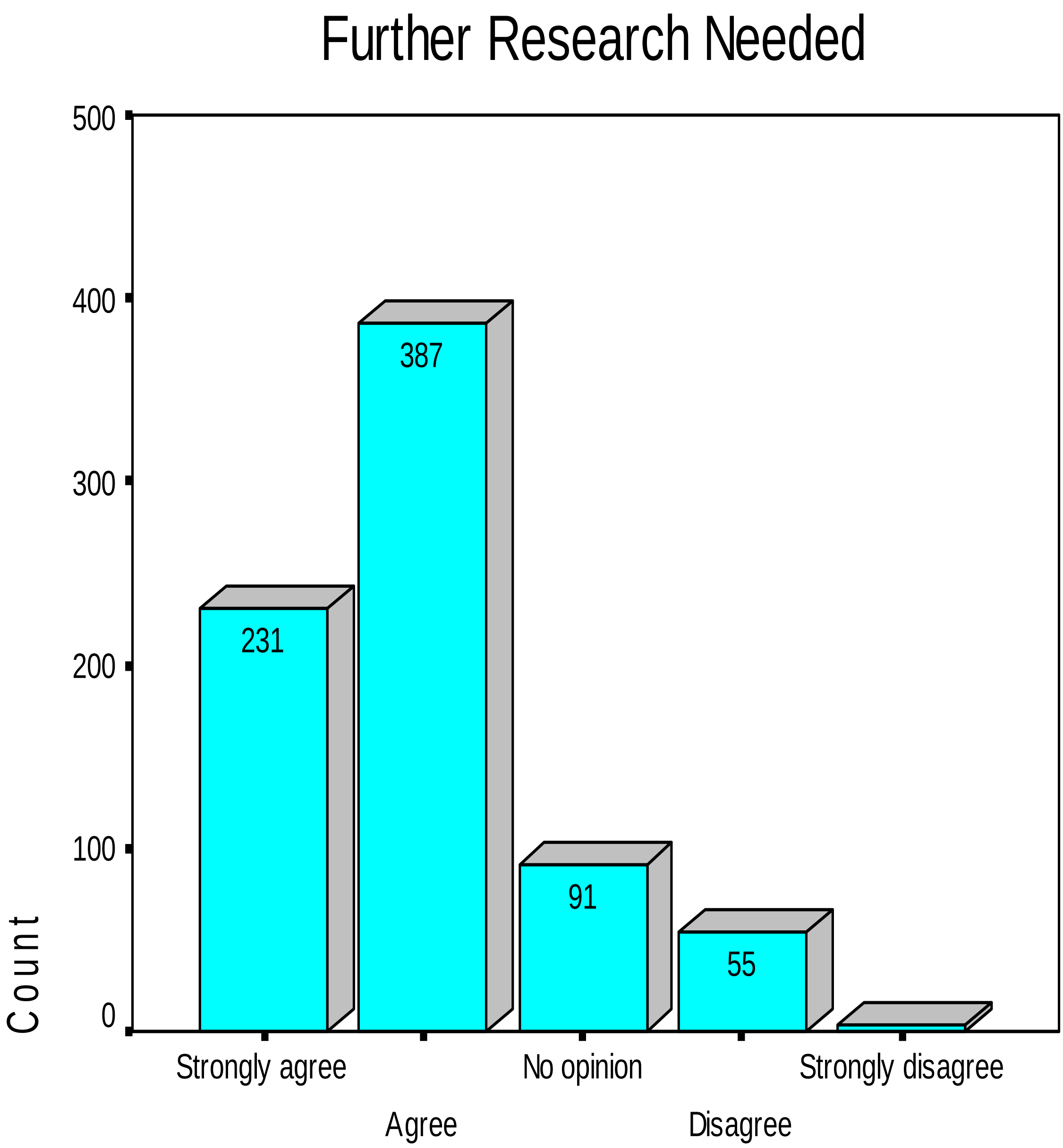
Please indicate whether you agree or disagree with the following statement for question 9.

Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q9. Further research is needed into alternative evacuation systems.

1		**2**		**3**		**4**		**5**	

Fig 11.1.3



Question No. 12.

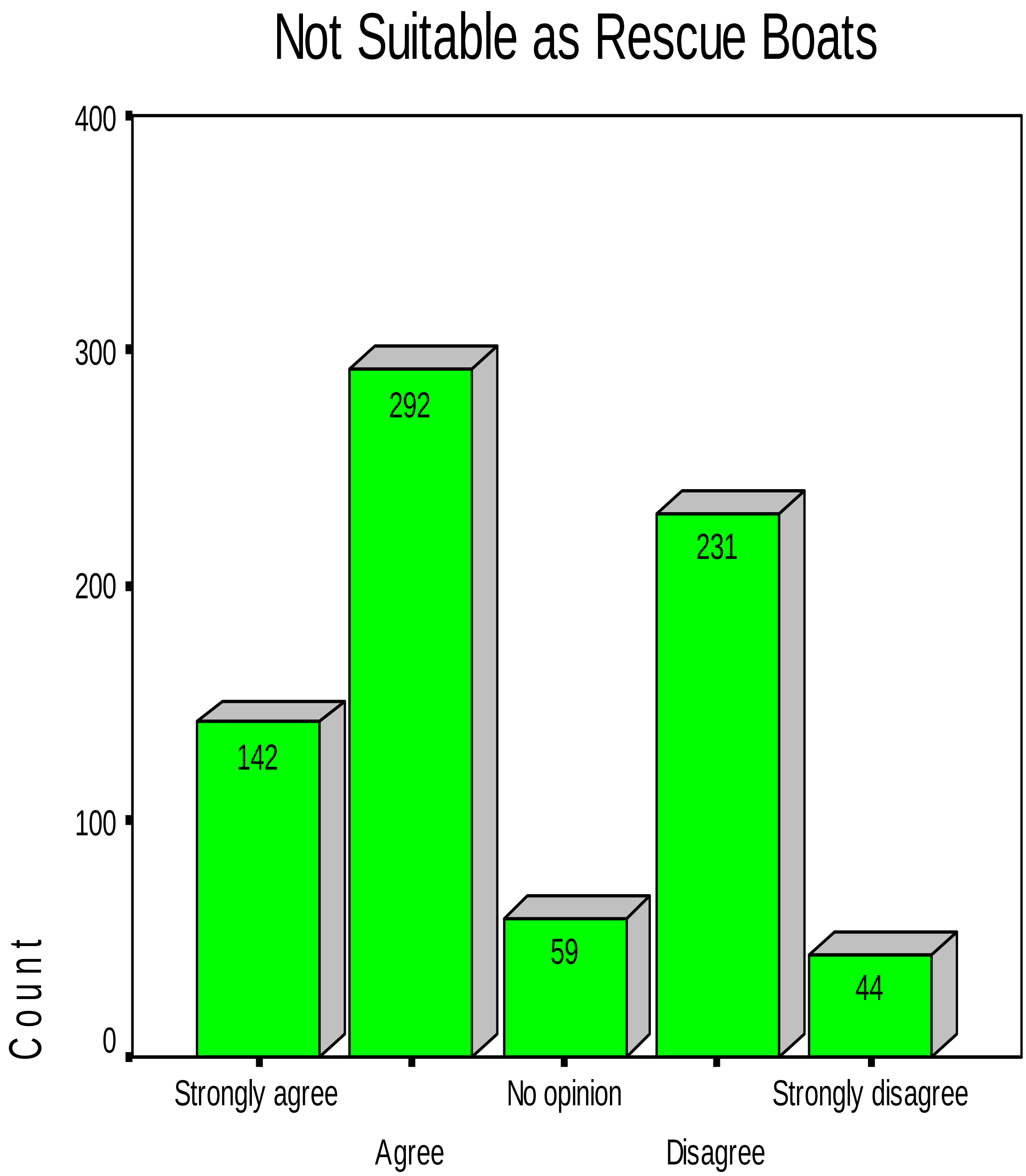
Please indicate whether you agree or disagree with the following statement for question 12.

Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q12. Lifeboats are not suitable for use as Man Overboard rescue boats.

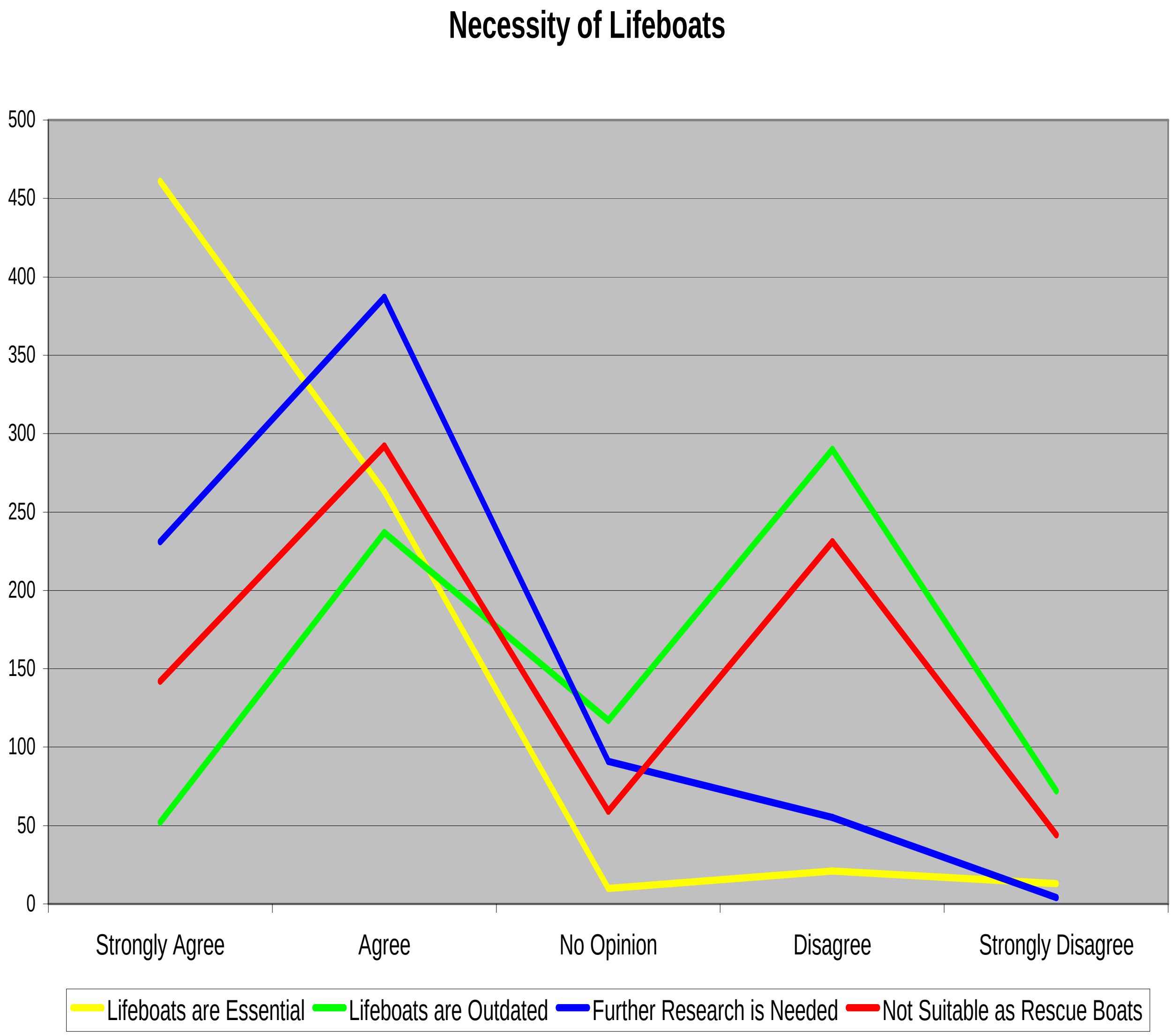
1		**2**		**3**		**4**		**5**	

Fig 11.1.4



The four questions are combined in the following graph.

Fig 11.1.5



11.2 Hypothesis Three - Necessity Conclusions

The initial question on the necessity of lifeboats appears to be answered very strongly in the affirmative, suggesting a clear level of confidence in lifeboats. However the results bear further examination. Of the 768 responses, 724 agreed/strongly agreed that lifeboats were essential however considerably less disagreed/strongly disagreed, that they were outdated. Rather strikingly 289 did agree that lifeboats are outdated while an extraordinary 117 couldn't decide. Adding the 117 who were undecided with the 289 who considered lifeboats outdated appears to show a very ambivalent attitude towards lifeboats. In fact only 362 out of 768 respondents actually disagreed that lifeboats are outdated; equalling less than 50% of the seafarers polled.

If seafarers truly considered lifeboats to be essential it seems unlikely they would then consider them outdated. However the ratios of responses which agreed and disagreed on the outdated question were not as great as would be expected given the predominantly positive response to the essential question.

The confidence demonstrated by the essential question answers was further weakened by the substantial majority of seafarers who considered that further research into alternative evacuation systems was desirable. If the perception was that lifeboats were fit for purpose in their current form, then it would be expected that the need for research into alternative systems would be seen as unnecessary.

These abnormalities suggest that the seafarers' perceptions of the suitability of ship's lifeboats are only positive until presented with alternative options.

The majority of seafarers did not consider lifeboats to be suitable as rescue boats. In previous conversations with seafarers it had become evident that the main concern was the ability to safely recover lifeboats after retrieving a casualty. Although designers have developed modifications which simplify the recovery procedure in such circumstances, the perceptions of the seafarers indicate that they did not consider lifeboats to be fit for purpose in this role. However given the overwhelming positive response to the 'essential' question, supported by the 'outdated' question, it was concluded that the seafarers' judgement was that, in general, lifeboats were fit for purpose.

11.3 Hypothesis Three - General Drills

Feelings about the safety of general drills were raised as part of hypothesis two, however it was not considered suitable to analyze the data at that stage. When establishing views towards the hazards presented during general lifeboat drills it was considered necessary to separate the same question into two parts.

All seafarers were required to take part in general drills however some were more involved than others. It was felt that the seafarers actively involved in the launch and recovery of the lifeboats were likely to have a different perception of the hazards involved compared to personnel who were removed from the process.

The seafarers were required to answer the question as either a member of the lifeboat launch party or as a participant only. The results are presented as percentages to allow for the disparity in numbers between the two sets of respondents.

Question No. 15.

Please answer ONE of the following questions as applicable to your involvement in the lifeboat launch party. *Rating system: 1 = Very Safe, 2 = Safe, 3 = No Opinion, 4 = Unsafe, 5 = Very Unsafe*

Q15. Overall how safe do you consider lifeboat drills to be?

Please answer here if you are NOT a member of the lifeboat launch party.

1		2		3		4		5	

Please answer here if you ARE a member of the lifeboat launch party.

1		2		3		4		5	

Fig 11.3.1

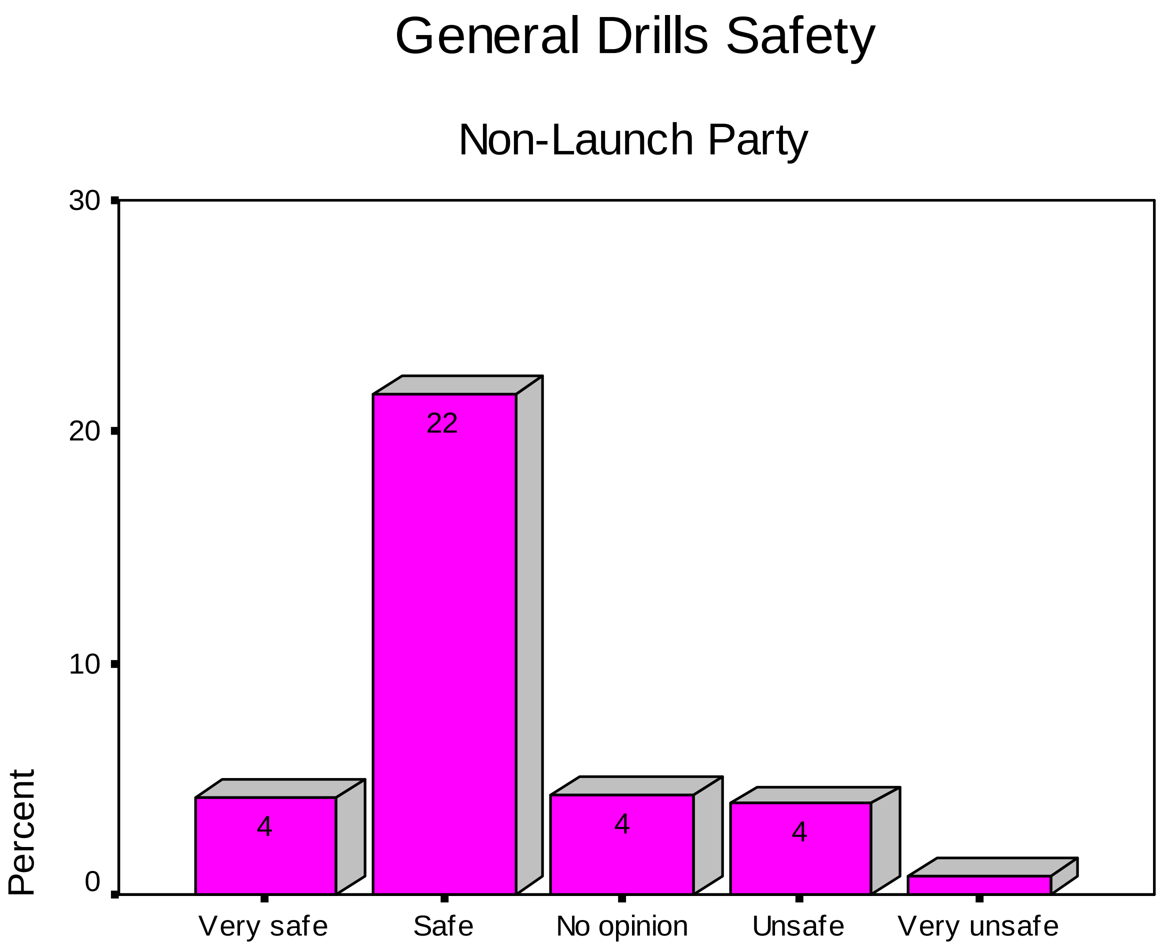
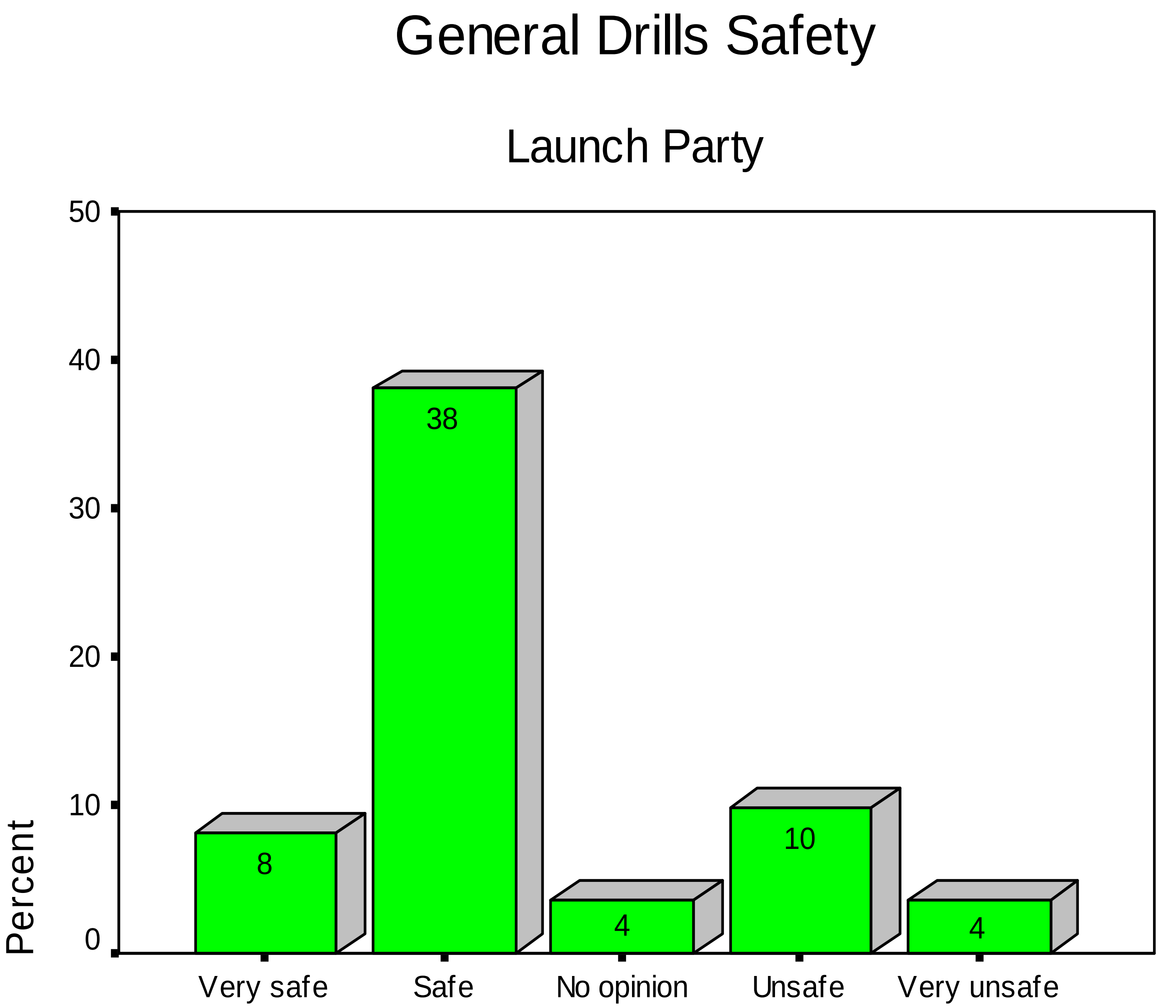
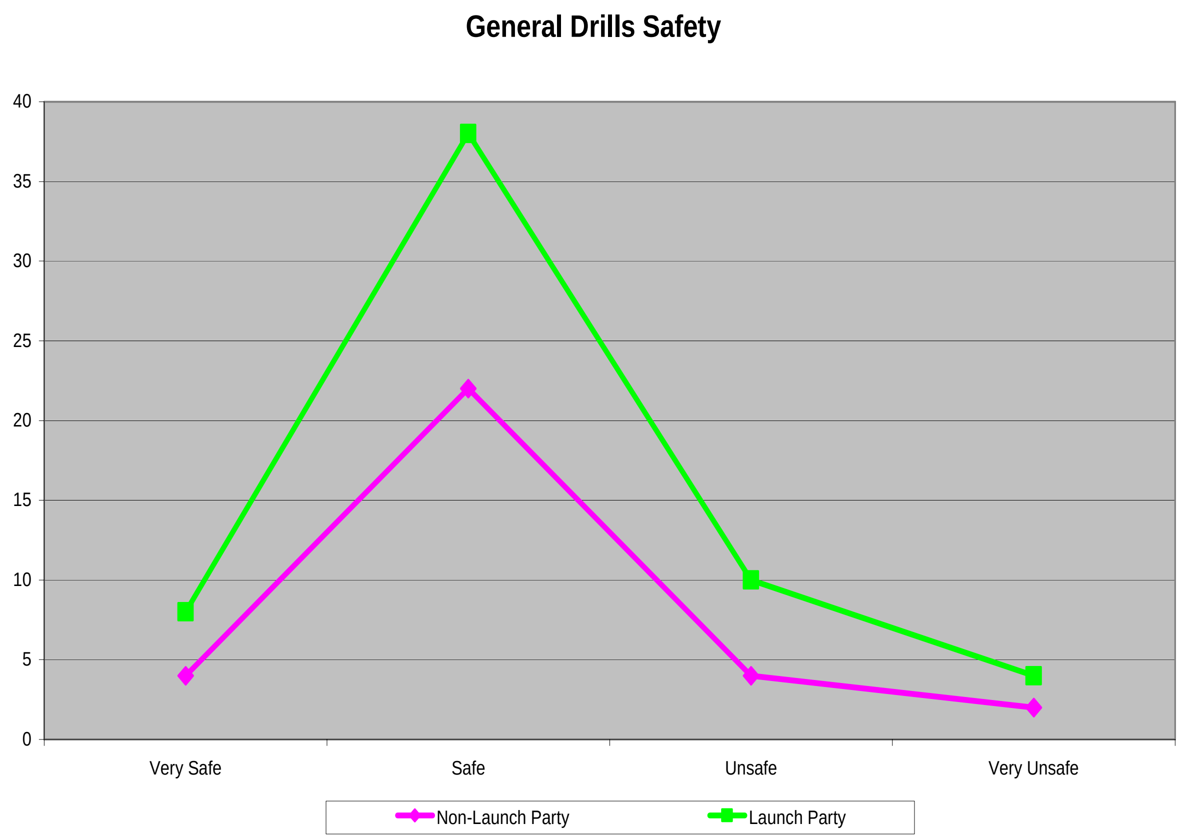


Fig 11.3.2



The results were combined in the following graph with the 'No Opinion' option removed for clarity.

Fig 11.3.3



11.4 Hypothesis Three - General Drill Conclusions

The results show that with their proximity to the hazards involved, the seafarers in the lifeboat launch party had stronger views than those more removed from the operations. The perceptions remained stronger regardless of whether the seafarers felt general drills were safe or unsafe. Interestingly though the two results follow each other very closely. This indicates that although the launch party hold stronger views, their perceptions are very similar to those held by the non-launch party and points to a uniformity of opinion concerning lifeboats regardless of proximity. The results clearly illustrated that seafarers considered lifeboats to be fit for purpose insofar as general drills were concerned. This perception is somewhat at odds with the fact that the great majority of lifeboat accidents occurred during general drills.

11.5 Hypothesis Three - Lifeboat Operational and Instructional Complexity

For an item of safety equipment to be considered fit for purpose it must have clear instructions and be simple to use in emergency situations.

The following questions intended to test lifeboats against these criteria. The first four questions dealt with complexity and were only required to be answered by the lifeboat launch party, as they were expected to be most familiar with the issues raised.

The last two questions of Hypothesis Three dealt with manufacturer's instructions and were required to be answered by personnel involved with lifeboat maintenance only, as they were expected to be most familiar with the issues raised.

11.6 Hypothesis Three – Operational Complexity

Question No. 16.

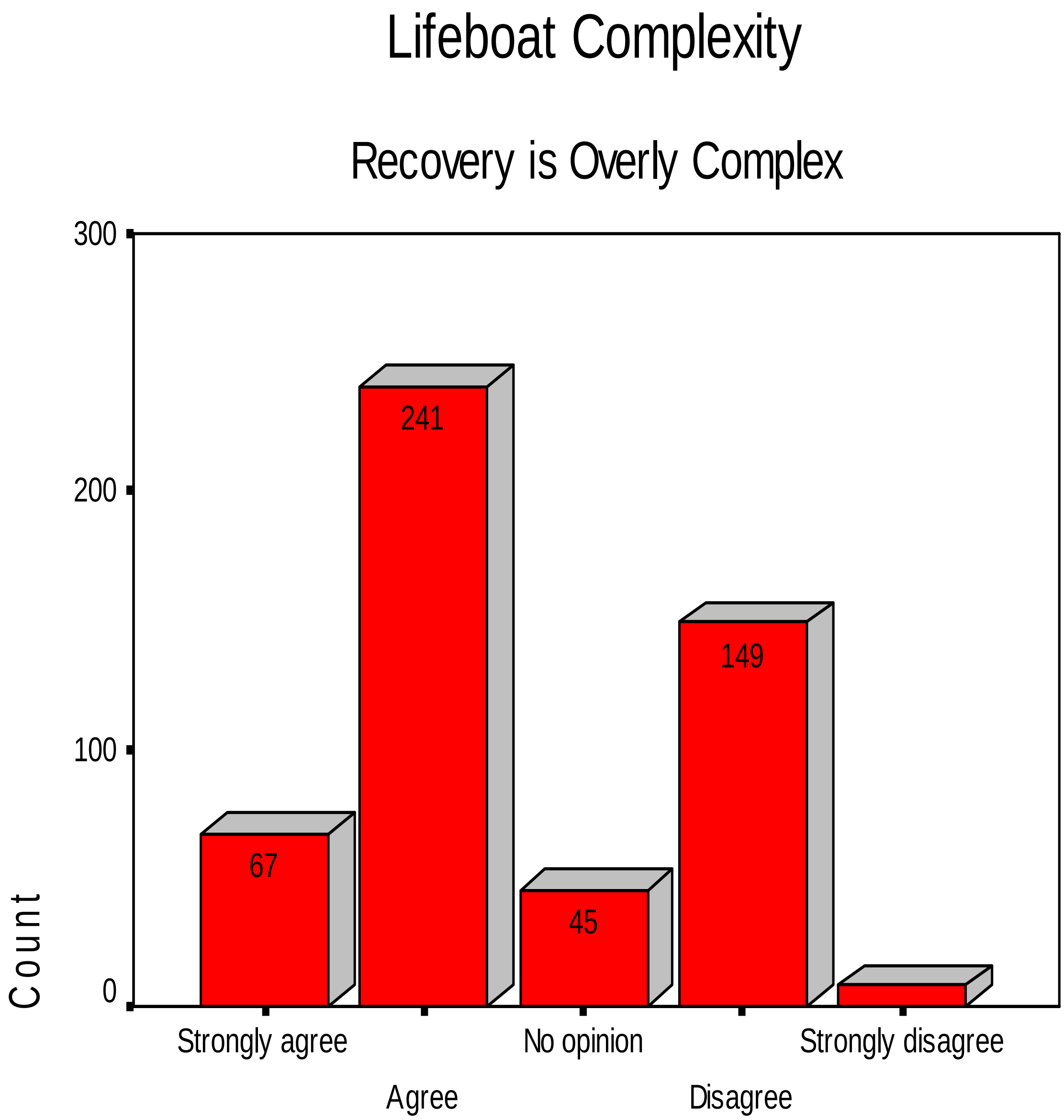
Please indicate whether you agree or disagree with the following statement for question 16.

Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q16. As a whole the lifeboat launch/recovery system is overly complex.

1		**2**		**3**		**4**		**5**	

Fig 11.6.1



Question N0. 17.

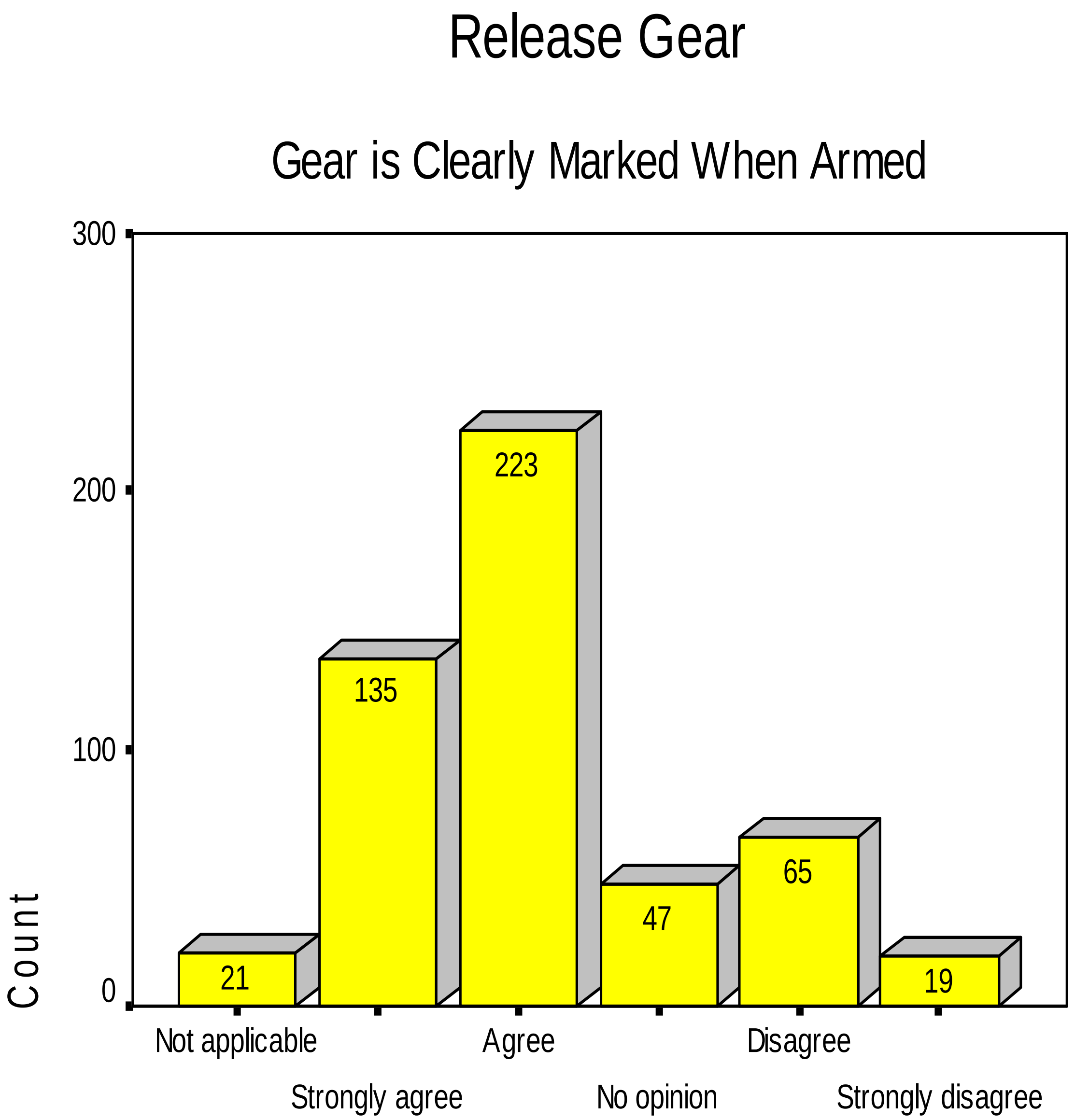
Please indicate whether you agree or disagree with the following statement for question 17.

Rating system: 0 = Not Applicable, 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q17. It is clear when the on-load release gear is armed.

0		**1**		**2**		**3**		**4**		**5**	

Fig 11.6.2



Project question No. 18.

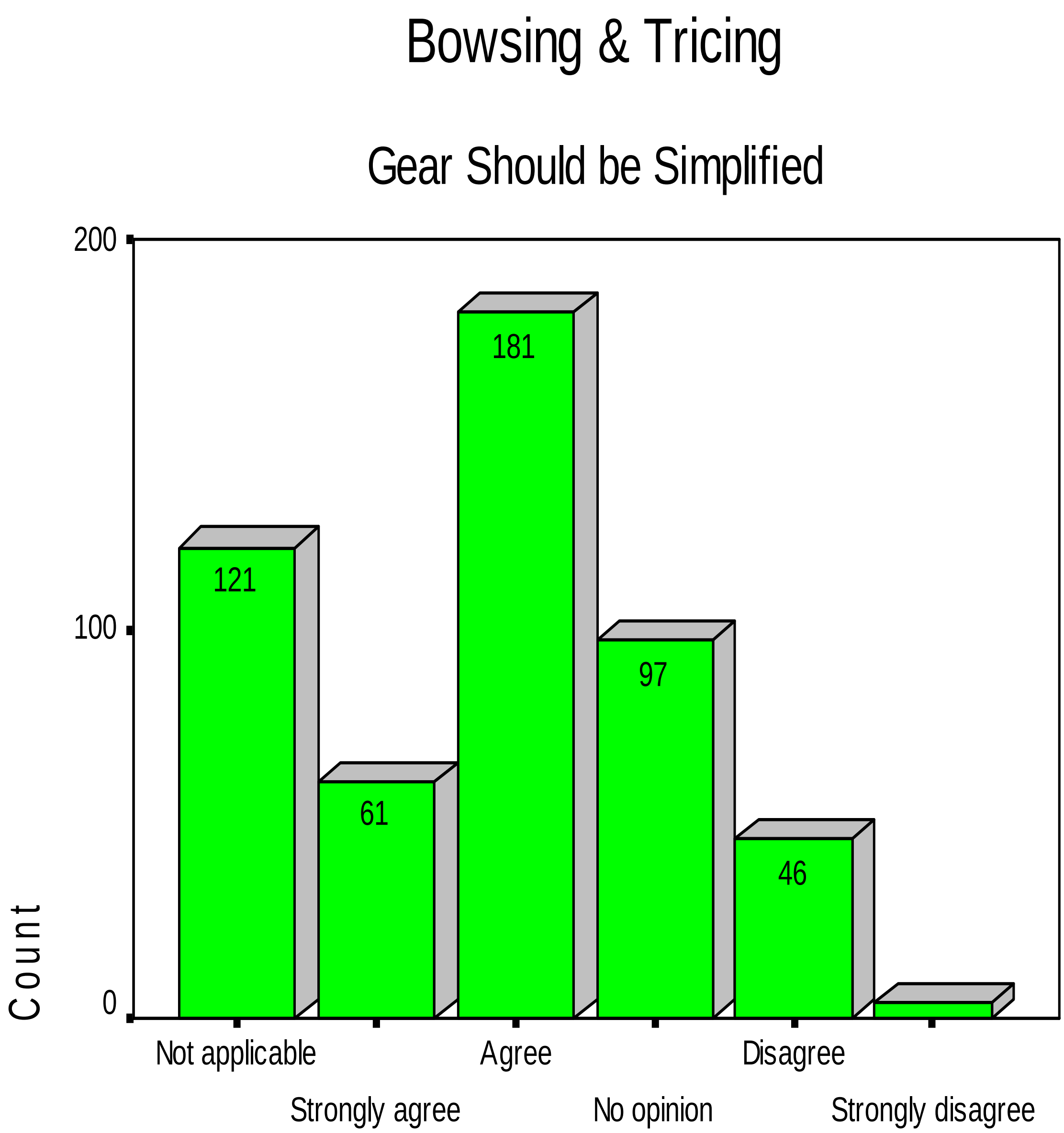
Please indicate whether you agree or disagree with the following statement for question 18.

Rating system: 0 = Not Applicable, 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q18. The bowsing and tricing requirements should be simplified.

0		**1**		**2**		**3**		**4**		**5**	

Fig 11.6.3



Project question No. 19.

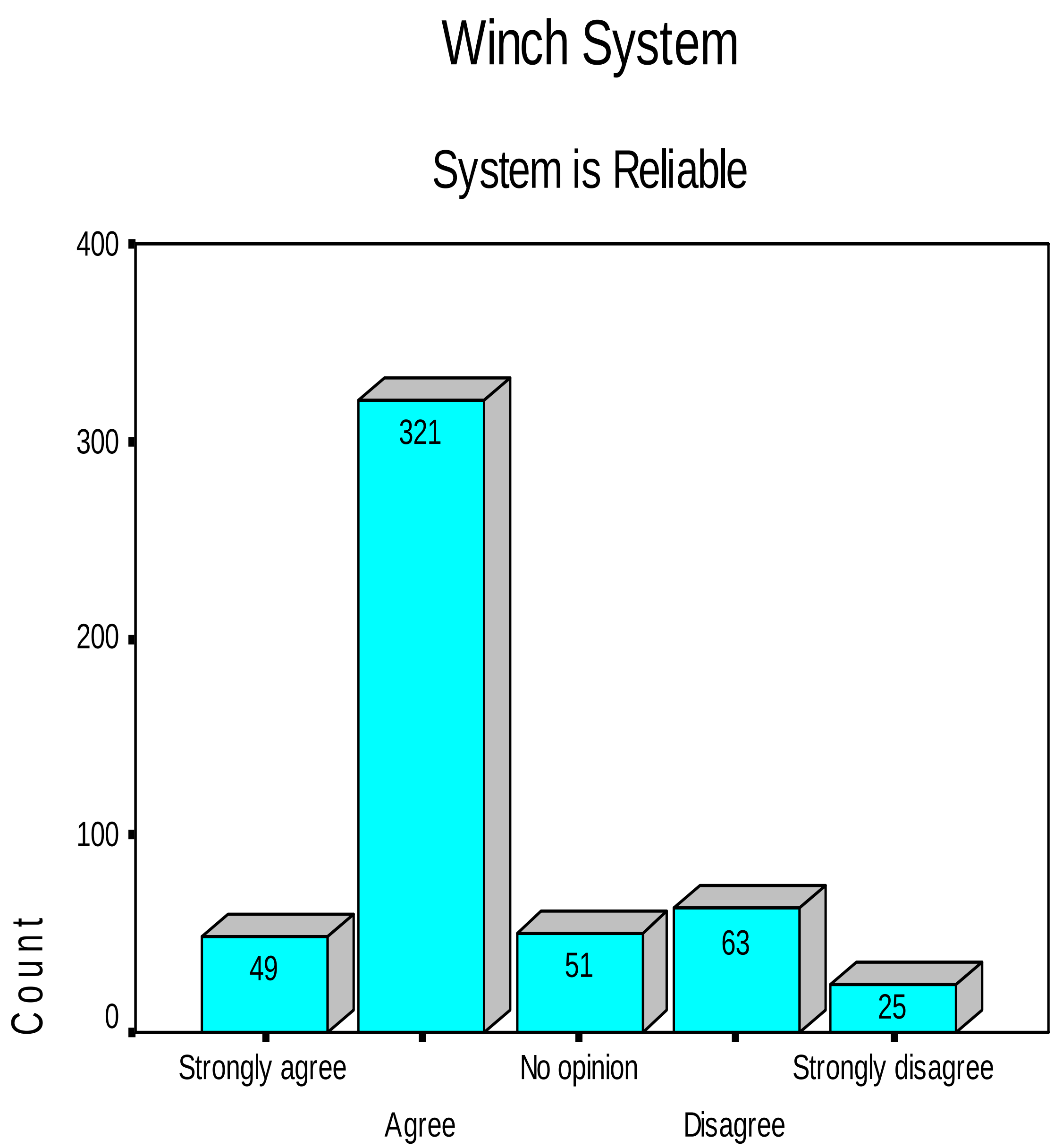
Please indicate whether you agree or disagree with the following statement for question 19.

Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q19. The lifeboat winch system is reliable.

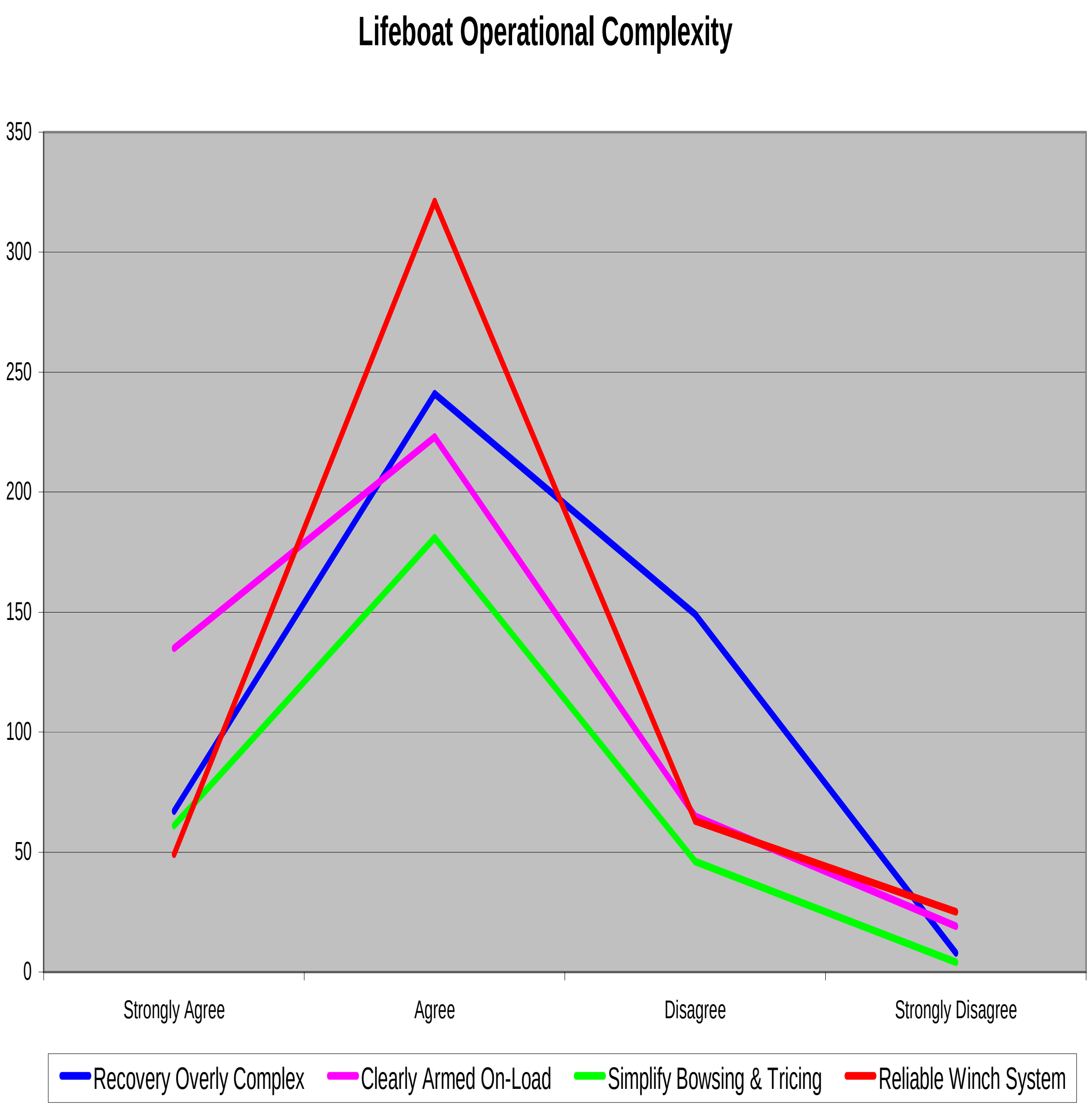
1		2		3		4		5	

Fig 11.6.4



The responses were combined in the following chart with the 'No Opinion' and 'Not Applicable' options removed for clarity.

Fig 11.6.5



11.7 Hypothesis Three – Instructional Complexity

The following two questions dealt with the complexity of the instructions provided for use with lifeboats.

Question No. 20.

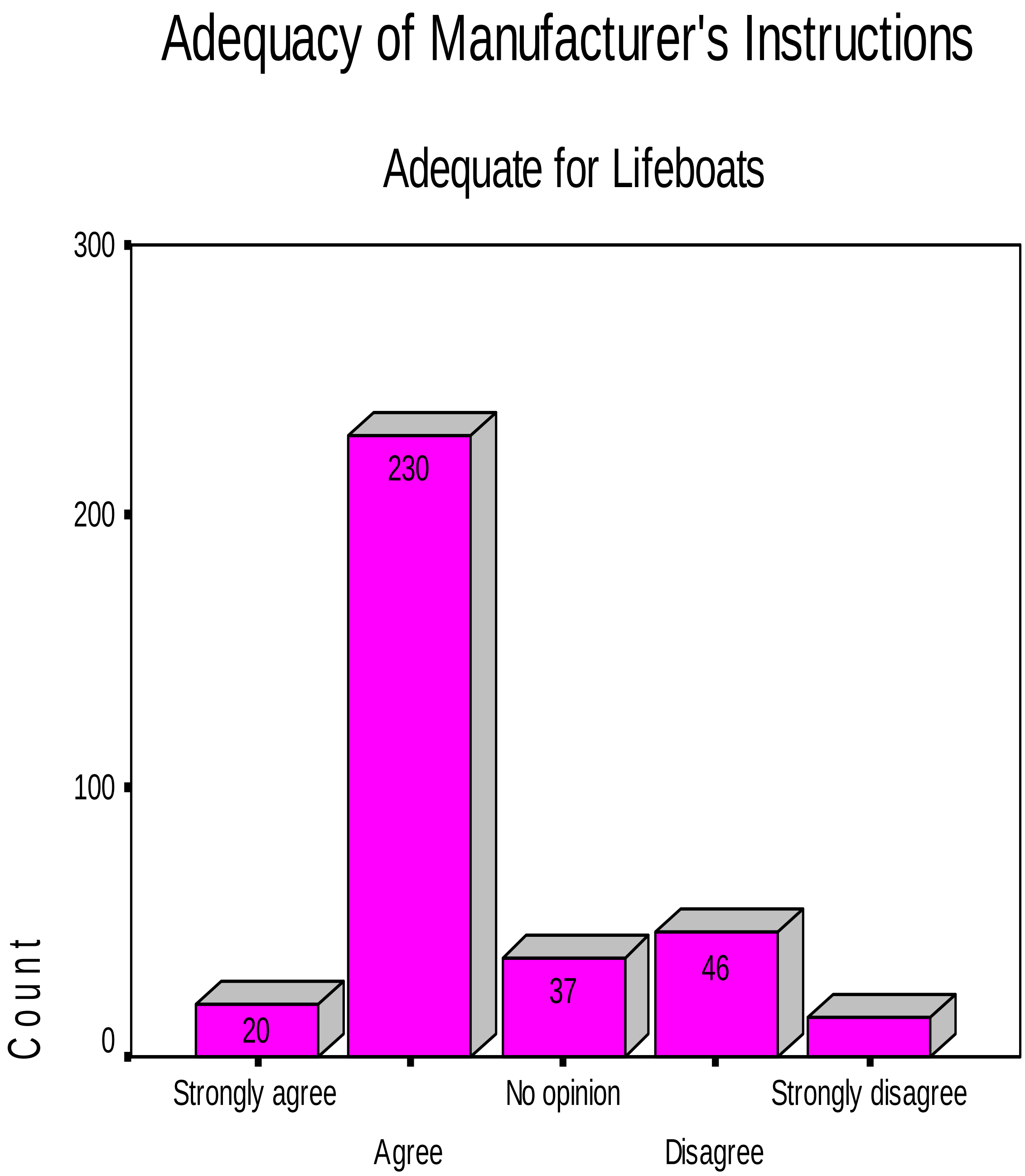
Please indicate whether you agree or disagree with the following statement for question 20.

Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q20. The manufacturer's maintenance instructions are adequate for the lifeboats on board.

1		**2**		**3**		**4**		**5**	

Fig 11.7.1



Question No. 21.

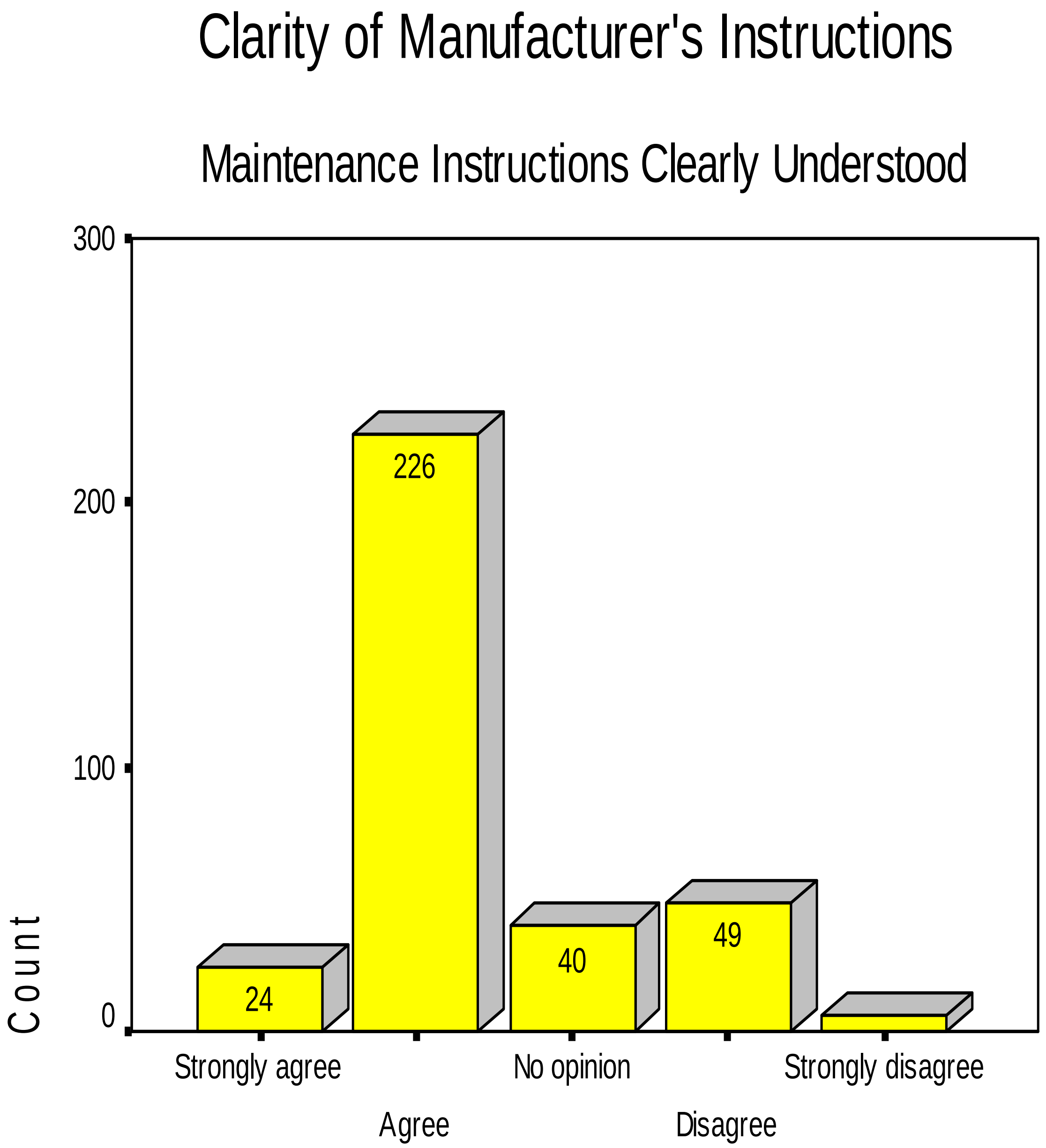
Please indicate whether you agree or disagree with the following statement for question 21.

Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q21. The manufacturer's maintenance instructions can be clearly understood by all personnel involved in lifeboat maintenance.

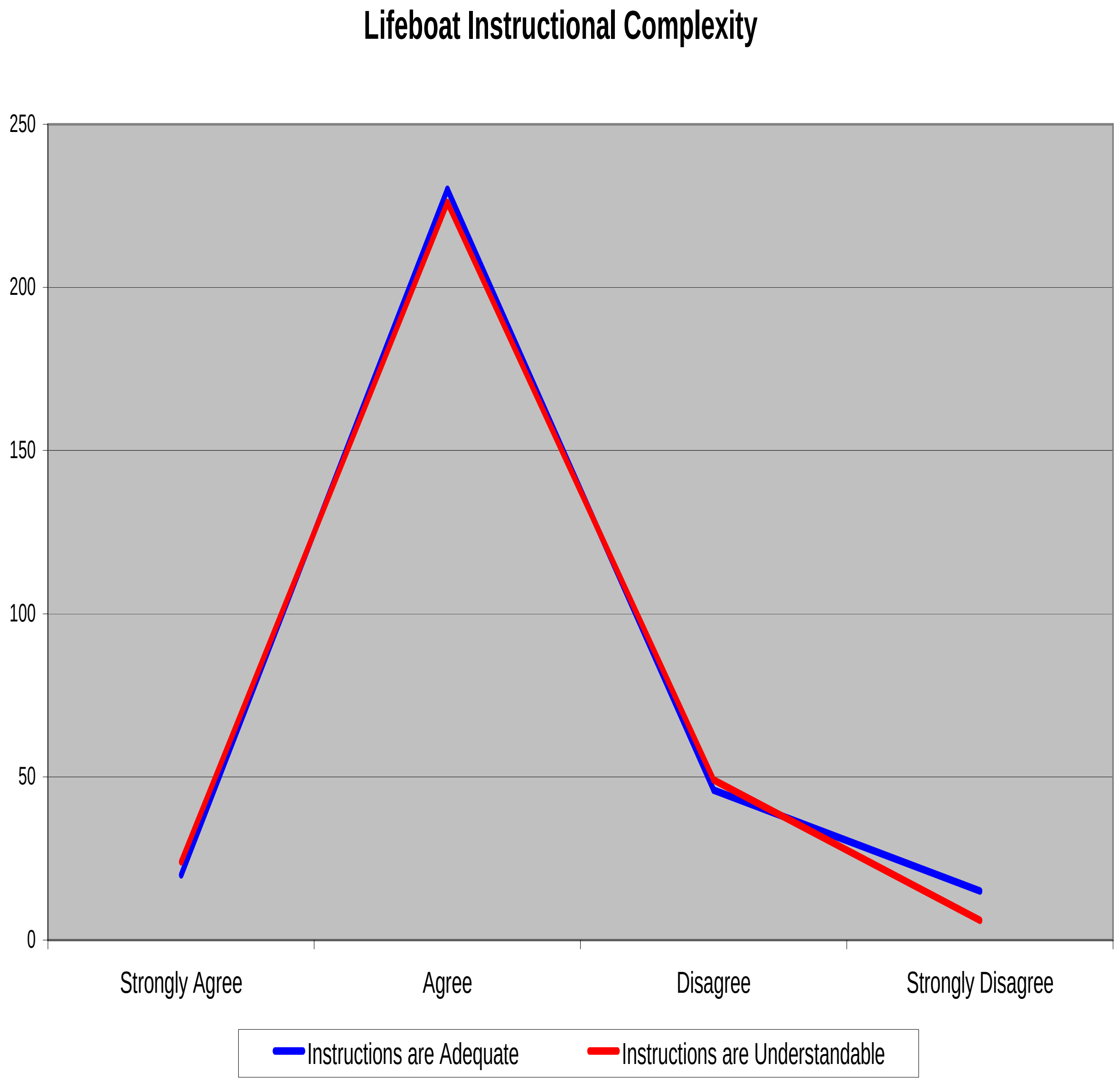
1		2		3		4		5	

Fig 11.7.2



The responses were combined in the following graph with the 'No Opinion' option removed for clarity.

Fig 11.7.3



11.8 Hypothesis Three – Lifeboat Complexity Conclusions

In operational complexity the greatest concerns were expressed over lifeboat recovery. As the majority of accidents occurred during recovery operations this was in line with the secondary data findings. Surprisingly, given the established unreliability of lifeboat winch systems, the seafarers again showed the most confidence in this area. The questions on instructional adequacy and clarity elicited a positive perceptions and very similar results.

11.9 Hypothesis Three – Final Conclusions

When the three sections of this hypothesis, necessity, general drills and complexity, were looked at together it was evident that the overall feeling towards lifeboats from the seafarers was a positive one. The majority of responses demonstrated faith in the safety and reliability of the equipment.

This positive belief was sometimes at odds with the actual causes of accidents, particularly evident in the judgements of the hazards presented by lifeboat winches and general drills. The perception of the seafarers was that these areas were less hazardous than they actually are. In other areas the seafarers' views were closer to the mark. Overly complex recovery systems and methods for bowsing and tricing of lifeboats were examples of where the seafarer's perceptions were more in line with the hazard levels identified through the secondary data.

The only area which elicited a clear belief that lifeboats were not suitable was in their role as rescue boats. It was significant that seafarers, who otherwise considered lifeboats to be fit for purpose, demonstrated a high level of concern in this area.

With the exception of their use as rescue boats, the data analyzed showed the seafarers' perceptions were that ship's lifeboats were fit for purpose. Therefore hypothesis three was considered proven.

Fig 11.9.1

Photo credit: Author

A free-fall lifeboat suspended high above the water on the stern of a merchant vessel.

CHAPTER TWELVE

12.0 Conclusions

The project objectives were four-fold. First, to provide explanations on why ship's lifeboats were causing so much harm to seafarers. This objective was discussed in as much detail as possible, given the limited size of this project, in the first section. The remaining objectives dealt with investigating and examining seafarers' perceptions towards the hazards presented by ship's lifeboats.

The objectives formed the basis from which the projects three hypotheses were developed. To test the hypotheses required primary data from seafarers', collected via a perception orientated questionnaire. Secondary data on lifeboat accidents was received from the marine investigation departments of seven countries. The project was the first to collate and analyze lifeboat accident reports on such a large scale. The project was also the first to poll seafarers for their perceptions on the extent of the hazards involved; only rarely are seafarers' views investigated on safety issues.

The hypotheses were proposed as they were considered to provide the best means to fulfil the project's objectives. In the end the tests of the hypotheses produced results that were slightly disappointing, although they did provide interesting data on issues beyond those being examined.

Hypothesis one addressed the correlation between accident cause and severity. The idea was advanced that failures in design would be the cause of the most severe injuries. Although the data showed design was responsible for a small majority of incidents involving multiple fatalities, the other factors were not sufficiently different to allow confident conclusions to be drawn. Training in particular was responsible for more total injuries and almost as many multiple fatalities.

Previous studies had looked at accident causes but this project was the first to combine cause with an analysis of severity. The data collected showed there was not a single cause responsible for the majority of serious injuries. If strategies to reduce injuries are to be effective they must address maintenance, training and design collectively, rather than treating them as individual issues.

Hypothesis two tested the correlation between the established hazards and the seafarers' perceptions of the hazards. It postulated that seafarers' judgements would be directly comparable to the actual hazard ratings. Results showed that while this was true for operational hazards, it was not so for component hazards. Because of the inconsistency between the results hypothesis two was deemed unproven.

However several interesting facts emerged from the testing of hypothesis two. Results showed that seafarers' views on component hazards bore little relation to the actual hazards. Seafarers overestimated the hazards presented from on-load release hooks and, more worryingly, underestimated the actual hazard present in the winch systems. This misjudgement indicates that seafarers have misplaced faith in one system and unreasonable concerns about another.

Despite the difference between the component and operational data results, the common link between them was that seafarers consistently sensed the hazards connected with lifeboats to be greater than they actually were. This finding was significant as it provided an understanding of seafarers' levels of concern and must be taken into account when creating strategies to address the issue of seafarers' confidence.

Hypothesis three tested seafarers' perceptions towards whether lifeboats were fit for purpose. The issue of fit for purpose is a complicated one and there was no single simple question that would have resolved this. Therefore by necessity hypothesis three was complex, involving several sections and questions. Overall the majority of seafarers demonstrated a positive view towards lifeboats and the hypothesis was considered to be proven.

However it is worth noting that several of the questionnaires from seafarers contained notes to the effect that their positive responses were given based on using a lifeboat in calm waters only. In any sort of a seaway they considered lifeboat operations to be too dangerous to undertake in any but an emergency situation.

Several interesting facts emerged from hypothesis three. Again seafarer's perceptions showed faith, or lack of faith, in lifeboat systems at odds with the actual hazards they presented. This was significant as again it provided information for organizations intending to develop training programs addressing seafarer confidence towards lifeboats.

The data also showed that seafarers had significant, and justified, concerns over fundamental operations like recovery of lifeboats. Views about the hazards connected with lifeboat recovery no doubt went a long way to influencing the seafarers' responses on the issue of lifeboats as rescue boats. The fact that using lifeboats as rescue boats was the one area in the entire project where seafarers' concerns overwhelmed positive responses must not be regarded as anything other than highly significant.

This study provides a starting point for further industry research into the perceptions of seafarers towards the hazards presented by lifeboats and other marine safety equipment. The marine investigation departments and companies involved have expressed interest in receiving the results. It is anticipated that the findings will be of use in better understanding seafarers' relationships towards lifeboats and developing effective training strategies.

CHAPTER THIRTEEN

13.0 Recommendations for Further Research

This study was restricted by both the scale allowed by the University as an MSc project and the resources available to the author. Assistance with the project from the marine community was outstanding and significantly more data could have been collected if more resources had been available. Seafarer perceptions and human factors in the marine industry are extremely under-addressed and much further research is needed in this area.

Specific studies are required into the ergonomics of lifeboats, particularly given the increasing size of workers in the marine industry and the requirement to wear bulky survival suits and lifejackets in the lifeboats. Analysis is also needed into the potentially harmful effects to seafarers following deployment of fully loaded lifeboats at both the upper and lower limits of their design capabilities.

The true costs of lifeboat accidents resulting from injuries, compensation, legal suits, lost time and fabric damage to ships should be established.

Finally, and most importantly, research into the practicalities and safety of continuing to use lifeboats as rescue boats is essential. However for such research to provide a balanced conclusion the analysis must be expanded to include accidents involving dedicated fast rescue craft.

Appendix I.

Acknowledgments:

Thanks are extended to the ship's Masters and crews from the following companies for their time and effort in responding to the project questionnaire.

British Antarctic Survey

Caledonian MacBrayne Herbriden & Clyde Ferries

Celtic Pacific (UK) Ltd

Euroship Services Ltd

ExxonMobil

Fred Olsen Ltd.

Hanson Aggregates Marine Ltd

James Fisher & Sons Crewing Services Ltd

NERC Research Ship Unit

OSG Ship Management

Shell International Trading & Shipping Company Ltd

V. Ships UK Ltd

Thanks also to the following organisations for providing accident data and information for the project.

Accident Investigation Board (Finland)

Australian Transport Safety Bureau (Australia)

Bahamas Maritime Authority (Bahamas)

Danish Maritime Authority (Denmark)

Federal Bureau of Maritime Casualty Investigation (Germany)

Health and Safety Executive (UK)

International association of Oil and Gas Producers (UK)

International Maritime Organization (UK)

Landsort Maritime Training AB (Sweden)

Mad Rock Marine Solutions Incorporated (Canada)

Marine Accident Investigation Branch (UK)

Marine Department (Hong Kong)

Maritime Services Board (Australia)

Norwegian Maritime Directorate (Norway)

Seagull AS (Norway)

Specialist Employment Group – Precious Associates Ltd (UK)

Survival Craft Inspectorate (UK)

The International Marine Contractors Association (UK)

Transport Accident Investigation Commission (New Zealand)

Transportation Safety Board (Canada)

United States Coast Guard (USA)

Appendix II.

LIFEBOAT QUESTIONNAIRE

SECTION ONE – GENERAL (Questions for all personnel)

Q1. What is your position on board?	
Master	
Deck Officer	
Deck Rating	
Engineering Officer	
Engineering Rating	
Catering Department	
Other (please specify)	

Q2. How long have you spent at sea in a professional role?	
Less than 1 year	
1 – 5 years	
6 – 10 years	
11 – 15 years	
16 – 20 years	
More than 20 years	

Q3. How long have you worked with the present company?	
Less than 1 year	
1 – 5 years	
6 – 10 years	
11 – 15 years	
16 – 20 years	
More than 20 years	

Q4. What type(s) of lifeboat is on your vessel?	
Free-fall	
Davit launched (fully enclosed)	
Davit launched (partially enclosed)	
Davit launched (open)	
Other (please specify)	

Q5. Have you ever been involved in an incident involving lifeboats?	
No	
Yes	
More than once (please specify number)	

Q6. What design are the lifeboats on your current vessel? (Or if ashore the one on which you spend most time)	
Please specify	
Do not know	

Please indicate whether you agree or disagree with the following statements for questions 7-12.
Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q7. Lifeboats are an essential piece of evacuation equipment.

1		2		3		4		5	

Q8. Lifeboat systems are outdated.

1		2		3		4		5	

Q9. Further research is needed into alternative evacuation systems.

1		2		3		4		5	

Q10. Lifeboat drills would be safer if personnel were not required to be in the lifeboat during the drill.

1		2		3		4		5	

Q11. Lifeboat drills will be less effective in preparing for a real emergency if personnel are not allowed in the lifeboat.

1		2		3		4		5	

Q12. Lifeboats are not suitable for use as Man Overboard rescue boats.

1		2		3		4		5	

Q13. Please indicate how safe you consider each exercise to be (each number may be used multiple times). **Rating system: 0 = Not Applicable, 1 = Very Safe, 2 = Safe, 3 = No Opinion, 4 = Unsafe, 5 = Very Unsafe**	
Launching lifeboats	
Recovering lifeboats	
Bowsing and tricing of lifeboats	
Boarding and exiting of lifeboats	
Manoeuvring of lifeboats	

14. Please indicate how safe you consider each item to be (each number may be used multiple times). **Rating system: 0 = Not Applicable, 1 = Very Safe, 2 = Safe, 3 = No Opinion, 4 = Unsafe, 5 = Very Unsafe**	
On-Load release hooks	
Winch mechanisms	
Bowsing and tricing systems	
Falls, sheaves and blocks	
Davit arrangements	

SECTION TWO – GENERAL (ONE question to be answered by each discipline)

Please answer ONE of the following questions as applicable to your involvement in the lifeboat launch party.
Rating system: 1 = Very Safe, 2 = Safe, 3 = No Opinion, 4 = Unsafe, 5 = Very Unsafe

Q15. Overall how safe do you consider lifeboat drills to be?

Please answer here if you are NOT a member of the lifeboat launch party.

1		2		3		4		5	

Please answer here if you ARE a member of the lifeboat launch party.

1		2		3		4		5	

This is the end of the general questions – ONLY those personnel involved in the maintenance of lifeboats and the lifeboat launch party should continue with the questionnaire.

SECTION THREE – LIFEBOAT LAUNCH PARTY ONLY

Please indicate whether you agree or disagree with the following statements for questions 16 - 19.
Rating system: 0 = Not Applicable, 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q16. As a whole the lifeboat launch/recovery system is overly complex.

1		2		3		4		5	

Q17. It is clear when the on-load release gear is armed.

0		1		2		3		4		5	

Q18. The bowsing and tricing requirements should be simplified.

0		1		2		3		4		5	

Q19. The lifeboat winch system is reliable.

1		2		3		4		5	

SECTION FOUR – PERSONNEL INVOLVED IN LIFEBOAT MAINTENANCE ONLY

Please indicate whether you agree or disagree with the following statements for questions 20 - 23.
Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q20. The manufacturer's maintenance instructions are adequate for the lifeboats on board.

1		2		3		4		5	

Q21. The manufacturer's maintenance instructions can be clearly understood by all personnel involved in lifeboat maintenance.

1		2		3		4		5	

Q22. Specific training should be provided in maintaining the lifeboat systems.

1		2		3		4		5	

Q23. Servicing of lifeboat systems by professional external personnel would reduce the number of incidents.

1		2		3		4		5	

End of Questions: I would like to express my appreciation to all personnel who have assisted with this questionnaire.

Appendix III.

Case Summaries

		Type of investigation report	Year of Incident	Industry Type	Vessel Flag	Investigating State
1		Summary	Not Established	Marine	Not Established	Canada
2		Summary	Not Established	Marine	Not Established	Canada
3		Summary	Not Established	Marine	Not Established	Canada
4		Summary	Not Established	Marine	Not Established	Canada
5		Summary	Not Established	Marine	Not Established	Canada
6		Summary	Not Established	Marine	Not Established	Canada
7		Summary	Not Established	Marine	Not Established	Canada
8		Summary	Not Established	Marine	Not Established	Canada
9		Summary	Not Established	Marine	Not Established	Canada
10		Summary	Not Established	Marine	Not Established	Canada
11		Summary	Not Established	Marine	Not Established	Canada
12		Summary	Not Established	Marine	Not Established	Canada
13		Summary	Not Established	Marine	Not Established	Canada
14		Summary	Not Established	Marine	Not Established	Canada
15		Summary	Not Established	Marine	Not Established	Canada
16		Summary	Not Established	Marine	Not Established	Canada
17		Summary	Not Established	Marine	Not Established	Canada
18		Summary	Not Established	Marine	Not Established	Canada
19		Summary	Not Established	Marine	Not Established	Canada
20		Summary	Not Established	Marine	Not Established	Canada
21		Summary	Not Established	Marine	Not Established	Canada
22		Summary	Not Established	Marine	Not Established	Canada
23		Summary	Not Established	Marine	Not Established	Canada
24		Summary	Not Established	Marine	Not Established	Canada
25		Summary	Not Established	Marine	Not Established	Canada
26		Summary	2004	Marine	Not Established	Canada
27		Summary	Not Established	Other	Not Applicable	UK
28		Summary	2004	Marine	UK	UK
29		Intermediate	2003	Marine	UK	UK
30		Summary	2002	Marine	UK	UK
31		Intermediate	2001	Marine	Bahamas	UK
32		Intermediate	2002	Marine	UK	UK
33		Intermediate	1997	Marine	UK	UK
34		Summary	2002	Marine	Bahamas	UK
35		Summary	2003	Marine	Antigua & Barbuda	UK
36		Summary	1999	Marine	UK	UK
37		Summary	2003	Marine	Bahamas	UK
38		Summary	2000	Marine	UK	UK
39		Summary	1999	Marine	UK	UK
40		Summary	2003	Marine	UK	UK
41		Summary	2001	Marine	UK	UK
42		Summary	2001	Marine	UK	UK
43		Intermediate	2001	Marine	Panama	UK
44		Summary	2002	Marine	UK	UK
45		Summary	2003	Marine	UK	UK
46		Summary	2002	Marine	UK	UK
47		Summary	1999	Marine	UK	UK
48		Summary	2004	Marine	UK	UK
49		Summary	2000	Marine	UK	UK
50		Summary	2003	Marine	UK	UK
51		Summary	2001	Marine	UK	UK
52		Summary	1995	Marine	UK	UK
53		Summary	1994	Marine	UK	UK
54		Summary	2001	Marine	UK	UK
55		Summary	1995	Marine	UK	UK

56		Summary	1993	Marine	Panama	UK
57		Summary	1994	Marine	Panama	UK
58		Summary	1995	Marine	UK	UK
59		Summary	1992	Marine	UK	UK
60		Summary	1996	Marine	UK	UK
61		Summary	1994	Marine	UK	UK
62		Summary	2002	Marine	UK	UK
63		Summary	1995	Marine	UK	UK
64		Summary	1993	Marine	UK	UK
65		Summary	1995	Marine	UK	UK
66		Summary	1994	Marine	UK	UK
67		Summary	1993	Marine	UK	UK
68		Summary	1997	Marine	UK	UK
69		Summary	1994	Marine	UK	UK
70		Summary	1998	Marine	UK	UK
71		Summary	1996	Marine	UK	UK
72		Summary	2000	Marine	UK	UK
73		Summary	2000	Marine	UK	UK
74		Summary	1995	Marine	UK	UK
75		Summary	1997	Marine	UK	UK
76		Summary	1995	Marine	UK	UK
77		Summary	1998	Marine	UK	UK
78		Summary	1994	Marine	UK	UK
79		Summary	1997	Marine	UK	UK
80		Summary	1997	Marine	Panama	UK
81		Summary	2002	Marine	UK	UK
82		Summary	1993	Marine	UK	UK
83		Summary	1999	Marine	UK	UK
84		Summary	2001	Marine	UK	UK
85		Summary	2001	Marine	UK	UK
86		Summary	1999	Marine	UK	UK
87		Summary	1995	Marine	Panama	UK
88		Summary	1999	Marine	UK	UK
89		Summary	1995	Marine	UK	UK
90		Summary	1997	Marine	UK	UK
91		Summary	2001	Marine	UK	UK
92		Summary	2001	Marine	UK	UK
93		Summary	2001	Marine	Panama	UK
94		Summary	2003	Marine	Panama	UK
95		Summary	1994	Marine	UK	UK
96		Summary	1995	Marine	UK	UK
97		Summary	1992	Marine	UK	UK
98		Summary	2001	Marine	UK	UK
99		Summary	1994	Marine	UK	UK
100		Summary	1995	Marine	UK	UK
101		Summary	1999	Marine	UK	UK
102		Summary	1999	Marine	UK	UK
103		Summary	1992	Marine	UK	UK
104		Summary	2001	Marine	UK	UK
105		Summary	1994	Marine	Panama	UK
106		Summary	1995	Marine	UK	UK
107		Summary	1996	Marine	UK	UK
108		Summary	1998	Marine	UK	UK
109		Summary	1993	Marine	UK	UK
110		Summary	2003	Marine	Panama	UK
111		Summary	2003	Marine	UK	UK
112		Summary	1997	Marine	Panama	UK
113		Summary	2003	Marine	Panama	UK
114		Summary	1999	Marine	UK	UK
115		Summary	1999	Marine	UK	UK
116		Summary	1998	Marine	UK	UK
117		Summary	1998	Marine	UK	UK
118		Summary	1994	Marine	UK	UK

119		Summary	1991	Marine	UK	UK
120		Summary	1997	Marine	UK	UK
121		Summary	1999	Marine	UK	UK
122		Summary	1995	Marine	UK	UK
123		Summary	2002	Marine	UK	UK
124		Summary	1995	Marine	UK	UK
125		Summary	2003	Marine	UK	UK
126		Summary	1995	Marine	UK	UK
127		Summary	2002	Marine	UK	UK
128		Summary	1998	Marine	UK	UK
129		Summary	2000	Marine	Panama	UK
130		Summary	1993	Marine	UK	UK
131		Summary	1995	Marine	UK	UK
132		Summary	1998	Marine	Panama	UK
133		Summary	1998	Marine	UK	UK
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136		Summary	1995	Marine	UK	UK
137		Summary	2001	Marine	UK	UK
138		Summary	2002	Marine	UK	UK
139		Summary	2004	Marine	UK	UK
140		Summary	2004	Marine	UK	UK
141		Summary	1998	Marine	UK	UK
142		Summary	1999	Marine	UK	UK
143		Summary	1994	Marine	UK	UK
144		Summary	1999	Marine	UK	UK
145		Summary	1995	Marine	UK	UK
146		Summary	2000	Marine	UK	UK
147		Summary	1996	Marine	UK	UK
148		Summary	1999	Marine	UK	UK
149		Summary	2004	Marine	UK	UK
150		Summary	1999	Marine	UK	UK
151		Summary	1999	Marine	UK	UK
152		Summary	1993	Marine	UK	UK
153		Summary	1999	Marine	UK	UK
154		Summary	2002	Marine	Panama	UK
155		Summary	1999	Marine	UK	UK
156		Summary	1993	Marine	UK	UK
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159		Summary	1994	Marine	UK	UK
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161		Summary	2001	Marine	UK	UK
162		Summary	2003	Marine	UK	UK
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164		Summary	1994	Marine	UK	UK
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167		Summary	1966	Marine	Panama	UK
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170		Summary	1998	Marine	UK	UK
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172		Summary	1993	Marine	Panama	UK
173		Summary	1993	Marine	UK	UK
174		Summary	2003	Marine	UK	UK
175		Summary	1995	Marine	UK	UK
176		Summary	1996	Marine	Panama	UK
177		Summary	1994	Marine	UK	UK
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182		Summary	1995	Marine	UK	UK
183		Summary	1996	Marine	UK	UK
184		Summary	1994	Marine	UK	UK
185		Intermediate	1996	Marine	UK	UK
186		Summary	1993	Marine	UK	UK
187		Summary	1993	Marine	UK	UK
188		Summary	2001	Marine	UK	UK
189		Summary	2004	Marine	UK	UK
190		Summary	2002	Marine	UK	UK
191		Summary	2003	Marine	UK	UK
192		Intermediate	1996	Marine	UK	UK
193		Summary	1998	Marine	UK	UK
194		Summary	2003	Marine	UK	UK
195		Summary	2000	Off-shore	Not Applicable	UK
196		Summary	1991	Off-shore	Not Applicable	UK
197		Summary	1991	Off-shore	Not Applicable	UK
198		Summary	1991	Off-shore	Not Applicable	UK
199		Summary	1992	Off-shore	Not Applicable	UK
200		Summary	1992	Off-shore	Not Applicable	UK
201		Summary	1992	Off-shore	Not Applicable	UK
202		Summary	1993	Off-shore	Not Applicable	UK
203		Summary	1993	Off-shore	Not Applicable	UK
204		Summary	1993	Off-shore	Not Applicable	UK
205		Summary	1993	Off-shore	Not Applicable	UK
206		Summary	1994	Off-shore	Not Applicable	UK
207		Summary	1996	Off-shore	Not Applicable	UK
208		Summary	1996	Off-shore	Not Applicable	UK
209		Summary	1997	Off-shore	Not Applicable	UK
210		Summary	1997	Off-shore	Not Applicable	UK
211		Summary	1997	Off-shore	Not Applicable	UK
212		Summary	1998	Off-shore	Not Applicable	UK
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217		Summary	1992	Off-shore	Not Applicable	UK
218		Summary	1993	Off-shore	Not Applicable	UK
219		Summary	1993	Off-shore	Not Applicable	UK
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223		Summary	1996	Off-shore	Not Applicable	UK
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225		Summary	1996	Off-shore	Not Applicable	UK
226		Summary	1992	Off-shore	Not Applicable	UK
227		Summary	1992	Off-shore	Not Applicable	UK
228		Summary	2003	Off-shore	Not Applicable	UK
229		Summary	2002	Off-shore	Not Applicable	UK
230		Summary	1998	Off-shore	Not Applicable	UK
231		Summary	1995	Marine	New Zealand	Australia
232		Summary	1999	Marine	Panama	Australia
233		Summary	1999	Marine	Australia	Australia
234		Summary	1998	Marine	Australia	Australia
235		Full	1994	Marine	Panama	Australia
236		Full	1999	Marine	Antigua & Barbuda	Australia
237		Full	1998	Marine	Australia	Australia
238		Full	1992	Marine	UK	UK
239		Full	2000	Marine	Nassau	Canada
240		Full	2000	Marine	Philippines	Australia
241		Full	1994	Marine	UK	UK
242		Intermediate	2001	Marine	Not Established	Finland
243		Full	1999	Marine	UK	UK

244		Full	2001	Marine	UK	UK
245		Intermediate	2000	Marine	Slovakia	New Zealand
246		Full	1993	Marine	Iran	Canada
247		Full	1998	Marine	Panama	Canada
248		Full	1999	Marine	UK	UK
249		Full	2002	Marine	Hong Kong	Australia
250		Full	2000	Marine	UK	UK
251		Full	1998	Marine	UK	UK
252		Full	2001	Marine	Nassau	New Zealand
253		Full	1998	Marine	Bahamas	Australia
254		Full	2002	Marine	Nassau	UK
255		Full	2001	Marine	Malta	Australia
256		Full	2001	Marine	Turkey	UK
257		Full	1999	Marine	New Zealand	New Zealand
258		Full	1992	Marine	Cayman Islands	UK
259		Full	2000	Marine	UK	UK
260		Full	2000	Marine	UK	UK
261		Full	2000	Marine	UK	UK
262		Full	2003	Marine	Hong Kong	Japan
263		Full	2001	Marine	Panama	Australia
264		Full	2001	Marine	Danish	Denmark
265		Full	1999	Marine	UK	UK
266		Full	1999	Marine	UK	UK
Total	**N**	**266**	**266**	**266**	**266**	**266**

Appendix IV

A4.0 Additional Data

When the project was initially designed the intention was to have four hypotheses rather than three. The fourth hypothesis intended to test seafarers' perceptions towards two proposed SOLAS changes to legislation affecting lifeboats, specifically, removal of personnel from the lifeboats during drills, and the requirement for lifeboat servicing to be conducted by external professionals rather than ships' crews. The project questionnaire was designed with the four hypotheses in mind.

However due to unforeseen and unavoidable circumstances the research process was delayed for longer than intended after the questionnaires had been sent out. In the intervening period, following comments on the initial scheme, it was reduced in size. The thesis limitation of 12000 words simply did not allow for the testing of all four hypotheses. Therefore the decision was made to remove the SOLAS section.

As the questionnaires had already been sent out it was not possible to amend the questionnaire to reflect this change, so information on the SOLAS hypotheses was collected. At the completion of the research it was decided that this data should not be lost as the findings might be of use to the parties who had expressed interest in receiving copies of the completed project. Therefore this information and the section of the project that related to SOLAS were added as an appendix. As this data exceeds the scope of the thesis no conclusions were drawn or actions taken other than to present it in a clear manner.

A4.1 SOLAS Legislation

Maritime safety agencies, aware of the problems involved with lifeboats, have strived to bring about changes to the International Convention for the Safety of Life at Sea 1974 (SOLAS) regulations that are governed by the IMO.

SOLAS was created following the high profile disaster to the *Titanic*, which is famously remembered for not carrying sufficient lifeboats for all personnel aboard, although *Titanic* did in fact carry more lifeboats than was required by the law at the time.[102]

SOLAS establishes the standards required of all Contracting Governments, however the implementation of the SOLAS conventions remains the responsibility of individual Governments and compliance varies considerably from country to country. Substantial differences in Flag State interpretations affect all areas of the marine industry including lifeboat design and accident investigation.[103] The IMO offers Flag States technical assistance and when ships enter foreign ports they can be inspected to IMO standards.

SOLAS can be open to considerable interpretation. For example SOLAS III/20 requires that all life-saving appliances shall be in working order and ready for use before the ship leaves port and at all times during the voyage. The regulation provides details of which appliances, like lifeboats, require weekly and monthly tests and inspections. However although SOLAS requires that '…*properly trained personnel familiar with the system…'* conduct such tests and inspections, it does not specify who this is. The result has been that testing has often been undertaken by inexperienced or inadequately trained personnel.[104]

Other SOLAS regulations can be directly linked to deaths and injuries caused by lifeboats. SOLAS III/19.3.3.3 requires that each lifeboat be launched with its assigned operating crew aboard at least once every three months. This requirement has meant that whenever a lifeboat failure has occurred it has almost inevitably resulted in injury to the lifeboat crew.

In an attempt to reduce lifeboat accidents, in May 2004 the IMO Maritime Safety Committee adopted Resolution 152(78), which amends Chapter III of SOLAS. The new regulations come into effect in July 2006 and alter the way lifeboat maintenance and safety drills are conducted.

Although the changes have been welcomed by the marine community they have not been without criticism. One change being made is that seafarers will no longer be required to be on board the lifeboat during drills. Therefore if an accident occurs there will be less chance of any personnel being injured, however while this may reduce the number of injuries it will not significantly reduce the number of accidents. This step may, in the long run, actually cause more accidents if the training drills are found to be less effective.

The new legislation also makes no attempt to address deficiencies in lifeboat design or to provide for an internationally agreed uniformity of design. This lack of consistency in design is a result of different interpretation being applied to IMO standards and has been identified with current lifeboat designs.[105] The Australian MSB raised the need for global consistency when they identified that non-standard control configuration between different designs of lifeboats was a key contributor to accidents.[106]

A4.2 Hypothesis Four

That the perceptions of seafarers' will reflect confidence in the proposed SOLAS legislative changes.

A4.3 Perceptions of Lifeboat Drills

Questions 10 & 11.

Please indicate whether you agree or disagree with the following statements for questions 10-11.

Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q10. Lifeboat drills would be safer if personnel were not required to be in the lifeboat during the drill.

1		2		3		4		5	

Q11. Lifeboat drills will be less effective in preparing for a real emergency if personnel are not allowed in the lifeboat.

1		2		3		4		5	

Fig A.4.3.1

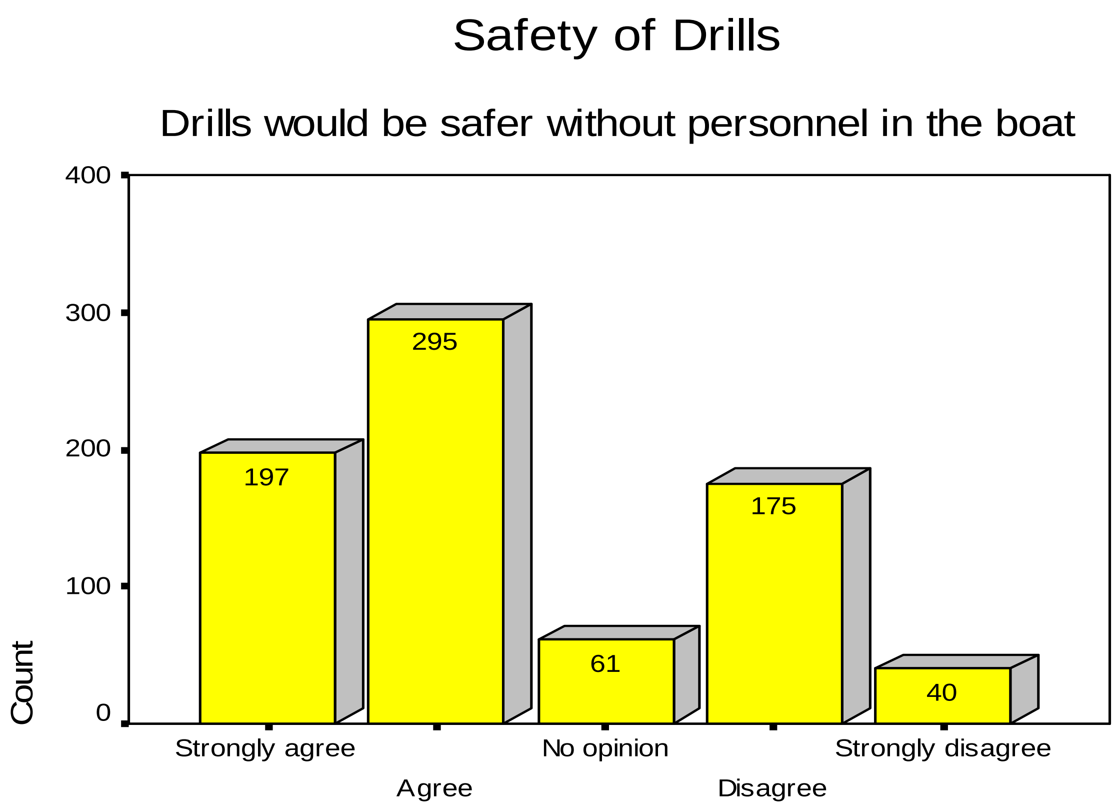


Fig A4.3.2

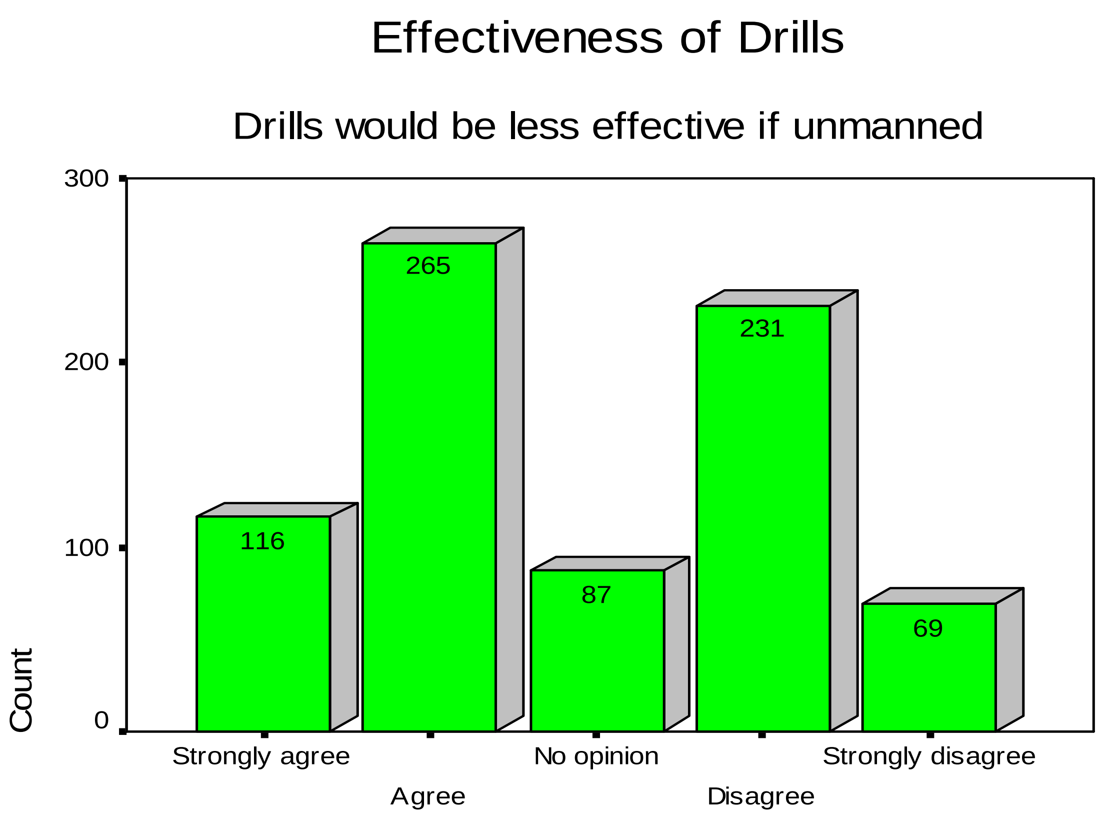
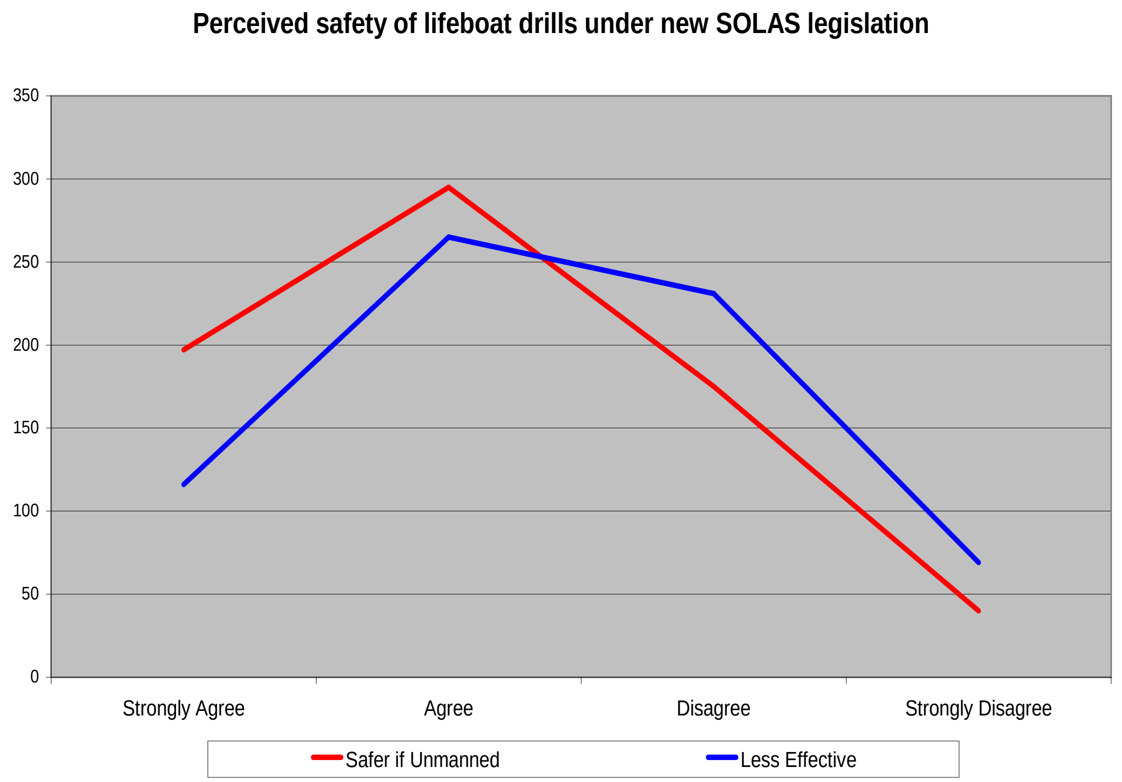


Fig A4.3.3



A4.4 Perceptions of Maintenance Issues

Questions 22 & 23.

Please indicate whether you agree or disagree with the following statements for questions 22 - 23.
Rating system: 1 = Strongly Agree, 2 = Agree, 3 = No Opinion, 4 = Disagree, 5 = Strongly Disagree

Q22. Specific training should be provided in maintaining the lifeboat systems.

1		**2**		**3**		**4**		**5**	

Q23. Servicing of lifeboat systems by professional external personnel would reduce the number of incidents.

1		**2**		**3**		**4**		**5**	

Fig A4.4.1

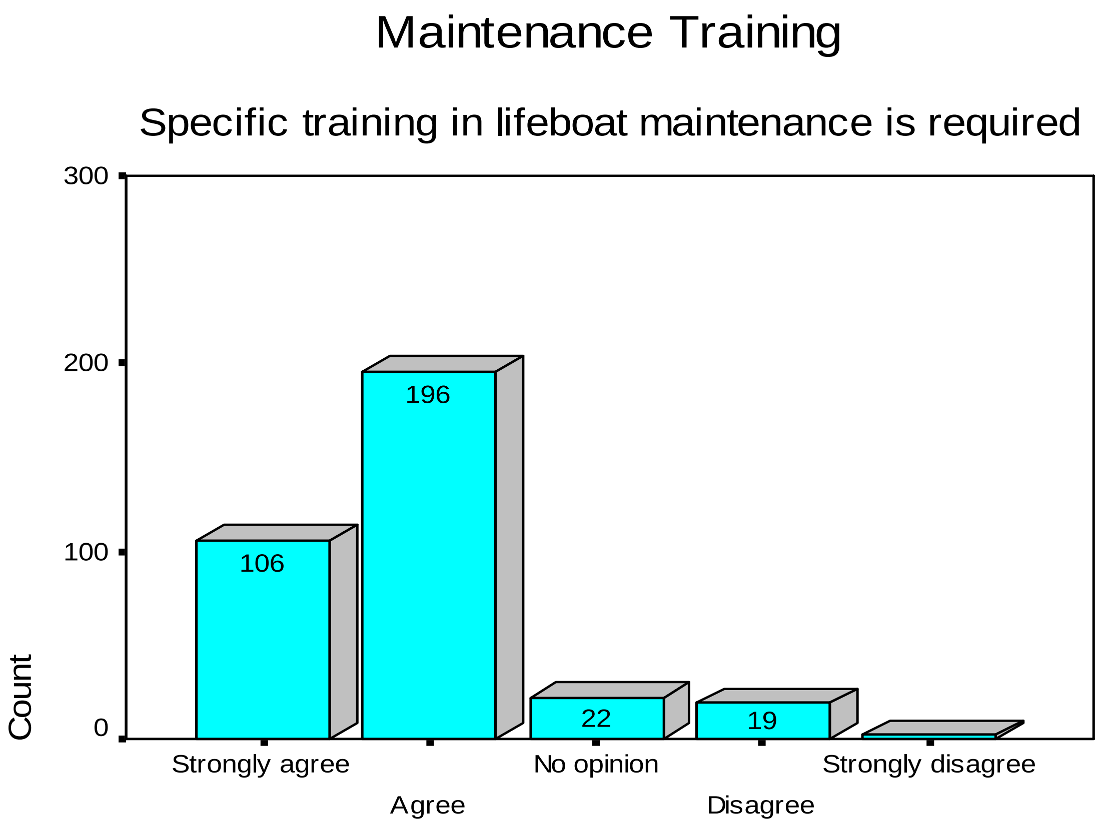


Fig A4.4.2

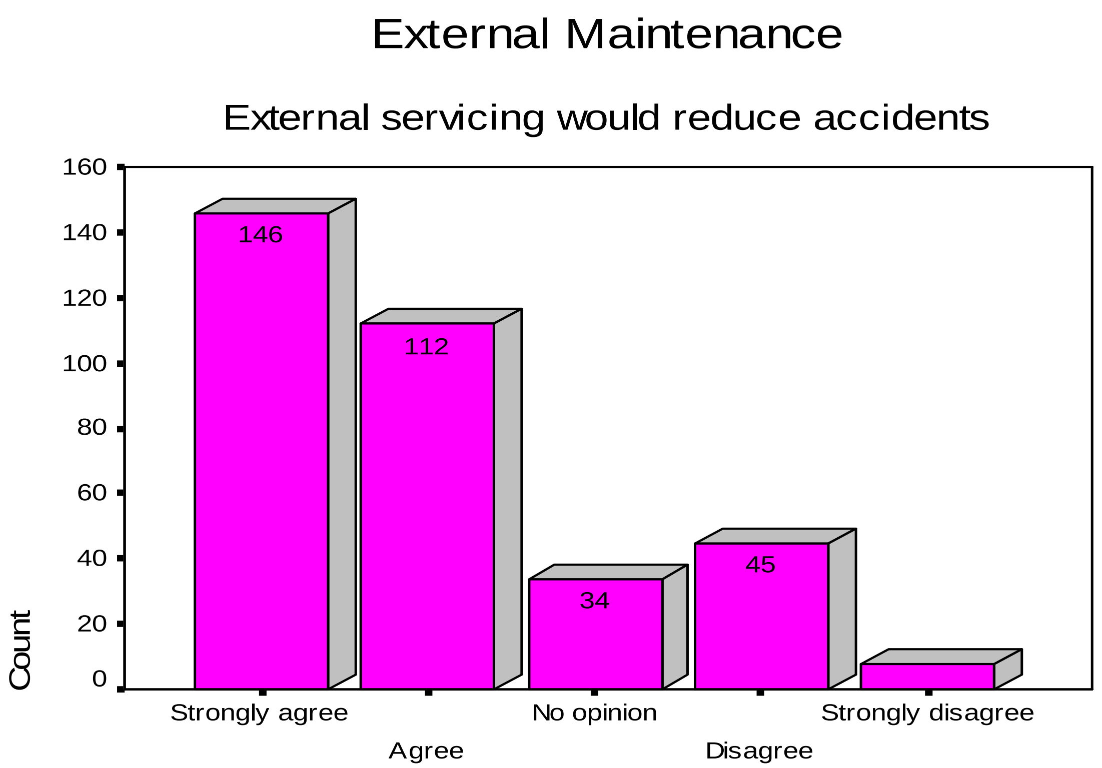
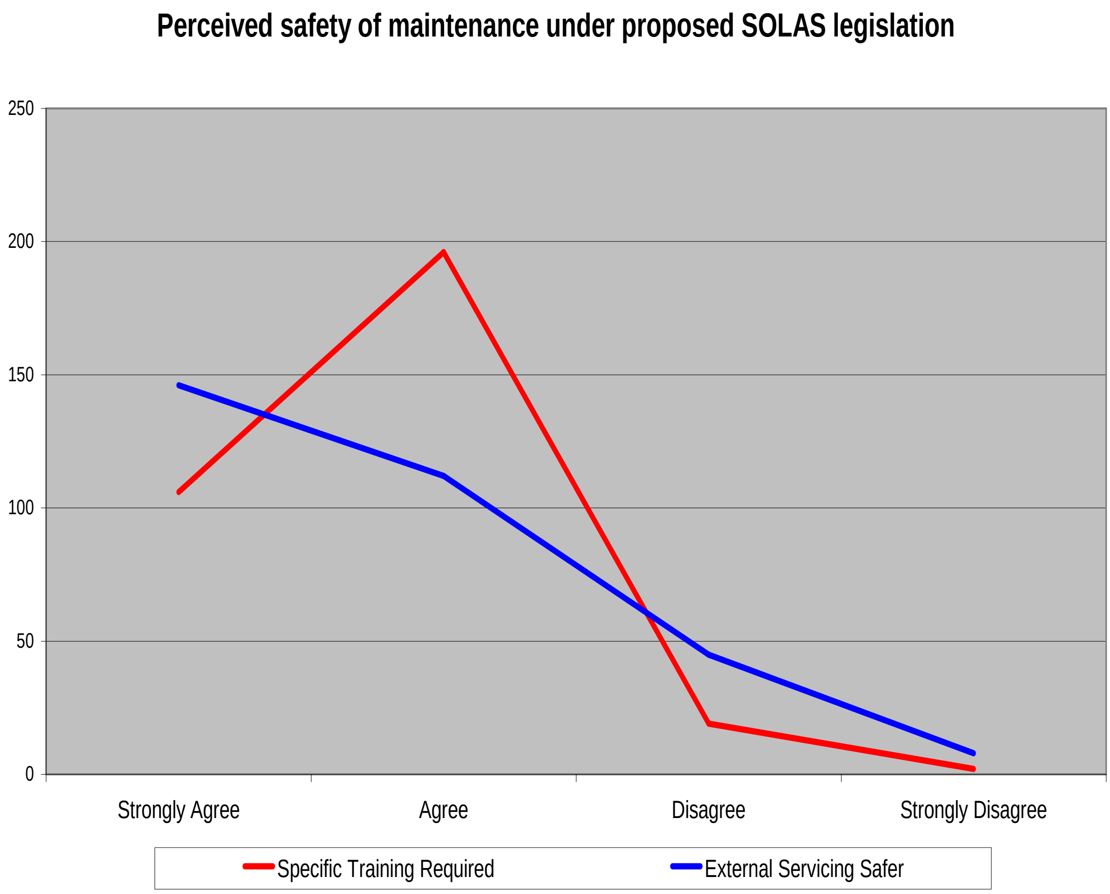


Fig A4.4.3


Perceived safety of maintenance under proposed SOLAS legislation
250
200
150
100
50
0
Strongly Agree
Agree
Disagree
Strongly Disagree
Specific Training Required
External Servicing Safer

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