

SAFETY STUDY 1/2001

**REVIEW OF
LIFEBOAT AND LAUNCHING SYSTEMS'
ACCIDENTS**

FOREWORD

The Marine Accident Investigation Branch's sole aim is to improve safety at sea. It achieves this in three ways. It investigates a small number of accidents very thoroughly to produce recommendations designed to prevent the same thing happening again. The findings of such investigations, together with the conclusions and recommendations, are made publicly available. Secondly it looks at a larger number of accidents to identify the lessons to be learned and, through its Safety Digests, passes them on to others and, thirdly, it analyses the information held in its database to identify trends or to draw conclusions from a number of accidents. The conclusions are then published in a Safety Study to draw attention to a particular shortcoming or concern.

For some time now, MAIB inspectors have become increasingly worried by the relatively high number of accidents involving ships' lifeboat launch systems. Many of these have resulted in people being killed or injured. The database was therefore searched for detailed information on the subject and, once analysed, confirmed the inspectors' suspicions that there were some fundamental problems with such systems.

This led to a thorough review of past lifeboat accidents to identify where the problems might lie. A principal aim was to draw the marine industry's attention to the findings and to highlight a number of shortcomings that were within the gift of the industry to correct. The review has found, however, that there are some fundamental weaknesses in the launch systems and poses the potentially controversial question as to whether lifeboats are strictly necessary in this day and age.

Although the MAIB database is reasonably extensive, it is recognised that before any significant changes can be made or even suggested, there is a need for a more wide ranging study to be undertaken with access to more comprehensive data than is available to just one marine accident investigation organisation. It is therefore recommended that the International Maritime Organization (IMO) undertakes a study on the present value, need, and desirability of lifeboats. Should this conclude that lifeboat launching systems are indeed necessary, it should go on to give consideration to formulating the requirements for safe lifeboat launching systems in merchant ships.

It is recommended that such a study be undertaken as a matter of urgency and before more seafarers are killed, maimed or injured.

It needs to be done before any passengers are killed.

J S Lang
Rear Admiral
Chief Inspector of Marine Accidents.

Acknowledgement

Various respected parts of the industry, operators and manufacturers, were consulted during the production of this Safety Study. Their responses have been carefully considered and, where possible, included. Some have been omitted because MAIB's database did not include data on the subject raised. Despite this reservation, all responses were supportive of the general objectives and conclusions of this study. MAIB thanks all those who made a contribution.

CHIEF INSPECTOR'S FOREWORD

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GLOSSARY OF ABBREVIATIONS

ARI	-	The Merchant Shipping (Accident Reporting and Investigation) Regulations 1999
GMDSS	-	Global Maritime Distress and Safety System
IMO	-	International Maritime Organization
MAIB	-	Marine Accident Investigation Branch
Ro-Ro	-	Roll-on Roll-off
RNLI	-	Royal National Lifeboat Institution
SOLAS	-	Safety of Life at Sea (Convention)

EXECUTIVE SUMMARY

In the decades since it became a requirement that lifesaving appliances are available for everyone on board a vessel, many design features of lifeboats and their launching systems have changed. These have usually been in response to the demands for larger lifeboat capacity, greater protection for those using them, ease of operation and enhanced safety.

Force for major change has usually come from recommendations following high profile accidents where there has been heavy loss of passenger life, most notably the *Titanic* in 1912. Although lifeboats have been used on many occasions since then and, most noticeably, in two world wars, there have been very few changes to lifeboat design and equipment even though many professional seafarers have lost their lives while using them.



Typical lifeboat / davit installation

Since it was formed in 1989, the MAIB has received a number of reports about seafarers being injured, and sometimes killed, in accidents involving lifeboats. Scrutiny of the data held by the MAIB suggests that anyone using a lifeboat, be it in a drill or a genuine evacuation, runs a risk of being injured or even killed.

The MAIB database accumulated over a ten-year period indicates that lifeboats and their launching systems have cost the lives of 12 professional seafarers, or 16% of the total lives lost on merchant ships. Eighty seven people have been injured. These accidents all occurred during training exercises or testing, with experienced and qualified seafarers either performing, or supervising, the operations.

The concern raised by study of the figures has prompted the MAIB to carry out an in-depth study of all accidents involving lifeboats, with the aim of identifying the nature of the problem and making recommendations to improve safety.

This Safety Study is now complete and the results published. It concludes there are significant risks when using lifeboats, and maintains there is a clear need for the marine industry to reconsider the effectiveness of, or indeed the need for, lifeboat launching systems. The MAIB believes the present incidence of loss of life and injury will continue, or even increase, unless changes are made. This study has sought to highlight both the problems and the risks, with a view to encouraging the marine industry to make the changes believed to be necessary.

The need for lifeboats as opposed to other lifesaving apparatus is based on the concept that the survival craft should be capable of being navigated independently. This stems from an era when communications were poor or even non-existent. There are numerous examples of survivors undertaking remarkable feats of seamanship in navigating lifeboats over long distances to a safe haven. It is almost inconceivable that this would be required in these days of Global Maritime Distress and Safety System (GMDSS) when a vessel in difficulty can quickly and automatically summon assistance

The need for navigable survival craft has largely disappeared. That they remain in service is a legacy of conditions applicable in the early 20th century and before. There are, however, situations when some form of power is needed, such as clearing a lee shore or a vessel that is on fire, capsizing or sinking. Power might also be necessary to clear lifesaving craft from a vessel in distress in rough weather, or when survivors are seen in the water and need to be rescued. These requirements can be met by means other than lifeboats with independent propulsion.

The Safety Study has found that people using lifeboats are exposed to the greatest risk during embarkation and recovery. It argues that if the number of people involved during these times can be minimised, the risks to individuals will be reduced, as will the loading on equipment.

Although the designs of lifeboat launching systems have developed over the years, many manufacturers have felt unable to offer innovative changes in design. Ship-owners have, for their own reasons, been unwilling to implement or finance any fundamental changes. As a result, the development of lifeboat launching systems has been incremental, slow and usually in response to changes in legislation.

The Study did not seek to criticise any sector of the marine industry, but set out to achieve five objectives.

To draw the industry's attention to the number of accidents that have occurred since 1989.

To ensure that lessons are not forgotten.

To identify common factors leading to these accidents.

To review the risks associated with lifeboat launching systems by examining common problems encountered.

To make recommendations which would contribute to improving safety at sea.

The Study found that a root cause of many of the accidents was the over-complicated design of the lifeboat launch system and its component parts, which in turn required extensive training to operate. It also found that personnel incurred many risks. It identified that training, repair and maintenance procedures fell short of what was necessary, and that there were extensive problems with manufacture, construction, maintenance and operation.

It recommends that IMO undertakes a study of the present value, need, and desirability of lifeboats. Such a study should embrace all reported incidents and accidents from around the world. If it concludes that lifeboat launching systems are necessary, the study should be extended to formulate requirements that embrace common operating procedures. The systems should be capable of being operated and readily understood by people with minimum training and experience and, above all, can be used for training and deployment both reliably and safely without injuring anyone.

SECTION 1 - BACKGROUND

1.1 INTRODUCTION

Since the United Kingdom's Marine Accident Investigation Branch (MAIB) was formed in 1989, it has received a number of accident reports involving lifeboats, davits, winches and associated equipment. Some of these accidents have resulted in loss of life or serious injuries and have, where possible, been fully investigated. Many others were less serious, and the brief reports received usually focused on the immediate causes. Few of these less serious accidents were investigated by the MAIB, but when taken with the others they showed that lifeboats featured as one of the most common sources of accidents in merchant vessels, accounting for an unacceptably large number of injuries and deaths.

The UK was not alone in making this discovery. In a note to the International Maritime Organization (IMO) Sub-Committee on Flag State Implementation, dated 14 October 1999, Australia submitted a summary of lifeboat accidents covering nine such incidents between 1991 and 1998. Many of the findings echoed those seen in the UK database, and also noted that most of the accidents occurred during training or exercises.

Neither the UK nor Australia had any record of a complete or partial emergency evacuation of a vessel using lifeboats but were aware that they had occurred in vessels of other flagged states. One of the most recent was the evacuation of the Bahamian-flagged cruise ship *Sun Vista* in the Malacca Strait on 20 May 1999, when everyone on board managed to get away safely in calm conditions. The MAIB noted from the accident investigation report that many lifeboat deficiencies were identified.

The MAIB was sufficiently concerned by the seemingly endless reports of accidents involving lifeboats, and their launching systems, that it decided to carry out a safety study and report its findings. This decision was prompted partly by reports that a number of people no longer felt that carrying out drills in lifeboats was safe. If true, and crews were indeed reluctant to train with lifeboats, it would mean that the necessary skills may not be readily available in the event of a real emergency.

The MAIB Safety Study was initiated to examine lifeboats and their launching systems.

1.2 STUDY AIMS

Using information held on the MAIB's database as its primary source, the Safety Study had five aims:

1. To draw the marine industry's attention to the number of accidents that have occurred since 1989.
2. To ensure that lessons are not forgotten.

3. To identify common factors leading to these accidents.
4. To review the risks associated with lifeboat launching systems by examining common problems encountered.
5. To make recommendations which would contribute to improving safety at sea.

1.3 MAIB's DATABASE

All accidents considered in this Study have been reported to the MAIB under the UK's Merchant Shipping (Accident Reporting and Investigation (ARI)) Regulations, or have been investigated by the MAIB on behalf of another administration.

Reports received since 1991 have been entered in to the MAIB database. Although the ARI have been amended twice since they were first introduced, and the classification of some types of incidents has changed, those associated with lifeboats and their launching equipment have remained constant.

The data for this Study has been derived from three basic sources: the MAIB's own investigations of the more serious incidents, information held on its database, and from reports submitted to the Branch by ship's safety officers, masters and/or shipping companies.

1.4 DATABASE SEARCH

The MAIB database was searched to identify accidents involving lifeboats, davits or their winches. The results are set out in **Annex A**.

The accidents were classified under the following headings:

Classification	Number of Incident	Injuries	Lives Lost
Hooks	11	9	7
Tricing and Bowsing	10	5	2
Falls, Sheaves and Blocks	12	19	2
Engine and Starting	18	15	0
Gripes	12	10	0
Winches	32	8	0
Davits	7	7	0

Free-fall	2	1	0
Weather	2	0	0
Not Otherwise Classified	19	13	1
Successful Evacuation	0	0	0
	Total	87	12

The 12 lives lost and 87 injuries relate only to professional seafarers.

1.5 OTHER FATAL ACCIDENTS

To put these accidents in perspective, a search was also made for all other fatal accidents, not involving lifeboats and launching systems, over the same period. The results are set out in Annex B and show that 73 lives were lost. They are summarised as follows:

<u>Type of accident</u>	<u>Lives lost</u>
Entering confined spaces	12
Fall overboard	12
Fires and explosions	10
Access to ship	7
Mooring and towing lines	6
Crush (machinery)	6
Slips and falls	6
Crush (cargo)	5
Lifting gear	3
Tug girting	2
Capsize	2
Weather	2

All lives lost were those of professional seafarers.

The list shows that the same number of lives were lost in accidents involving lifeboats and their launching systems as were lost in each of the two other activities that had the most fatalities: entering confined spaces (12) and falls overboard (12).

SECTION 2 - COMMON PROBLEMS ENCOUNTERED WITH LIFEBOATS AND LAUNCHING SYSTEMS

2.1 ON-LOAD RELEASE HOOKS

The most common cause of fatal accidents involving lifeboat launching systems is the failure of on-load release hooks. In the 11 accidents reported over the 10-year period, seven people were killed and nine injured. These figures suggest that although there are still relatively few such failures, the consequences can be serious.

A SOLAS requirement for lifeboats on ships built after 1 July 1986 stipulates that they should be fitted with a hook disengaging gear, capable of being operated both on and off-load. This requirement has resulted in a number of manufacturers worldwide developing various ingenious mechanisms for satisfying the regulation. As a result, many on and off-load release hooks have become over-complicated, and a number of accidents have occurred.

These accidents have generally resulted in a lifeboat being released involuntarily from one or both of its hooks. On those occasions when only one hook has been released, the attachment at the other end was often torn away, causing the lifeboat to drop into the water; sometimes inverted.

As older vessels are withdrawn from service, the proportion of vessels susceptible to this predicament will increase.

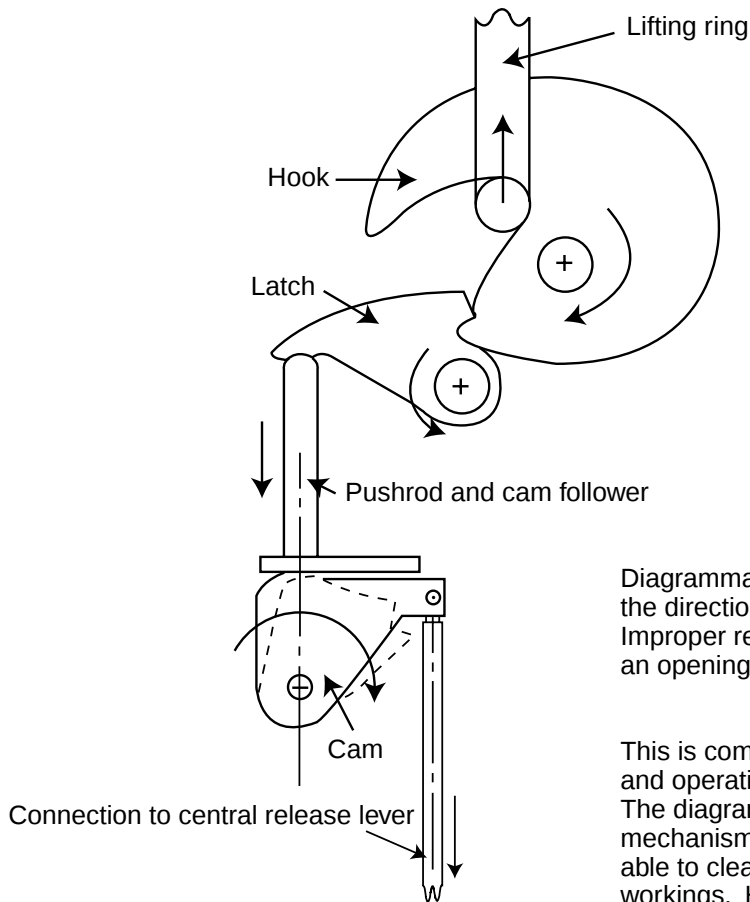
2.1.1 Operational

It has been found that crews generally have a poor understanding of the operating principles involved with release hooks, often because of inadequate training. This is not the only reason. Poor labelling, complex mechanisms and hard to follow operating instructions in some manufacturers' manuals have also featured as contributing factors **(see Figure 1)**.

Once a lifeboat is afloat, crews can often find a method of releasing it from its hooks even if they cannot operate the release mechanism correctly. At the present level of development of on-load release systems, it is usually possible to remove the lifting rings locally. This is not an explicit requirement of SOLAS, but systems so far encountered by the MAIB have always been arranged like this.

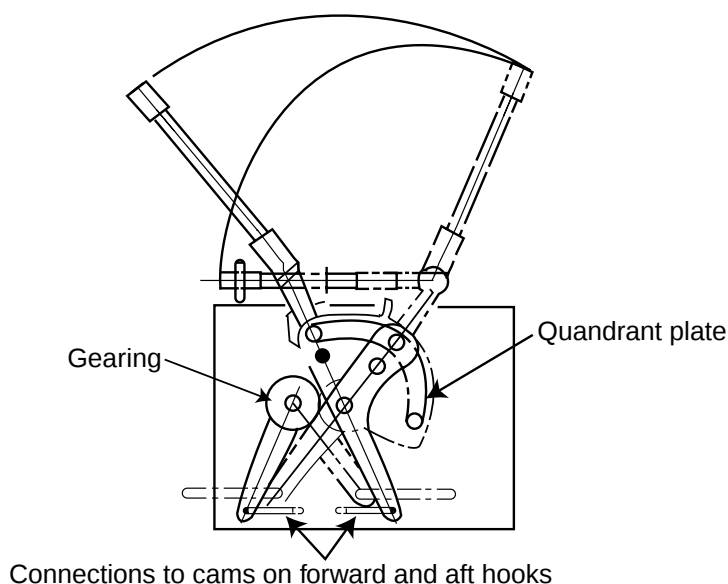
Analysis of a number of accidents reveals that premature hook release has often been caused by the failure to re-set it correctly when the lifeboat was being recovered from its previous launching. This shortcoming stems from a lack of understanding of the mechanism involved, inadequate training and poor maintenance. Once the hook has been incorrectly reset, spontaneous release is possible at any time before the lifeboat is next put in the water **(see Figures 2 and 3)**.

Figure 1



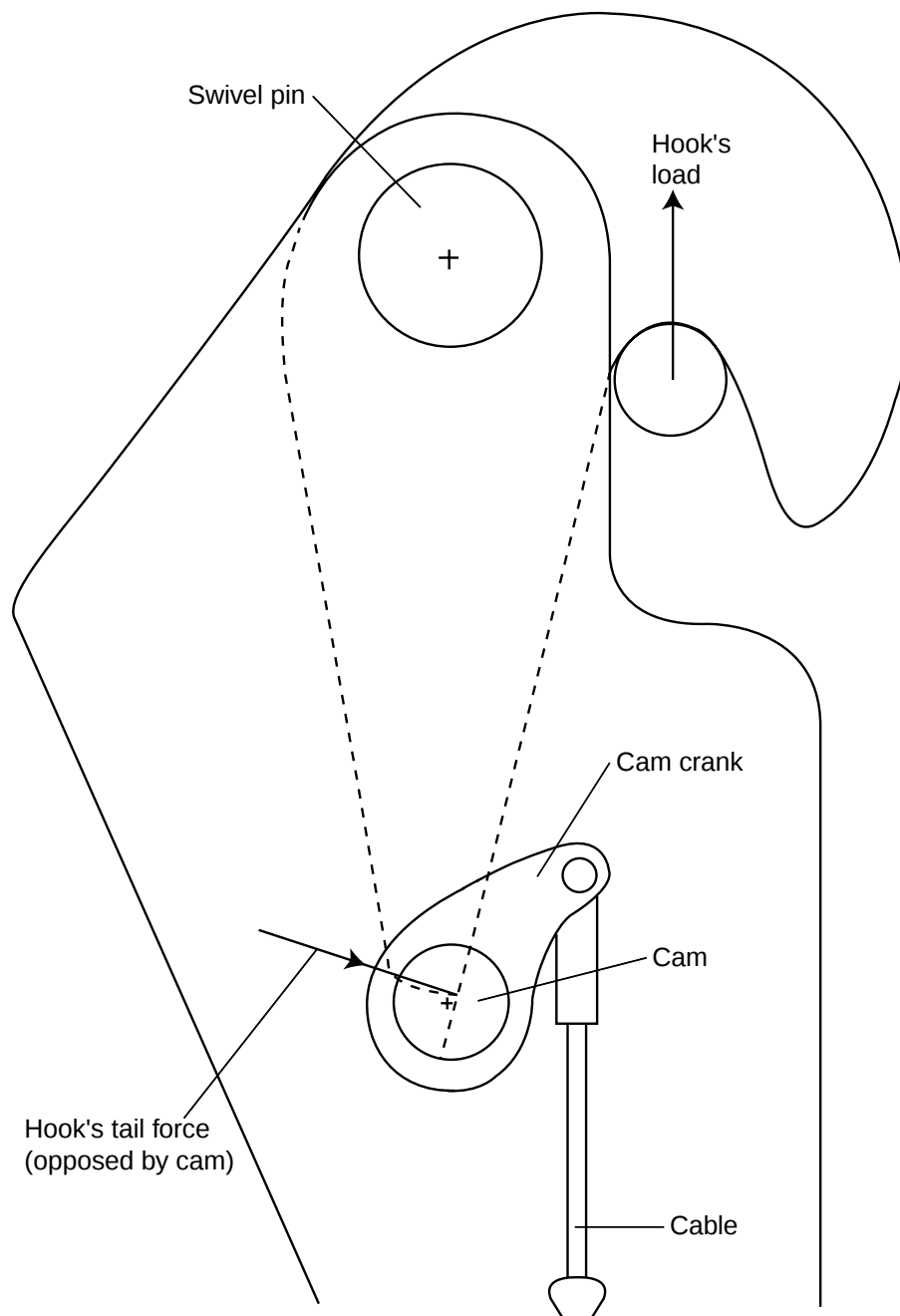
Diagrammatic arrangement of hook release mechanism and the direction of movement of its components during release. Improper resetting of the cam, as shown dotted, can induce an opening moment leading to inadvertent release.

This is compounded by the complexity of the mechanism and operating instructions that are difficult to understand. The diagram, showing the important features of resetting the mechanism, is complicated and makes it necessary to be able to clearly see the actual mechanism to understand its workings. However, viewing the mechanism is difficult, making understanding of the diagram difficult. Other material in the manufacturer's instruction manual was of little help in this task.

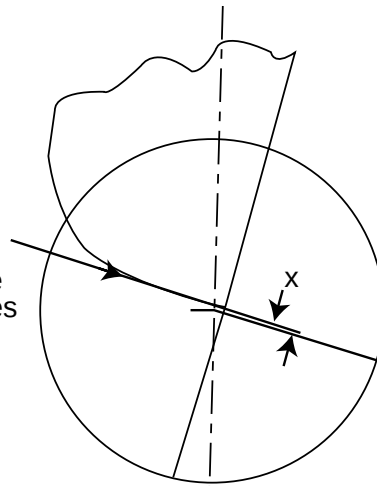


The central operating lever is placed adjacent to the coxswain's position, often in such a fashion that the gearing, quadrant and very important safety pin cannot be viewed easily. Indeed it is often impossible for the user to obtain the same view of the mechanism as it is shown on the instruction panel, he can see it only from above, making the important components difficult to identify. This problem is aggravated by these parts being below the bottom boards of the boat in an area of darkness.

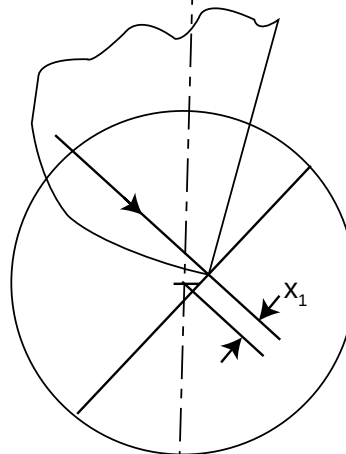
Figure 2



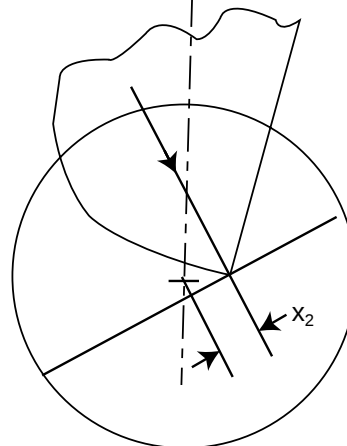
Hook and cam in fully closed position. Flat face of cam and tail of hook are in contact. This gives the minimum lever 'x' by which the force from the hook's tail generates an opening moment on the cam. This moment is resisted by the moment generated by the cable force.



Partially closed condition. Improper resetting of the cam when a boat is being recovered might generate this state. Can be aggravated by sticky cables. The size of the lever ' x_1 ' is much greater than that for the fully closed position 'x'. This allows the force from the hook's tail to generate a much larger opening moment on the cam. It is possible for this moment to overcome that generated by the cable leading to rotation of the cam and spontaneous opening of the hook.



Further rotation of the cam leads to increase in the size of the lever to ' x_2 '. The moment generated on the cam is so large that it will almost certainly overcome the moment generated by the cable force. The hook is then able to fully open.



The above sequence shows the magnification in hook opening effects due only to the growth in lever of the force in the hook's tail. Other changes take place as the cam's face rotates, which result in an increase in magnitude of the hook's tail force and thus also the cam rotating moment. All of these effects indicate the importance of properly resetting the cam when recovering a boat.

Any other factors which increase the lever, such as wear of the hook's swivel pin and bush, will, when under load, allow the hook and its tail to rise relative to the cam. Even in the fully locked position the lever 'x' is then increased, as are the levers ' x_1 ' and ' x_2 ' during the later part of the opening sequence. A similar effect is achieved if the tip of the hook's tail, where it makes contact with the cam, is excessively worn.

IMO Resolution MSC.48(66) adopted the International Life Saving Appliance (LSA) Code on 4 June 1996. This amended Chapter III of SOLAS on lifesaving appliances and arrangements by requiring a *special mechanical protection* to be provided, rather than the earlier *adequate protection* to counter the possibility of accidental or premature release of hooks.

The new code requirement applies only to equipment fitted to new ships. It is not yet clear how future designs will evolve to satisfy this requirement. It is equally unclear how such changes will reduce the number of premature releases of lifeboat hooks.

2.1.2 Design

Most designs of on-load release hooks are fitted with an interlock designed to prevent release before the lifeboat enters the water. To satisfy the SOLAS requirement for an on-load release capability it is, however, possible to override them.

There is also a SOLAS requirement for the on-load release capability to be protected against accidental or premature use. Some designs include a hydrostatic or mechanical interlock to satisfy this requirement. Where fitted, the MAIB knows of no incident where failure of such a device has led to involuntary release.

Some flag administrations interpret this SOLAS requirement differently. They do not insist on an interlock to prevent premature release, and this has meant that a number of companies worldwide, have made systems that do not have a common level of protection against premature release. The failure to provide an interlock has been responsible for a number of accidents. Responsibility for this situation lies with the Flag States and not the manufacturers who merely comply with the requirements.

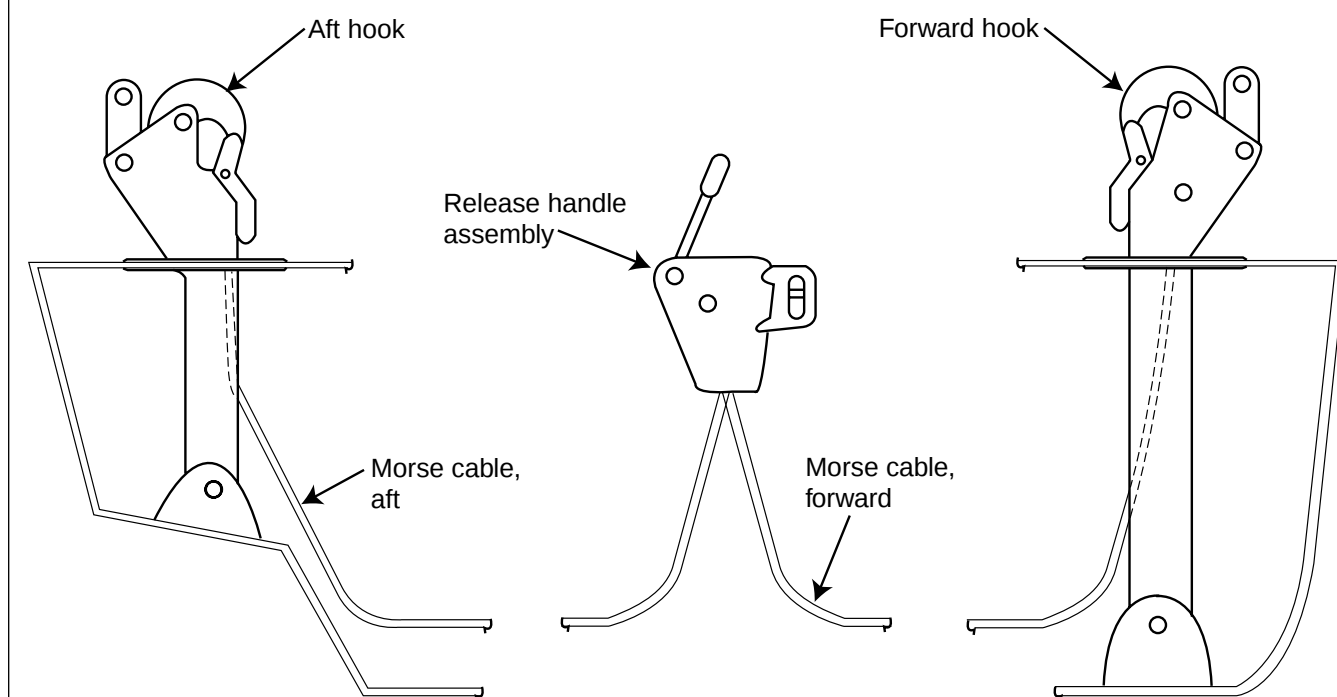
Amendments to Chapter III of SOLAS, contained in The International Life Saving Appliance (LSA) Code, contain additional wording covering requirements for on-load release hooks. It remains to be seen whether these changes will lead to a reduction in the number of accidents, or any uniformity of requirement between administrations.

Despite these developments, a problem still exists with some vessels built after 1986. These have equipment unprotected by mechanical interlocks, or have operating procedures that do not differentiate between releasing on and off-load.

2.1.3 Maintenance and repair

To comply with the requirement that both hooks are released simultaneously from a single control position, it is common for release mechanisms to include flexible cables to connect the control lever to the hook mechanisms (**see Figure 4**).

Figure 4



Operating cables

The cables are usually of a type where an inner multi-strand wire slides within an outer sheath; sometimes referred to as *bowden* or *morse* cables. They offer a lightweight, cost effective and simply installed method of transmitting the usually moderate forces and motions required to operate most hook designs.

The MAIB has found, however, that these cables can seize if the stranded wire becomes corroded. This can result in the on-load release hook failing to close properly when being reset. This in turn has resulted in inadvertent release later. Once corroded these cables cannot be repaired effectively, and have to be replaced. The evidence shows that management and crews are often unaware that such replacement is necessary.

In response to one MAIB recommendation, a manufacturer amended its on-load release hook operation and maintenance manual to emphasise the importance of replacing damaged or corroded cables. It is not always the case. It is known that some other manufacturers do not draw attention to the inherent dangers of not replacing corroded cable.

Complexity of design

Investigations of several incidents have found that on-load release hook systems are complex and difficult to understand without having an in-depth knowledge of their mechanism and the operating instructions.

One hook design associated with a particularly serious accident relied on very fine engineering tolerances being maintained. Wear, combined with fretting and corrosion, affected the forces on its components and its ability to resist spontaneous opening. Its designers and type approval organisations paid insufficient attention to the hostile environment in which it had to function, such as salt air, weather and vibration. There was also a failure to recognise how seriously these conditions would degrade the hook's performance. The MAIB is uncertain whether the existing testing requirements for this particular system are sufficient to address these very real concerns. It believes that a unified testing document would help.

Automatic approval should not always follow when a system performs the tests presently required by SOLAS. Consideration must also be given to the likely ability of the system to perform in the marine environment between surveys and inspections.

Crews rarely possess the necessary engineering knowledge to fully understand the system operating principles. In several accidents the complexity of the design has been clearly linked to maintenance and operating problems. This complexity has not always been appreciated, nor the need for maintenance by staff with specialist knowledge recognised.

Without specific training for the equipment in use or easily understood and high quality instruction and operation material, seafarers are unlikely to acquire an adequate understanding of these designs. This has been shown to have an adverse influence on the quality of on-board maintenance, and has also led to sloppy and dangerous operating procedures.

The need for reliable and comprehensive maintenance is paramount; there is sufficient evidence to show this is not being achieved in a number of vessels. The MAIB believes that the need for such quality maintenance based on an in-depth understanding of the design and mechanisms is so important that only the manufacturers and their agents should service such systems, or personnel who have undertaken a manufacturer's approved course. This is supported in the text of the 1996 Amendments revision to SOLAS, which requires *thorough examination and test during surveys by properly trained personnel familiar with the system*.

The MAIB notes that the amendment has not yet been included in the legislation of the United Kingdom and some other Flag States.

2.2 BOWSING AND TRICING

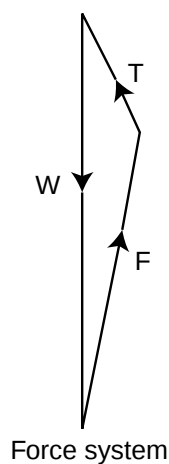
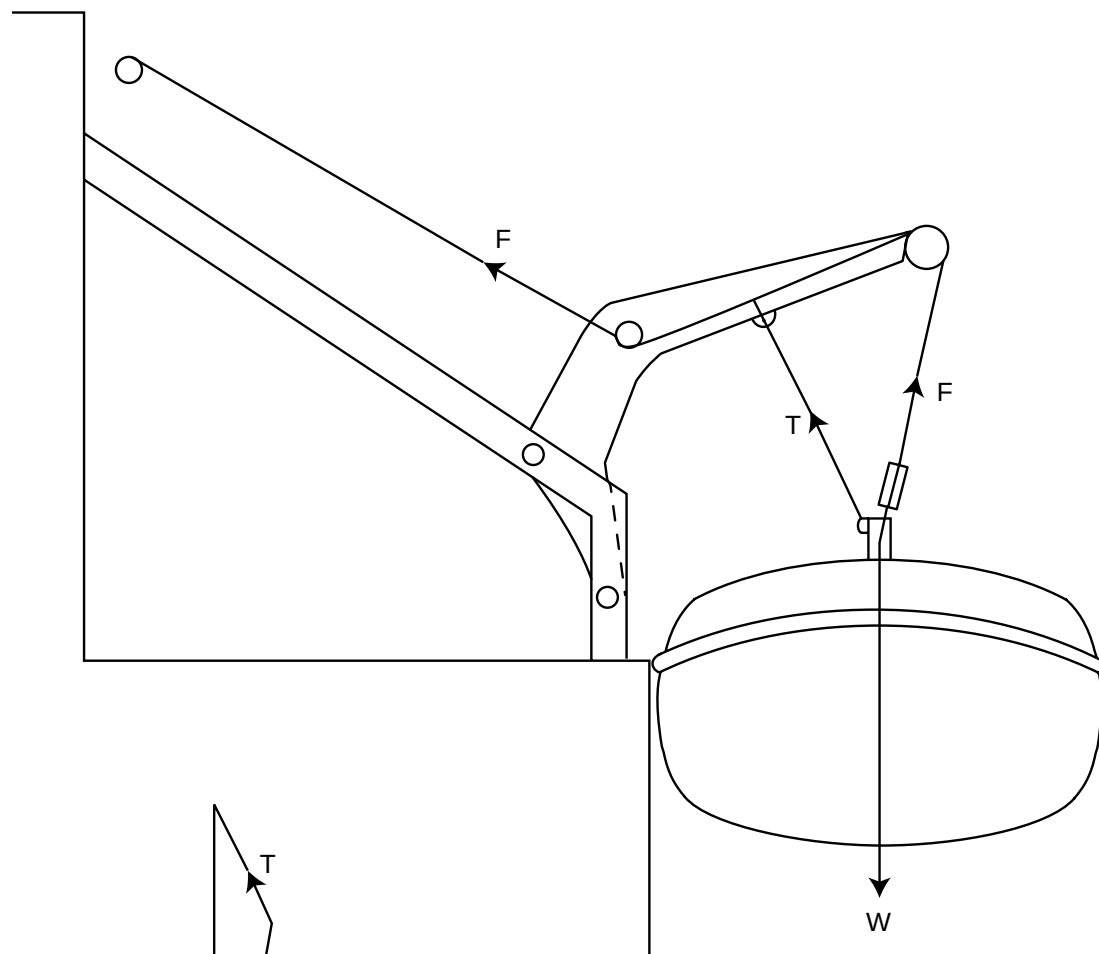
Of the ten accidents reported involving bowsing and tricing, one resulted in two fatalities, and five in injury.

2.2.1 Operational

If a lifeboat is not to be boarded in the stowed position, it must be capable of being held in to the side of the vessel for safe embarkation. This is achieved conventionally by the sequential use of tricing pennants and bousing tackles.

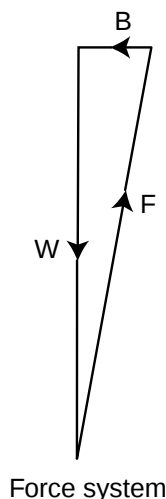
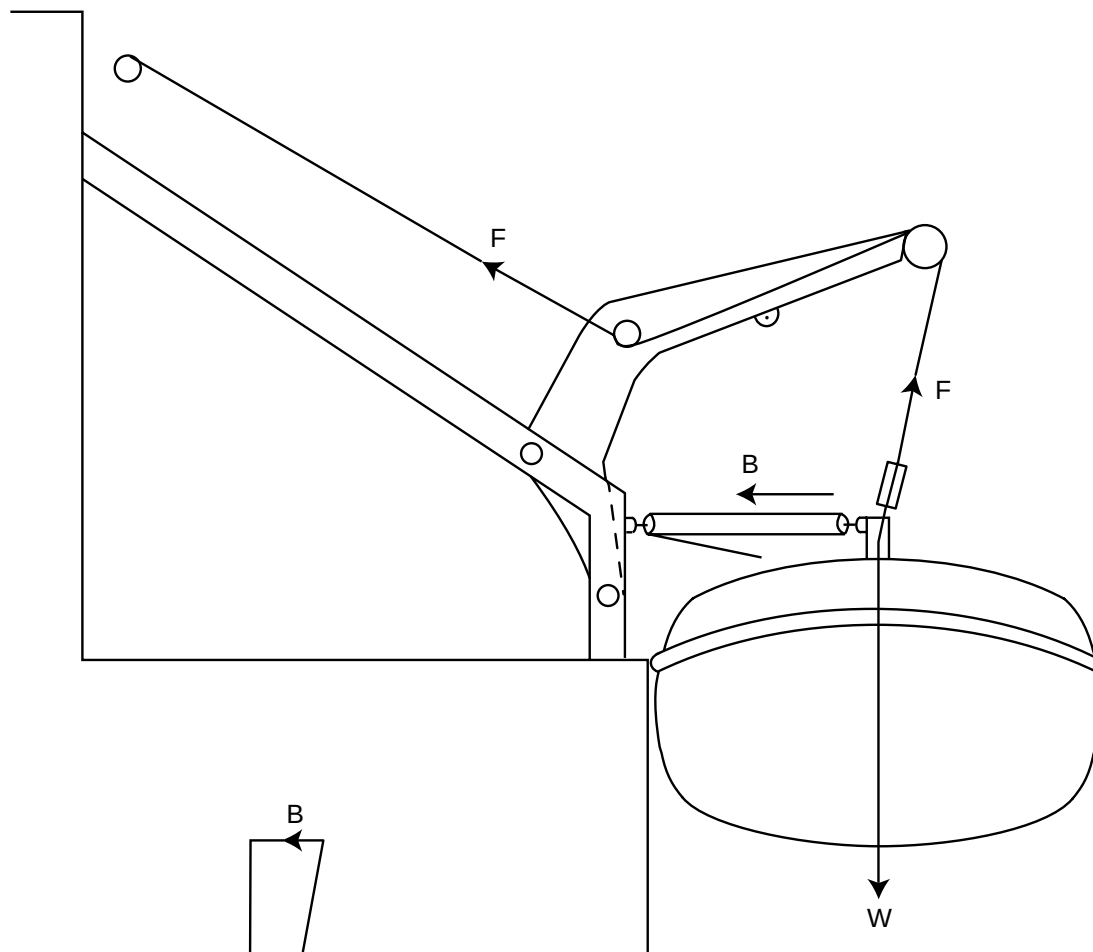
Launching procedures call for the lifeboat to be lowered to embarkation level while the tricing pennants pull it into the side of the vessel (**see Figure 5**). Once at the correct level, bousing tackles are secured between the forward and aft lower blocks and the ship (**see Figure 6**). When tightened they take over the function of the tricing pennants, which are then disconnected.

Figure 5



Lifeboat lowered to embarkation level. Winch is stopped at a position such that the tricing pendants have pulled the boat almost into contact with the ship's side, or in very light contact only. The boat's weight (W) is shared between the tricing pendants (T) and the falls (F). Note that the tricing pendant load (T) is noticeably less than the boat's weight (W).

Figure 6



Lifeboat lowered to embarkation level, triced in and the bowsing tackles fitted. Once tricing pendants are slipped, properly tensioned bowsing tackles retain the lifeboat into the ship's side. Because the bowsing forces are virtually horizontal, only the falls load (F) supports weight (W), as intended. Also, F is acting in the back falls and contributes to the support of the davit arms.

This process can be time-consuming while the bowsing tackles can be heavy and awkward to handle, particularly on high capacity lifeboats. Investigations have shown that the full bowsing-in procedure is often ignored during crew exercises.

When the lifeboat carries only its launching crew, holding the lifeboat to the side of the vessel with just the tricing pennants can be achieved with relative ease, and causes no serious problem. Attempting the same procedure with a fully or, indeed, partially laden boat is potentially dangerous. A number of accidents have occurred as a result.

In most exercises the lifeboats are rarely fully loaded, and the need for rigging bowsing tackles is often ignored, particularly if the boat is to be returned to its stowed position

immediately afterwards. Such a procedure then becomes the normal practice, and the correct techniques are either ignored or forgotten, with launch crews viewing the bowsing tackles as cumbersome and an unnecessary nuisance.

Bowsing tackles have an important role to play to bring the lifeboat plumb on its falls. With the lifeboat triced into the embarkation position it becomes necessary to transfer the load to them. Many accident investigations, however, reveal a variety of shortcuts and unsafe procedures that result in injuries.

There is evidence to show that some crews do not rig the bowsing tackle, but choose instead to let go the tricing pennants by releasing the senhouse slips. This, at best, results in a lifeboat swinging out from the ship's side in an uncontrolled fashion and injuring those embarked, sometimes seriously. Unless the lifeboat's crew are safely secured, they may be injured by the sudden movement, or lose their balance and fall over the side. The risk of this happening is high, particularly if any of the crew is on the lifeboat's canopy to gain access to the tricing pennants' senhouse slips.

Properly rigged and tensioned bowsing tackles remove the loads from the tricing pennants before they are slipped. By gradually paying them out, the lifeboat can be controlled to reach the plumb condition so that undesirable and potentially dangerous swinging is avoided. This is the procedure that properly trained and disciplined seafarers or lifeboatmen are expected to follow, and one of increasing importance if the vessel is developing a lowside list.

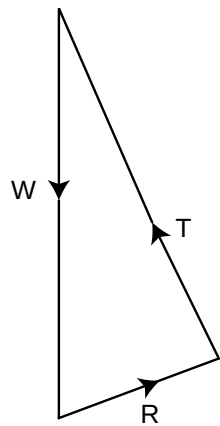
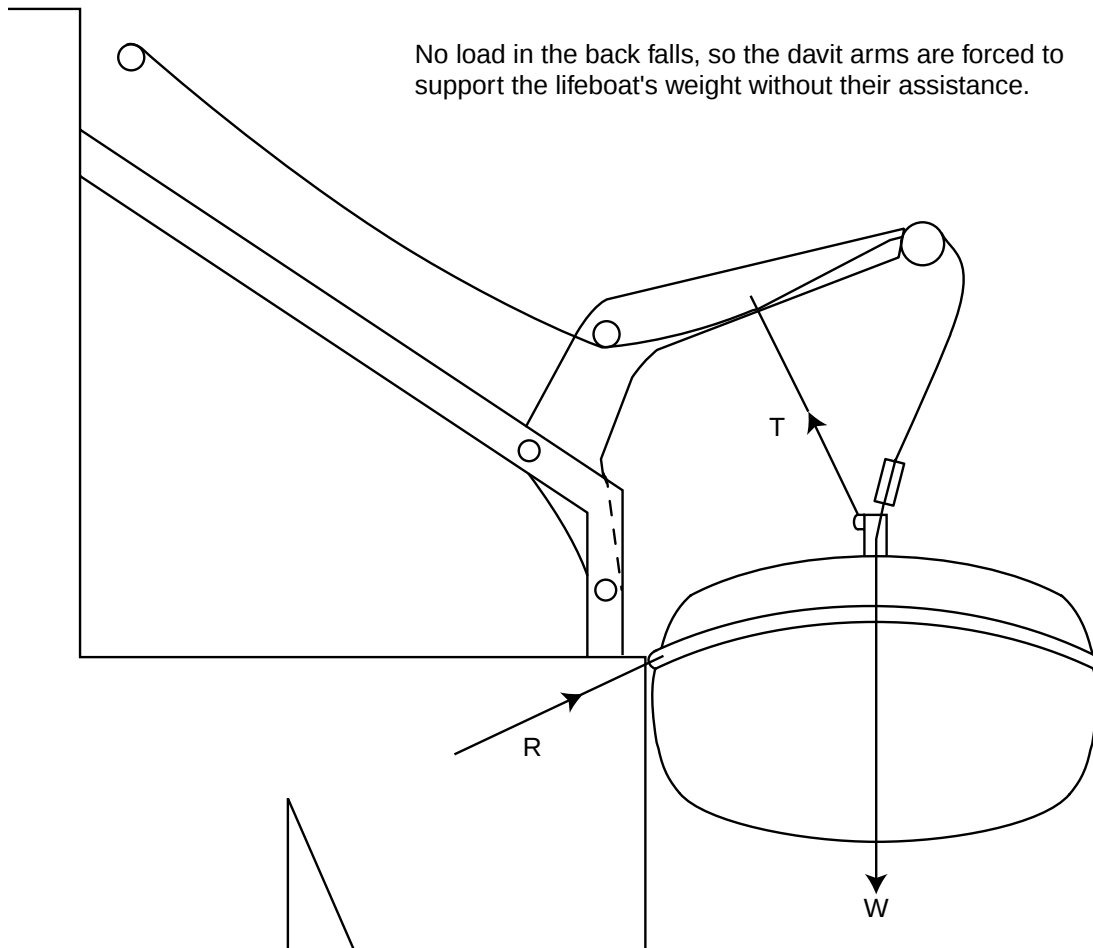
Because so many exercises do not involve lowering the lifeboat into the water, the decision is often taken to dispense with the bowsing tackles altogether, and continue with the tricing gear alone. What starts as a convenient measure develops into accepted practice which may well lead to injuries in training or drills or, worse still, the procedure to be used in an emergency.

A second potential danger of not bowsing in a lifeboat is that a loaded lifeboat might overload the tricing pennants. If they fail (**see Figure 7**), the consequences can be serious. This is likely to occur if the lifeboat is brought hard against the ship's side. It can even lead to the falls going slack if the winch wire is paid out too far. Tricing pennant failure would again cause the boat to swing uncontrollably, endangering anyone who happened to be embarking at that particular moment.

Failure of a single tricing pennant with slack falls has been known to have serious implications. When continuous falls are fitted, they will run out at the end where the failure has occurred. The lower block at the other end will simultaneously rise, sometimes sufficiently far and hard to hit the head of the davit arm. This imposes a dynamic overload on it and may lead to failure with the consequential repercussions for anyone in the lifeboat. This seemingly unlikely train of events has occurred in one boat where the crew was testing experimental tricing/bowsing gear (**see Figure 8**). It was a serious accident and people were killed.

The MAIB has received reports of tricing pennants failing in some vessels, and the crews being persuaded to increase the pennant strength to prevent a repetition. In the MAIB's opinion this further encourages the crew to retain tricing pennants in exercises, rather than use the bowing tackles.

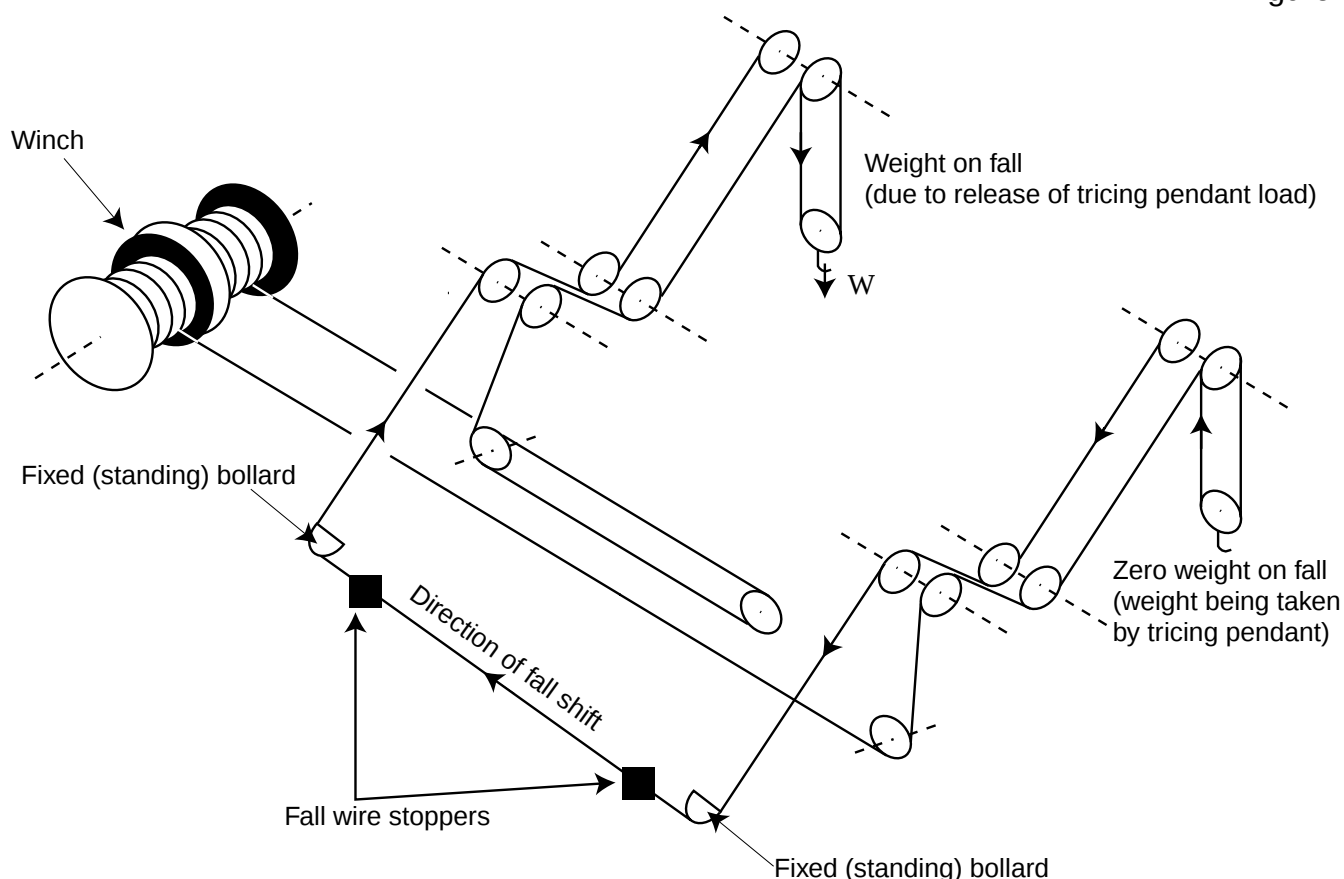
Figure 7



Force system

Lifeboat lowered to embarkation level. However, winch is allowed to run to the extreme position where the falls become slack. The boat's gunwale is in heavy contact with the ship's side. The tricing pendants now take the boat's weight (W) alone and their loading is much increased. A load that they are rarely designed to take.

Figure 8



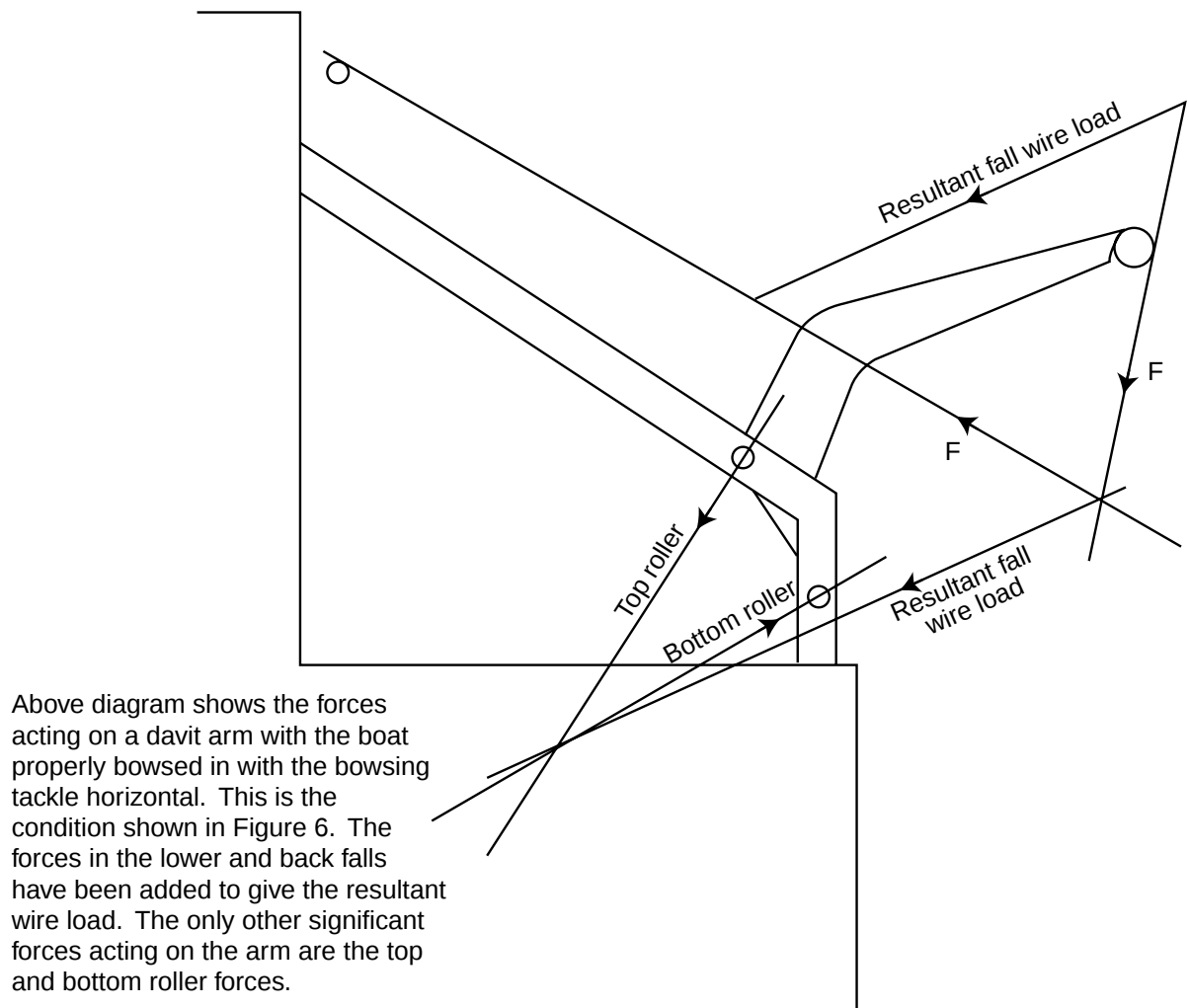
When lowering the boat to embarkation level, the winch might be payed out so far that the falls go slack. Only the tricing pendants then take the boat's weight. Should one tricing pendant then fail, or is slipped, the weight at that end attempts to transfer to the falls. However, as there is no weight on the falls at the other end, because the remaining tricing pendant is still taking it, they can offer no balancing reaction. They then have a tendency to shift or slide towards the end where the tricing pendant has failed. This tendency is normally resisted by friction between the falls and the standing bollards. But, again, without load in the falls no significant friction force can be generated.

The shift may be sudden and might not be resisted by the fall wire stoppers.

2.2.2 Design

A further consequence of not properly bowing in a lifeboat can occur if the load bearing capacity of the davit arms is dependent on support offered by the back falls which lead inboard from the davit heads (**see Figure 9**). With the lifeboat at embarkation level, and supported by falls and tricing pennants, its weight is shared between them. The greater the proportion of weight taken by the tricing pennants, the less will be taken by the falls. This gives a corresponding reduction in the load on the back falls, which means that their contribution to supporting the davit arm is reduced. This results in an increased portion of the load being taken on the supporting structure of the davit arm and can, on some designs, overload it if the boat is fully laden (**see Figure 10**).

Figure 9



Above diagram shows the forces acting on a davit arm with the boat properly bowsed in with the bowsing tackle horizontal. This is the condition shown in Figure 6. The forces in the lower and back falls have been added to give the resultant wire load. The only other significant forces acting on the arm are the top and bottom roller forces.

The diagram to the right is the above force system giving the relative magnitudes of the forces.

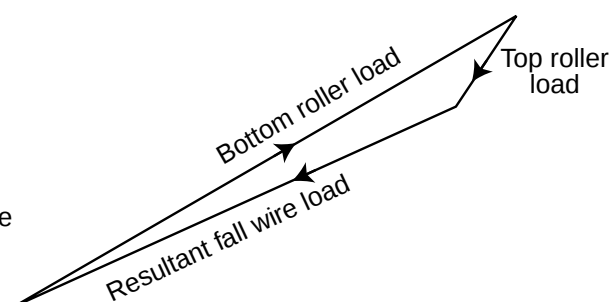
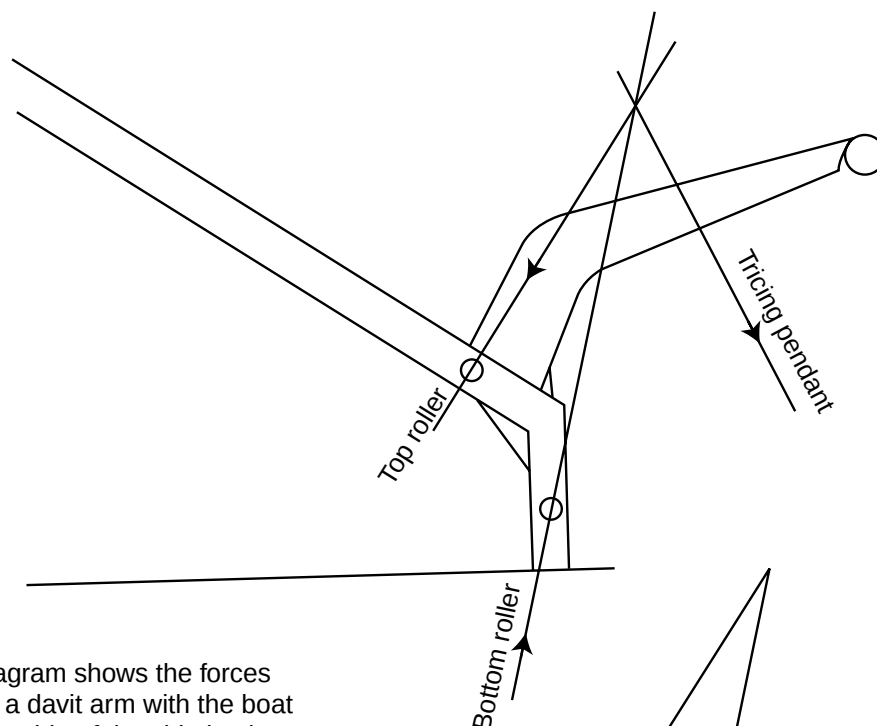
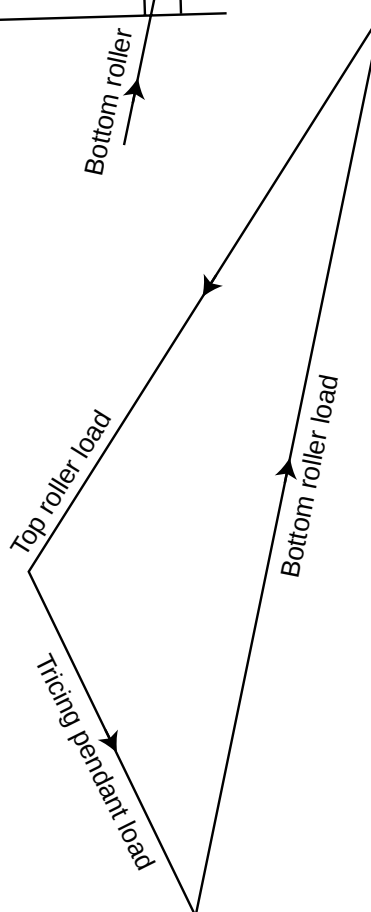


Figure 10



Above diagram shows the forces acting on a davit arm with the boat held to the side of the ship by the tricing pendants and with the falls slack. This is the condition shown in Figure 7. The only significant forces acting on the arm are the tricing pendant load, the top and bottom roller forces.

The diagram to the right is the above force system giving the relative magnitudes of the forces. Notice how much greater are the roller loads compared to the properly bowed in condition of Figure 9.



In this context it should be noted that bowsing tackles, in contrast to tricing pennants, are normally arranged so that when fully rigged, they are close to the horizontal. Tricing pennants are usually much nearer to the vertical, and therefore take a greater proportion of the boat's weight. This geometry ensures that properly rigged bowsing tackles are unable to support any significant component of the boat's weight, so make no significant reduction to the load on the falls.

This critical feature has led to one total failure of a davit arm during an overload test. The surveyor failed to recognise the contribution made to the davit arm's support by the back fall load. He agreed to the test load being supported directly from the davit head, rather than being applied to the hook and lower block. On application of the test load, the davit arm was torn from its trackway. Fortunately since it was a test, nobody was in a position to be injured, but it demonstrates how important the support of the back falls load can be in some designs.

Ship's crew can rarely identify whether back fall loads are critical features of a davit design. Such information is normally the preserve of the designer or those who have carefully analysed the design. Those who actually operate the systems do not, in practice, need such detailed knowledge providing they routinely follow the correct tricing and bowsing which will eliminate any possible danger.

The examples of failures stemming from the incorrect use of tricing pennants, and the difficulties found in using bowsing tackles, raises the question as to whether they are still necessary.

They were first introduced in days when lifeboats tended to be relatively small, light and open. Over the years lifeboats have become increasingly larger and heavier, and many are now enclosed. Both tricing pennants and bowsing tackles have, however, been retained with their strength being simply increased in proportion to the increased weight. The increased size and weight of many modern lifeboats has further implications: an increase in manual effort for the crew.

Some owners and equipment manufacturers have recognised these shortcomings in exercises. Many of the problems are operational, but by the time the system has been selected, installed and commissioned, it is too late to do anything other than make comparatively minor, non-structural, changes to improve matters. Solutions to the known problems of trying to hold in a large heavy boat have usually been solved by designing a combined tricing and bowsing gear operated by a winch.

Some equipment manufacturers have rethought the entire concept, and have designed new types of launching systems which have totally dispensed with tricing and bowsing systems. Although the costs are higher than many more traditionally based systems, the design philosophy appears to be worth close scrutiny by the industry.

As part of its study, the MAIB attempted to gauge the industry's reaction to such a development, and soon detected a difference of opinion. On the one hand there are

designers attempting to market systems which they consider to be better and safer than those currently in use. On the other, there are shipowners who are not only concerned by the additional costs involved, but have reservations about the risks of introducing an untried system. They are also concerned about the possibility of having to modify or change it after installation to ensure that it works properly.

Some shipowners are also influenced by the international regulatory system, and the need to satisfy the requirements of SOLAS. While a laudable attitude at face value, it ignores the reality that these standards are minimum requirements and can be exceeded.

2.2.3 Maintenance and repair

MAIB's database has insufficient information to allow an analysis to be made of the effectiveness of maintenance and repair regimes for tricing and bowsing gear.

2.3 FALLS, SHEAVES AND BLOCKS

Two people have lost their lives and nineteen have been injured in twelve incidents involving the failure of suspension links or chains.

A factor identified in most of these accidents was that the components were manufactured from high tensile steel. Analysis of the incidents has shown that incomplete post-welding heat treatment generated inappropriate properties. It was also found that incomplete test records contributed to the final outcome.

The UK administration accepted these findings, and introduced additional survey and documentation requirements for these high tensile items.

Several failures of fall wires have occurred due to incorrect installation, abuse or failure of components, such as sheaves or motor limit switches. None resulted in death or injury and there has been only one case where failure was attributed to corrosion and/or fatigue. An overall analysis suggests that the present requirements for fall surveys and replacements are satisfactory.

2.4 ENGINE STARTING

Some crew members have been injured while attempting to start lifeboats' engines. In general these have been caused by poor starting techniques, and there is no evidence to indicate the problem was unique to lifeboat engines.

Many of the incidents were attributed to a lapse of attention and are common in any activity, including the starting of engines. They can be avoided.

2.5 GRIPES

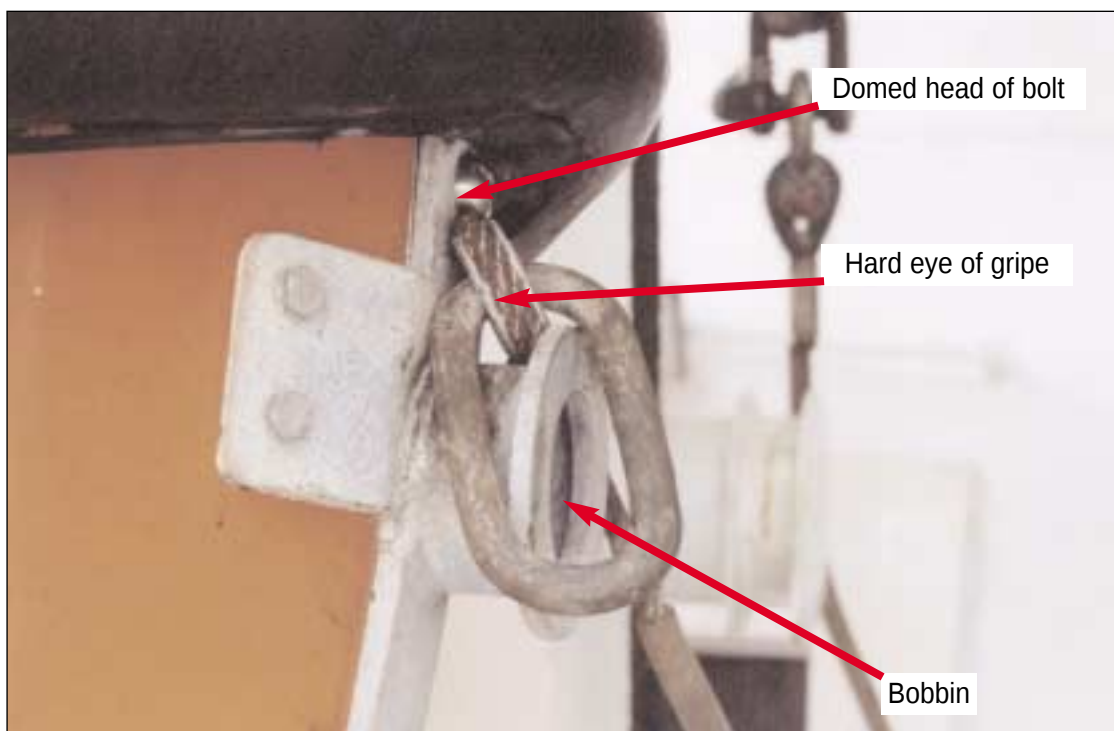
Relatively minor injuries have been caused by various parts of lifeboats' gripes. Ten people have been injured in 12 incidents.

The most frequently observed cause is when the gripe is under tension, and a hand or finger is trapped by the senhouse slip leg, springing back when the retaining ring is knocked clear.

The need to free gripes manually is gradually diminishing with the introduction of automatic gripe systems; favoured where lifeboats are boarded in the stowed position. These appear generally successful in the sense that they require no manual operation of slips etc. They effectively remove operators from potential danger.

The MAIB received one report where the hard eye on the freed end of a gripe fouled the gripe's bobbin and the domed head of a mounting bolt (**see Figure 11**). This happened during the early stages of lowering. Fortunately it happened during an exercise where there was someone available on the vessel to free the gripe. Had this occurred in different circumstances, the lifeboat could have been loaded, lowered clear of its davits, and yet been prevented both from being lowered to the water and raised under control of the people in the lifeboat. Changing the size of the hard eye allowed the gripe to slide freely over the bobbin and cured the problem.

Figure 11



2.6 WINCHES

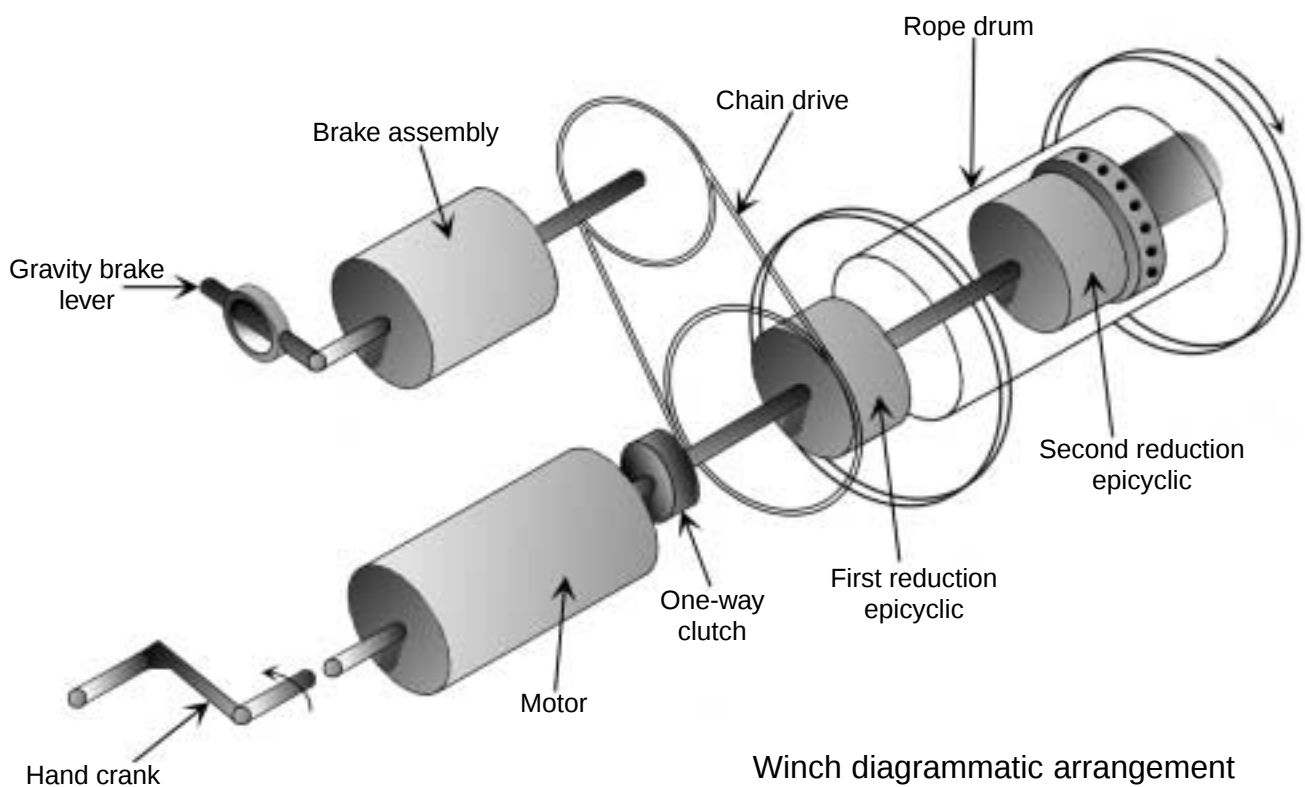
The most frequently recorded source of accident involves winches: there have been 32 incidents leading to 8 injuries. Although there have been no fatalities, some of the failures have had the potential to cause very serious accidents.

2.6.1 Design

Some designs of lifeboat davit winches employ a form of one-way clutch to allow their gear train to rotate while hoisting and without the need for the brakes to be released simultaneously. Alternatively, they are used to prevent rotation of the hoist motor shaft when power is shut off (**see Figure 12**). For a number of years these units consisted of spring-loaded pawls running over toothed sprockets.

During the 1960s several new designs of winches were submitted to the UK Administration for approval. Some employed one-way sprag-type clutches. These used smooth inner and outer tracks, and relied entirely on friction forces to lock the unit. Carefully shaped spring-loaded sprags within the annular space between the tracks, generated the locking forces. These units ran free when one half of the unit turned, and locked when opposite rotation was applied.

Figure 12



Confidence in these apparently untried units was initially low, and did not improve until several designs had been subjected to rigorous on-load testing. Most one-way clutches were fitted to winches having a Safe Working Load (SWL) of 6 tonnes or less, and many were designed for hoisting using hand power alone. If hoist motors were supplied they were often portable.

Winch designs have changed in the decades since then, and lifeboat winches now often have one-way clutches. There are also more types used, including one that uses spring-loaded rollers. Another uses non-symmetrical sprags and disengages with the help of dynamically-generated forces.

Some of these one-way clutches have failed in service. In such circumstances a lifeboat can lower uncontrollably and in some conditions, such as having bowing or tricing gear connected, it can tilt. The consequences for any occupants are likely to be serious.

Clutch failure can also lead to the lifeboat descending with neither the centrifugal nor manual brakes having any effect. Such failures have been found to occur immediately the hoisting motor has been stopped, when stowing the lifeboat, or when adjusting its position at embarkation level using the motor. The clutch is unable to re-lock after having run in the freewheel direction.

The MAIB is concerned about these failures, and is carrying out an investigation to identify the principle reasons why one-way clutches in lifeboat winches have failed. This investigation is not yet complete.

2.6.2 Maintenance and repair

Although there is no recorded incident of a winch's gear train failing, there are many reports of other components not functioning as intended, such as one-way clutches, brakes and switches. These have usually been due to shortcomings in their maintenance, repair or adjustment but have not, fortunately, resulted in any fatalities.

Reports by owners and ships' officers point to many instances of neglected or incorrect maintenance, causing brake failure. Examples include excessive wear, oil or grease contamination, incorrect adjustment and assembly. Efficient winch brakes are essential to the safe lowering of lifeboats, and to ensure they function correctly they must be correctly maintained.

The winches are often regarded as being straightforward items of machinery, and very suitable for maintenance by ship's staff or general engineering contractors. Regular preventative maintenance is, of course, essential and well within the competence of a qualified ship's engineer, but many owners arrange for ship's staff or non-specialist contractors to undertake major overhauls and rebuilds. This is not satisfactory and many reported incidents owe their origins to such work being carried out incorrectly.

Because of their position in the power control system of winch motors, limit switches are regarded as being part of the winch system. They often malfunction. Winch motor control switches have also failed. If this prevents the motor being stopped while hoisting it can lead to other components being damaged. Such occurrences have been reported but, so far, without anyone being injured.

Crankhandle interlock switches are designed to isolate the power supply to the winch motor when the handle is in place. Instances of the switches failing, or being over-ridden, have been reported, as have the consequences; the handle begins to turn when the motor is started and catches people unawares. Injury results.

Common factors in the failure of many of these switches include the ingress of water and resultant corrosion. There are also reports of inappropriate or careless application of paint, which demonstrates fundamental shortcomings in maintenance.

It is reasonable to expect that a certificated ship's engineer is capable of performing much of the maintenance and repair work satisfactorily. He should however recognise the limitations.

Most ship's engineers will have followed some form of core training and certification programme covering the basic principles of engineering and marine equipment. But such training cannot be sufficiently comprehensive to cover everything. It will often emphasise the types of equipment found in the traditional machinery spaces. Lifeboat winches are often regarded as being outside that domain and are given a very low priority during core training. It may not be covered at all.

Faced with having to repair a lifeboat winch, the ship's engineer is unlikely to have received any type-specific training for the task and will not find the maintenance manual sufficiently comprehensive or accurate for his needs. Despite his best intentions, he will be working without detailed knowledge of many important features of a winch's design.

It is also evident from a number of the reports examined that lifeboat winch maintenance does not attract a high priority. Unless a port state control inspection or other survey has identified a deficiency, it takes a very determined chief engineer to allocate staff to the task of winch adjustment, or even repair. He is much more likely to give a higher priority to main machinery. His choice will largely be influenced by the actual attitude to safety by the owners. Although the declared position may well be that safety is paramount, it will often take second place to commercial considerations, especially if any delay leads to large financial penalties.

The MAIB has encountered a few exceptional examples where a company's declared policy is truly applied, and safety does take precedence. It is worth noting that a large proportion of these outstanding companies employ equipment manufacturers, or personnel trained by them, to maintain their winch and davit systems. One of the sad features of the shipping industry is that apart from having fewer accidents, few people ever reward the company that invests in greater safety.

2.7 DAVITS

Seven incidents involving davits have been reported to the MAIB. None has involved a fatality or an injury.

Current practice is to install lifeboat davits on the lowest of a vessel's weather decks. Generally this allows for access and, to a degree, minimises the detrimental effect of top weight on a vessel's stability. To achieve this weight reduction, apart from cost consideration, optimising the use of structural materials is important.

Notwithstanding this requirement for lightness, reported structural failures of davits have been notable by their absence. Failures have occurred, but these have all been under conditions of overload, such as during testing or when large dynamic forces have been generated as a consequence of other components giving way.

Davits are invariably positioned so that the lifeboats can be stowed within a vessel's beam. This means they must slide, swing, or otherwise rotate to bring the lifeboat clear of the ship's side when required for use. In some passenger vessels, headroom restriction sometimes prevents this movement from being achieved by gravity alone. Stored energy systems are then employed to satisfy the dead ship operating requirement, but it increases the operating complexity and generates a need for maintenance. The position is aggravated where a large number of davits are carried.

The constraint on space is an aspect of davit design, particularly in some new vessels that greatly concerns davit manufacturers in private. They are hesitant to voice their misgivings to potential customers. No such constraint is considered in this review.

2.8 FREE-FALL LIFEBOATS

Only two incidents involving free-fall lifeboats are on MAIB's records. One resulted in injury due to the failure of a seat during launching.

Once training has been completed, and trial launches experienced, crew appear to quickly develop and maintain confidence in the free-fall concept. This level of confidence is in sharp contrast to the lack of enthusiasm by experienced crews for some davit launched lifeboats.

On cargo vessels a single free-fall unit over the stern is acceptable, and removes the need for a lifeboat to be positioned on both sides of the vessel. This has encouraged owners to install these boats, and many view them as an improvement over davit launched systems.

At present it is accepted that use of free-fall lifeboats requires some degree of physical mobility, even fitness, on the part of the occupants. The capacity of each boat is also limited by the need for secure individual seating. These factors may prevent their

widespread use in passenger ships where numbers are likely to be large and a percentage will lack the necessary levels of fitness and health to use them.

2.9 WEATHER

Only two cases involving weather and lifeboats have been reported to the MAIB. In each, heavy seas damaged a lifeboat. There were no injuries.

In view of the need for ready access to lifeboats, and the parallel requirement for immediate readiness, there is probably little scope for removing existing launching systems totally from areas of a vessel where heavy seas, or the elements, are likely to be encountered. Because of the apparent infrequency of these incidents, there is probably little justification in attempting to further reduce the risk of weather damage by changes in position and design alone.

Somewhat perversely, the role of weather may limit the number of accidents involving lifeboats. Most of the reported accidents have occurred during crew training or exercises. The timing of the activities is, therefore, under the control of a vessel's master. In poor weather, few masters would elect to carry out a practice launching, or even lowering. This is not because of any thoughts for their crew's comfort, but more out of consideration for their safety.

The net result is that lifeboat drills and training are, for quite sound reasons, generally carried out in good weather conditions. The systems and their crews are therefore rarely used or tested in adverse conditions, and the limits and capabilities remain unknown factors.

2.10 NOT OTHERWISE CLASSIFIED

A number of accidents, including one that was fatal, do not fall into any easily identifiable category. Analysis shows a range of factors which would be difficult to overcome by changes in equipment design alone.

A number involve operating errors made while operating equipment. Such mistakes are, however, common to operating many types of machinery. Some of these served to remind people that lifeboat launch systems are necessarily heavy, and parts are often unprotected by guards.

Other reported accidents point to poor practice. This was typified in one particular incident when an apparently experienced officer fell from a lifeboat while manoeuvring to come alongside. He was not wearing a lifejacket, and lost his life as a result.

2.11 SUMMARY OF SECTION 2

With one exception, all fatalities have occurred during the lowering, launching or recovery of davit launched lifeboats. A substantial proportion of the injuries has also

occurred during such operations. Once waterborne, a lifeboat should pose no greater risk to its occupants than any other boat of comparable size. This is borne out by examining the data held by the MAIB.

Risks can be reduced if the number of people within lifeboats during launching or recovery is kept to a minimum. Liferrafts, using marine evacuation systems (MES) are launched empty. Although serious practical difficulties of control may arise if lifeboats are launched empty, such practice would eliminate risks.

Many cruise ship operators, who use lifeboats as passenger tenders boarded from a buoyant platform with access from the mother ship by gangway, follow a similar principle.

Launching and recovering manned lifeboats poses risks for the occupants. Other aspects of lifeboat use offer much lower risks. Provided the industry continues to consider lifeboats to be an important, necessary and desirable means of evacuation, the risks associated with their launching and recovery needs to be re-examined.

SECTION 3 - RELATED FACTORS

3.1 CONSTRUCTION AND TESTING

Lifeboat launching systems are required to be tested to 2.2 times working load during manufacture, and 1.1 times working load after installation. Given proper testing procedures, there has been no incident where a davit structure, or its fixing to the ship, has failed and caused an accident. The MAIB's data offers no material to suggest that these requirements need to be changed.

Davit failures have occurred during testing. Two lives were lost in one particular instance, and the MAIB considers that failures should be anticipated during tests. Such operation should, and can, be managed so that if it fails nobody is placed at risk. Careful management and planning of these operations is seen as essential, and the UK administration has introduced appropriate guidance to surveyors, owners and others.

Adequate risk assessment should be carried out prior to any testing or training of individuals. The results of the assessment should be used to minimise the risk.

3.2 OPERATION, MAINTENANCE AND TRAINING MANUALS

Lifeboat launch system manufacturers often supply material that is used by the owner, or a consultant, to produce the operation, maintenance and training manuals.

Quality

The MAIB considers the quality of the material in these manuals to be sometimes poor. It frequently lacks clear and accurate descriptions of the equipment and operating principles. Superfluous information, particularly where one instruction manual is intended to serve several types of system, leads to confusion. Inaccurate translations between languages can compound these problems.

These shortcomings result in crews ignoring them on the grounds that they are not only unreliable, but also contain too much extraneous material. They become time consuming to read, and the end result is incorrect maintenance and operation of equipment. This in turn becomes a principal factor as to why there are so many accidents.

Without obvious exception, much attention is given to designing, producing and testing equipment to the required SOLAS standards. This energy is not reflected in trying to produce good instructional material, and probably accounts for the emphasis that some owners place on training and maintenance.

The cost of improving the general quality of these manuals will, ultimately, fall on the shipowner. However, there appears to be little merit in spending large sums purchasing the necessary lifesaving equipment, and then attempting to cut costs by accepting poor support documentation.

Good instructional material is a 'once only' cost, but its availability encourages staff to use and maintain equipment as intended throughout its working life. Not only can this improve safety, but whole life costs may even be reduced.

Updating manuals

User feedback of operational experience with lifeboat launching equipment leads to manufacturers amending their manuals. The updated versions benefit safe operations and maintenance, but manufacturers complain about the difficulties of contacting the present shipowner to update the manuals. When a ship changes hands, sometimes several times in its life, the contact is lost. All the equipment manufacturers encountered by the MAIB in the course of its several investigations have touched on this problem.

Exactly the same problem arises when manufacturers try to maintain a service contact with an owner after a vessel has been sold. There have, however, been instances when the first owner has deliberately severed such contact in an attempt to reduce costs.

This approach is in sharp contrast to an owner's attitude to main machinery. A link with the manufacturer of a ship's main machinery is often maintained throughout its working life; even if only through the agents selling spare parts. Owners will often consider this link important to the efficient operation of their vessels.

It is not entirely clear why some appear to consider the efficiency of their launching systems less important, but there is evidence to indicate that they view these systems as simple pieces of general engineering. These owners believe that the principles of operation and design can be picked up by non-specialist service engineers, and without recourse to support from the manufacturers. Those so employed are unlikely to provide feedback to the manufacturers.

Manufacturers should be encouraged to use their Internet web sites to display manuals and updates to their customers. They should also make arrangements to attract users service feedback to a suitably designed web site.

3.3 CREW CONFIDENCE

Since the MAIB was established in 1989 there has been no incident reportable under UK regulations, of a merchant vessel using lifeboats to evacuate passengers or crew in an emergency.

One ro-ro ferry was partially evacuated following the outbreak of an engine room fire. Since she was operating as a ro-ro cargo ferry, very few passengers were on board. Sufficient lifeboats for a total evacuation were swung out and prepared for embarkation but were not, in the event, used. Passengers and non-essential crew were evacuated into tugs and RNLI lifeboats, by disembarking through a pilot door from the vehicle deck. Although the vehicle deck was slightly affected by smoke, and the deck plating was showing signs of heating by the fire beneath, the master judged his chosen evacuation

route to be preferable to using the vessel's lifeboats.

He was unable to offer clear and considered reasons for making his choice. But it seemed that he did not have total confidence in the capability of his ship's lifeboats and their launching systems, to disembark personnel safely.

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 the need for them to do so.

3.4 EXERCISE AND TRAINING

Incorrect procedures have been the cause of several accidents involving lifeboats. The relevance and importance of some procedures can only be appreciated by the equipment's designer. This is particularly the case when separate tricing and bowsing systems are employed, or where on-load release hooks are fitted.

Many of these incidents have occurred during exercises when lifeboats are being lowered or launched by trained and experienced seafarers, or by people under their supervision. These seafarers are used to preparing the lifeboats for use, replenishing their stores, and performing routine inspection and maintenance. They are, therefore, familiar with the equipment because of this almost daily contact with it. Despite this familiarity, accidents still happen.

On vessels with perhaps two or four lifeboats, it is likely there would be sufficient number of experienced seafarers available to launch them in an emergency. In a passenger vessel this might not always be the case, and some lifeboats might be in the charge of crew drawn from the hotel or entertainment staff who do not have the seafarer's familiarity with the equipment.

Although MAIB's data does not include incidents where such staff were in charge of a lifeboat, it is aware that this has occurred on board some foreign-flagged vessels. In the MAIB's opinion there will be a higher risk when such staff find themselves in such an environment. These risks will, however, be reduced by a continuous commitment to training. Simplified and standardised launching controls and procedures will greatly help overcome identifiable problems.

Meanwhile, training of all staff needs to be specific to the launching system type and design. Owing to the number of different designs used at sea, training of crews before joining a vessel is difficult. The alternative is the use of high quality operation and training material, coupled with intensive type-specific on-board training. In this context, the experience of some owners has shown the tremendous value of working models as training aids. Such models provide a useful supplement to training on lifesaving equipment, and do much to reduce the risk of an accident.

For training material to be effective it should go beyond the 'how to' or 'do it like this' approach. It is important that the reasoning behind the procedures is explained. By knowing *why* things are done in a particular way will do much to ensure that the trainee understands the procedures, and will remember them when under pressure. Inspection of many training manuals reveals they do not extend this far. As such, the authors underestimate the willingness of most seafarers to get things right and their ability to understand rather than just remember.

Practical, on job training is the most effective of all, but crews must have confidence in the systems. Above all, training on the job with real equipment must be safe.

SECTION 4 - CONCLUSIONS

MAIB's Study has concentrated on the hazards of lifeboat-based evacuation systems. This does not necessarily suggest that evacuation systems using free-fall lifeboats, davit-launched liferafts, fast rescue craft or marine escape systems are any less hazardous. Accidents during their use have been reported to the MAIB, but in significantly smaller numbers than for lifeboat launching systems. There are various reasons for this difference in the number of accidents between the different types of lifesaving systems.

Marine escape systems and inflatable liferafts are not deployed with the same frequency as lifeboats, largely because of the difficulty of restoring them to a state of readiness, and the need for specialist servicing and repacking.

Stand-by vessels in the UK's offshore industry use fast rescue craft extensively, but elsewhere the operating experience is still limited. Because of recently introduced SOLAS regulations, the number of fast rescue craft employed on SOLAS convention ships will increase, particularly on ro-ro passenger vessels. Owing to their many similarities with davit launched lifeboats, there are fears that the accident rate will be similar. Some parties which were consulted during the production of this report suggest the accident figures may well be higher, owing to the requirement for operation in poor weather and the use of single point suspension systems on high sided vessels. Pending fuller evaluation and trials of the use of fast rescue craft in merchant ships, especially in rough weather, the MAIB cannot argue with these views.

The data collected by the MAIB indicates that lifeboats and their launching systems have cost the lives of a significant number of seafarers. Twelve have lost their lives and eighty seven have been injured in the past ten years. The twelve lives lost represent 16% of all those killed in reportable accidents.

Accident causes are considered to have their roots in the complexity of systems which, although complying with statutory requirements, do not have the confidence of the seafarer. This is compounded by poor instructional and training material.

There has been no balancing payoff in lives saved by these systems. During the last ten years, the MAIB has never received a report where a lifeboat has been used in an evacuation, successful or otherwise. It is known, however, that other flag states do have experiences where lifeboats have been used, with varying degrees of success, to evacuate both crews and passengers.

MAIB's data suggests that seafarers will continue to be injured and lose their lives while operating these systems in the future. However, because MAIB's figures cover only a small proportion of marine accidents worldwide, a wider study of the subject should be undertaken.

As the umbrella body concerned with maritime safety internationally, IMO should undertake this study using data from as many flag states as possible. The objectives

should extend to reviewing the present requirements for lifeboats and, if it were judged that they continue to be worthwhile evacuation systems, the compiling of requirements which would enhance their safety.

The single recommendation of this report is therefore directed to IMO.

SECTION 5 - RECOMMENDATIONS

Following this review, it is recommended that IMO undertakes a study on the present value, need, and desirability of lifeboats. Reported incidents and accidents worldwide should be examined with regard to the specification of lifeboat launching systems.

If it concludes that lifeboat launching systems are necessary, the study should be extended to give consideration to formulating the requirements for safe lifeboat launching systems. Such requirements would seek to introduce integrated systems which:

- have common operating procedures independent of the manufacturer;
- can be readily understood by non-technical persons;
- will reliably perform their tasks, which include lowering and deployment for training purposes
- will perform safely under the control of operators with minimum experience and training

Classification of accidents associated with lifeboats and launching systems

Hooks

Premature release of hook (6 killed)
Inadvertent release of hooks
Premature release of hook
Inadvertent release of forward hook (injury)
Boat improperly secured during hook testing, one end fell (1 killed)
Unintentional release of FRC hook
Inadvertent release of hooks
Inadvertent release of hooks (6 injuries)
FRC fell due to unintentional release of hook (injury)
Unintentional release of hook (injury)
Premature release of one hook

Total 11 7 killed (58% of total deaths) 9 injuries

Tricing and bowsing

Experimental T&B system caused overload on davits (2 killed)
Bowsing tackle slipped, crewman fell between boat and ship (injury)
Bowsing tackle slipped, crewman fell from boat
Crewman released tricing under load, two crew fell from boat
Tricing pennant failed
Crew released tricing pennant under load, seaman fell (injury)
Finger trapped in tricing pennant during boat recovery (injury)
Eye bolt on lower block failed due to wrong specification
Bowsing tackle slipped, crewman slipped (injury)
Crewman injured hand when releasing bowsing tackle (injury)

Total 10 2 killed 5 injuries

Falls, sheaves and blocks

Faulty limit switch caused overload and failure of falls
Sheave failed on overload due to faulty limit switch
Final turn of fall jumped from winch drum and failed
Fall broke free, incorrect assembly of standing part
Falls failed due to jammed motor 'raise' switch
Falls overheated during welding of davit, later failed during exercise
Suspension hooks found cracked during maintenance
Failure of suspension link (16 injuries)
Fall slipped from sheave due to worn safety bar
Failure of sheave fixing causing falls to fail

Failure of suspension chain link (2 lives lost)
Failure of suspension chain (3 injuries)
Fall failed due to corrosion and fatigue

Total 12 2 killed 19 injuries

Engines and starting

Explosion of gas from starting battery
Injured hand when using starting handle to start engine (1 injury)
Injured knee when using starting handle to start engine (1 injury)
Injured hand when using starting handle to start engine (1injury)
Injury when using starting handle to start engine (1 injury)
Poorly adjusted gearbox control prevented selection of neutral
Engine control cable failed as boat was approaching falls for recovery
Injured back using starting handle to start engine (1 injury)
Injured hand when using starting handle to start engine (1 injury)
Injured wrist when using starting handle to start engine (1 injury)
Injured wrist when using starting handle to start engine (1 injury)
Injured hand when using starting handle to start engine (1 injury)
Injured hand while starting engine (1 injury)
Injured thumb when using starting handle to start engine (1 injury)
Injury while using starting handle to start engine (1 injury)
Injured wrist when using starting handle to start engine (1 injury)
Injured hand when using starting handle to start engine (1 injury)
Injured thumb when using starting handle to start engine (1 injury)

Total 18 15 injuries

Gripes

Gripe bottlescrew failed (2 injuries)
Self-release gripe fouled during launching
Gripe wire severed crewman's finger (injury)
Crewman's hand trapped in senhouse slip (injury)
Self-releasing gripe fouled during launching
Gripes failed due to wear, boat lost at sea
Hand injury when releasing senhouse slip (injury)
Hand injury when releasing senhouse slip (injury)
Hand injury when releasing senhouse slip (injury)
Hand injury when releasing senhouse slip (injury)
Hand injury when releasing senhouse slip (injury)
Injury when releasing senhouse slip (injury)

Total 12 10 injuries

Winches

Grease on clutch prevented recovery of lifeboat
Brake failed due to wear and oil contamination
Brake failed due to oil contamination of lining
Grease on lining and missing screw caused brake to fail
Weld on brake lever failed allowing slip (not LSA)
Erratic brake operation due to sticky remote brake cable (injury)
Winch brake overheated due to excessive use on exercise
One-way clutch springs failed causing slip
Failed interlock allowed crank handle to kick (injury)
Worn one-way clutch allowed handle to kick (injury)
Failed brake lining caused winch to seize
Failed interlock allowed crank handle to kick (injury)
Gravity brake failed due to poor adjustment (injury)
Wiring defect caused control of winch motor to be lost
Winch ran away due to slipping one-way clutch
Failed interlock allowed crank handle to kick (injury)
Winch bearing failed, jamming winch
Winch ran away. Suspected improperly applied brake
Electrical fault caused loss of control of winch motor
One-way clutch failed and lifeboat lost at sea
Brake failed during exercise
Failed interlock allowed crank handle to kick (injury)
Phases of motor wired incorrectly giving wrong direction of rotation
Grease on lining caused brake failure
Remote brake operating cable fouled
Faulty brake caused crank handle to kick (injury)
Mooring boat lost at sea due to faulty winch brake
Fire in winch motor starter
Winch failed due to incorrect assembly (3 injuries)
Temporary weld repair on brake failed
One-way clutch failed allowing winch to run away
One-way clutch failed allowing winch to run away
Total 32 8 injuries

Davits

Davit failed due to incorrect loading during testing
Harbour pins left in place prevented davit operating
Faulty davit roller jammed davit arm
Hydraulic ram failed while stowing boat
One davit arm seized
Hydraulic hose failed
Fault in trackway prevented stowing of boat
Total 7

Free-fall

Boat launched itself due to poor securing and hook arrangements
Seat failed during launching (injury)

Total 2 1 injury

Weather

Boat damaged by heavy seas
Boat damaged by heavy seas

Total 2

Not otherwise classified

Crewman's finger caught between wire and winch drum (1 injury)
Swell caused seaman to trap hip between boat and fender (injury)
Roller of davit ran over seaman's finger while clearing gripes (injury)
Swell tipped officer from lifeboat during recovery (no L/Jt) (1 life lost)
Wrist injury handling lower block (1 injury)
Crewman trapped finger during recovery of lifeboat (1 injury)
Hand crushed by davit roller when stowing boat (1 injury)
Crewman injured by movement of winch handle (1 injury)
Crewman's grip on winch crank handle slipped and he fell
Crewman injured by movement of winch handle (1 injury)
Crewman fell from boat when connecting lower blocks
Crewman's foot caught in lifeline
Crewman injured arm handling lower block (1 injury)
Hand trapped between hook and lifting ring (1 injury)
Crewman injured when lifeboat ran into quay (1 injury)
Crewman's hand trapped between boat and ship (1 injury)
Painter fouled lifeboat's propeller
Compressed air hose failed due to chafing on lifeboat
Crewman holding falls when another operated winch (1 injury)

Total 19 13 injuries 1 life lost

ANNEX B

Lives of crew members lost due to causes not related to lifeboats and their launching systems

Description	Deaths
Tanker explosion due to defective cargo pump	2
Fall during access to ship	1
Whiplash from failed towline during berthing	1
Tug crewman hit by sudden movement of bridle	1
Crewman found dead in unventilated tank	1
Electrician crushed when working on lift cage	1
Bosun hit by wave when on forecastle head	1
Boiler explosion	1
Crewman crushed by container during loading	1
Crewman crushed by folding hatchcovers	1
Crewman fell while rigging gangway	1
Crewman fell from deck outboard of guardrails	1
Crewman fell from sail training vessel	1
Crewmen entered non-ventilated hold	2
Crewman fell into river when working overside	1
Engineer entered unventilated ballast tank	1
Fitter fell onto cargo conveyor belt	1
Crewman fell over the side	1
Engineer lost overboard when working on deck	1
Crewman fell on stairway	1
Crewman fell overboard from painting stage	1
Capsize due to cargo shift(vessel lost)	2
Attempting access to ship by non-approved means	1
Officer missing overboard	1
Fitter fell onto cargo conveyor	1
Entering unventilated deep tank	3
Crushing between cargo containers	1
Crewman lost overboard	1
Entering unventilated cargo space	1
Crushed by deck cargo	1
Entering unventilated cargo tank	2
Passing under suspended load that slipped	1
Engine room fire	3
Fall from gangway	1
Whiplash from failed mooring line	1
Head injury during cargo operations	1
Tug girted	1
Crushed by engine room door in heavy weather	1
Galley fire from chip pan	1

Failure of lifting lugs on cargo frame	1
Acetylene explosion	1
Chip pan fire	1
Fall from painting stage on funnel	1
Mooring rope slipped from fairlead	1
Fall overboard	1
Lost overboard	1
Knocked overboard by shifting deck cargo	1
Struck by failed mooring rope	1
Lost overboard	1
Fall from access ladder	1
Fall gaining access to ship	1
Electrical explosion	1
Tug girted	1
Crewman crushed in powered watertight door	1
Fell gaining access to ship	1
Passing beneath load which fell	1
Entering unventilated hold	1
Crewman fell down stairway	1
Crewman fell down stairway	1
Fell gaining access between vessels	1
Entering unventilated hold	1
Hit by fast moving mooring line	1
Fell while rigging accommodation ladder	1
Riding on lifting gear	1
Crewman hit by large sea over bows	1
Total	73