Report of the investigation of

the lifeboat release gear test on

RFA *Fort Victoria*

which caused injuries to two people

at Falmouth ship repair yard

10 September 2004

Marine Accident Investigation Branch
Carlton House
Carlton Place
Southampton
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Extract from

The Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2005 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 13(9) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purpose is to attribute or apportion liability or blame.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

CPO	-	Chief Petty Officer
CPSC	-	Certificate of Proficiency in Survival Craft
GRP	-	Glass reinforced plastic
G (g)	-	Gravity
HSE	-	Health and Safety Executive
ILAMA	-	International Lifesaving Appliance Manufacturers' Association
IMO	-	International Maritime Organization
ISM	-	International Safety Management Code
LSA	-	Life Saving Appliances
MCA	-	Maritime and Coastguard Agency
MSC	-	Marine Safety Committee
OAN	-	Operational Advice Note
RAF	-	Royal Air Force
RFA	-	Royal Fleet Auxiliary
Ro-Ro	-	Roll on - Roll off (ferry)
SOLAS	-	The International Convention for the Safety of Life at Sea, 1974 (as amended)
SOP	-	Standard Operating Procedures
TSB	-	Transportation Safety Board of Canada

SYNOPSIS

On 10 September 2004, a Maritime and Coastguard Agency (MCA) surveyor, and a lifeboat crew member, sustained back injuries during a planned lifeboat exercise drill which took place on board RFA *Fort Victoria*.

At least a week earlier, the surveyor had notified the vessel that, in addition to a standard lifeboat drill, he wanted to observe the operation of the on-load release gear of a lifeboat suspended just above the water. It was not unusual for MCA surveyors to witness such a drill in order to check that crews were aware of the correct operating procedures.

The surveyor boarded RFA *Fort Victoria* at 1500. The lifeboat exercises were scheduled to take place at 0830 that morning, but had been delayed as a direct result of a fatal accident on another vessel in the port the previous day, which had required the surveyor's involvement as part of the investigating team. As a consequence of the delay, it was decided to carry out only the exercise involving operation of the on-load release gear.

Although the lifeboat crew conducted a safety briefing, the surveyor was distracted by several mobile telephone calls relating to the fatal accident. With the briefing completed and the boat ready for launching, the surveyor joined the six crew members on board the lifeboat.

When everyone was seated and strapped in the lifeboat, the engine was started and the lifeboat was lowered away. When the lifeboat had been lowered most of the way to the water, the surveyor was asked if the lifeboat's position above the water was correct for the on-load test. Although unwilling to take charge of the exercise, the surveyor briefly looked out of the lifeboat and told the crew to lower it further.

After the lifeboat had been lowered a further distance, the on-load release gear was operated without another check being made on the boat's distance above the water. This resulted in the boat freefalling a distance of about 1.2m, before striking the water. The impact with the water resulted in one crewman being hospitalised due to a fractured vertebrae, and the surveyor suffering a back injury which required subsequent medical assistance.

Both RFA and MCA have made changes to operational procedures to ensure that a similar accident does not occur again. Recommendations have been directed at the International Lifesaving Appliance Manufacturers' Association (ILAMA) to improve aspects of the ergonomic design of lifeboats and safety warning signs.

Figure 1

RFA Fort Victoria

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF RFA *FORT VICTORIA* AND ACCIDENT

Vessel details

Registered owner	:	Ministry of Defence
Port of registry	:	London
Flag	:	UK
Type	:	Combined Fleet Support Tanker & Stores Ship
Built	:	Harland & Wolf Belfast, 1994 (in service)
Classification society	:	Lloyd’s Register of Shipping
Construction	:	Steel
Length overall	:	203.9m
Gross tonnage	:	28821
Other relevant info	:	8 x 70 person self-enclosed lifeboats
Lifeboat type	:	Watercraft 9.4m Mk IV
Lifeboat manufacturer	:	Watercraft (Umoe Schatt-Harding Limited)

Accident details

Time and date	:	1520 on 10 September 2004
Location of accident	:	Alongside A&P ship repair yard, Falmouth
Persons on board	:	7
Injuries/fatalities	:	One crewman hospitalised with fractured vertebrae, one surveyor suffered slight compression to vertebrae, with inflammation and bruising
Damage	:	Several fractures to internal sections of lifeboat GRP

1.2 DESCRIPTION OF THE VESSEL (Figure 1)

RFA *Fort Victoria* is one of a flotilla of 18 ships operated by the Royal Fleet Auxiliary (RFA). She is one of a class of replenishment ships that combine the function of ocean-going fast fleet support tanker with that of a stores support ship.

Fort Victoria is a registered British merchant vessel which, like all RFA vessels, is designed to meet the requirements of the Ministry of Defence (Navy) and comply, as closely as possible, with current international merchant ship standards.

Her role is to support Royal Navy fleet units while underway, by replenishing fuel, dry and refrigerated stores, ammunition, missiles, general stores and spare parts. She also provides aviation support.

Fort Victoria accommodates 134 ship's company and 150 embarked air crew. RFA personnel follow the traditional training paths of their Merchant Navy equivalents in order to obtain professional qualifications, but include a substantial overlay of Naval training, so that they may develop the skills needed for a military operating environment.

1.3 DESCRIPTION OF THE LIFEBOATS AND DAVITS (Figure 2)

The seating arrangement on each of *Fort Victoria's* eight Watercraft Mark IV lifeboats - originally designed to carry 80 people - had been modified to hold 70 people in accordance with her lifeboat manning requirement.

The lifeboats are supported on gravity-operated swinging arm davits; a deck-mounted winch controls swinging out and recovery. Each lifeboat can be remotely lowered from inside the boat using a remote control wire connected to the winch brake.

Each lifeboat is 9.4m long with a beam of 3.5m. They are of a monocoque design, built using sprayed on glass-reinforced plastic (GRP), and are totally enclosed and self-righting. They are powered from an inboard diesel engine driving a fixed-pitch propeller with a controllable Kort nozzle. This is capable of propelling the lifeboats at 6 knots when fully laden.

The lifeboats weigh 5873kg net, but fully laden, their maximum gross weight is 12050kg. They are designed, constructed and equipped in accordance with the International Convention for the Safety of Life at Sea 1974 (SOLAS), as amended by the 1983 amendments to Chapter III.

Each lifeboat has four main hatches in its canopy. Two are located approximately midships on either side, two more are located aft on either side of the centreline. In addition, there is a small hatch in the forward canopy to allow the lifeboat crew to reach the forward lifting hook, and another hatch above the helmsman's position to aid effective communications with the vessel during launching and recovery.

The internal layout and configuration is typical of modern, totally self-enclosed lifeboats. Crew seating is arranged along either side, and also along the centreline in four rows running fore and aft. A black painted circle on the GRP and a safety harness denote each seating position.

The coxswain's position is raised in a 'conning tower' towards the stern of each boat. The coxswain has a reasonable all-round view through four windows, and has access to all of the lifeboat's main controls except the on-load release lever.

The number 2 lifeboat, which was the boat involved in the accident, was first certified for use on 20 June 1989.

Figure 2

View of No 2 lifeboat after recovery

1.4 DESCRIPTION OF THE ON/OFF-LOAD RELEASE GEAR (Figure 3)

SOLAS requirements for lifeboats built after 1 July 1986, stipulate that they should be fitted with a hook disengaging gear, capable of being operated both on and off-load. Chapter III of SOLAS, on lifesaving appliances, was amended in June 1996 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.

Durapart in Norway manufactured the Tor on-load lifeboat disengaging gear, fitted to the number 2 lifeboat of *Fort Victoria*.

The system comprises the following equipment:

- Two lifting (suspension) hooks with hook plates;
- One hydrostatic valve;
- One release gear;
- Set of deck plates;
- Instruction book and poster.

The lifting hooks are of the on-load/off-load release type. They are designed to open simultaneously to release the lifeboat either in an emergency while it is suspended from the falls out of the water, and under tension, or while in the water with no tension on the falls. The release handle assembly incorporates three safety devices to prevent inadvertent release of the hooks.

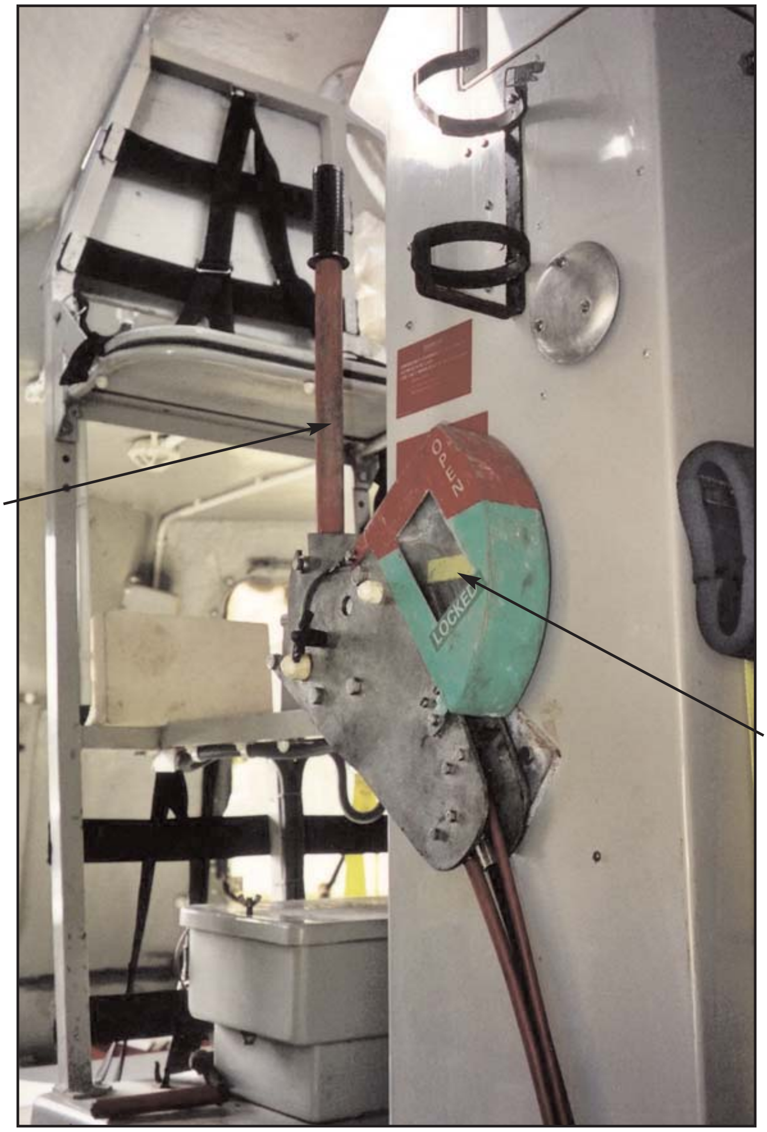
These safety devices comprise:

- A removable ‘T’ bar to prevent operation of the release handle;
- A requirement to lift the release handle against a return spring to clear the profiled side plates, and;
- A hydrostatic release valve.

The simultaneous release of the hooks is achieved by lifting and moving aft the release handle on the starboard side of the helmsman’s control console, with the lifeboat in the water. Or, when clear of the water, operating the interlock lever simultaneously with the release handle. This requires assistance from another crew member.

The release handle is connected to the fore and aft hooks by heavy-duty marine push-pull cables. The hook ends of these cables are connected to a release pin cam. The flat of the half round pin cam bears against the flat of the tail of the hook. When the release handle is pulled, the pin cam rotates and releases the tail of the hook. The rotation of the hook between the hook plates simultaneously releases the hooks from the suspension rings at the end of the falls.

Figure 3



Release gear and coxswain's seat

To prevent inadvertent operation of the release handle while the lifeboat is suspended from, and with tension on, the falls, a hydrostatic valve and interlock is incorporated. The hydrostatic unit is located as low as possible in the lifeboat, in an upright position, and directly underneath the release unit. The valve and interlock, which are located within the release unit, are also connected by a heavy-duty marine push-pull cable.

The interlock lever **(Figure 4)** is painted yellow, and is enclosed within a housing, one side of which has a clear Perspex screen. The housing is painted in red and green to denote the lever position, either in the open (red) or locked (green) position. During an emergency, the screen can be smashed to gain access to the lever. For testing purposes, it is usual to remove the housing, to enable manual operation of the interlock lever.

Figure 4

Interlock lever with protective cover removed

Once the lifeboat has entered the water, water pressure acts on the hydrostatic valve, which lifts and operates the cable. This, in turn, raises the interlock lever against a return spring. The interlock lever blocks the operation of the release handle and prevents unintentional release when there is tension on the falls. With the interlock lever raised, the release handle is free to be operated and the hooks disengaged.

1.5 EVENTS PRECEDING THE ACCIDENT

RFA *Fort Victoria* was reaching the end of a major refit which was being carried out at A&P Falmouth's shipyard. The vessel was berthed, starboard side to, at a layby berth.

As part of the refit work, her eight lifeboats had been inspected and worked on ashore by an independent lifeboat service contractor, who was not, however, approved by the lifeboat manufacturer. The work had included the inspection, testing and overhaul of all the hydrostatic units.

The contractor had also tested the on-load equipment. The tests included a simulation of the operation of the on-load release gear for all eight lifeboats using hydraulic test rigs.

The lifeboats were subsequently refitted on board *Fort Victoria.*

The principal MCA surveyor in Falmouth required the crew to carry out exercises with the lifeboats prior to the vessel returning to service.

At least 1 week before the accident, the surveyor informed the third officer, who was the officer responsible for the operation and maintenance of the lifeboats, that two lifeboats were to be launched during the planned exercise starting at 0830 on 10 September. The surveyor also advised that the exercises would include the operation of the on-load release gear for one of the lifeboats with it suspended just above the water, to simulate failure of the hydrostatic release valve.

The surveyor also requested that the lifeboat service contractor be present during the exercise, to provide guidance to the crew on the operation and maintenance of the lifeboat equipment.

The surveyor was due to spend the week starting 6 September 2004 on leave. During Monday, Tuesday and Wednesday of that week he worked for many hours on his own boat. However, at short notice, he was asked to return to work to enable a colleague to take leave; he agreed to do so.

The surveyor returned to work on 9 September, but continued to work long hours on his boat during the evening. That day, he worked a total of 17 hours.

A fatal accident had occurred earlier in the day on a vessel in Falmouth dry dock. The police and HSE led the investigation into the causes of the accident, but due to their lack of marine knowledge, the MCA surveyor was asked to assist them in the investigation on the following day.

The surveyor arrived at his office at 0800 on 10 September, and spent the morning, and part of the afternoon working on issues related to the accident investigation.

Plymouth and Falmouth marine offices are paired together, and support each other with personnel if the work demands. The surveyor needed assistance with the heavy workload in Falmouth, so he contacted his manager in Plymouth. Unfortunately, no surveyors were available.

The surveyor was unfamiliar with the way fatal accident investigations were conducted, and felt quite daunted by the demands this work was placing on him.

Despite being actively involved with the accident investigation, he still intended to visit *Fort Victoria* at about 1500 for the planned, but delayed, lifeboat exercise. He had not been regularly involved with *Fort Victoria*'s refit, and was under the impression that it was near completion and that she was to be handed over to RFA imminently.

1.6 NARRATIVE OF THE ACCIDENT

The surveyor boarded *Fort Victoria* shortly before 1500 on 10 September, and was met by the boat crew who had mustered in readiness for the lifeboat exercise. The surveyor discovered that the lifeboat service contractor had already left the shipyard. The third officer had also left the vessel for weekend leave, and had informed the second officer of the surveyor's requests. Although the attendance of the contractor had been an important element of the exercise, the surveyor decided to proceed, as both he and the lifeboat crew were available. The weather was good, creating smooth, calm water.

The surveyor informed the second officer that, because of the limited time available, he now wanted to see only one lifeboat lowered, the winch brake tested and operation of the on-load release gear with the lifeboat clear of the water. The second officer confirmed to the surveyor that he understood the operation of the on-load release gear.

The lifeboat crew were aware of the requirement to operate the on-load release gear with the boat clear of the water.

The CPO(Deck) pointed out to the surveyor that the lifeboat crew had not carried out a drill like this before. He explained that during previous drills, they had operated the off-load release handle only when the boat was in the water, when the hydraulic valve disengaged the interlock on the release handle.

The surveyor explained that he wanted to be sure that the crew understood how to operate the on-load release gear, which was why he wanted to release the boat when it was just clear of the water.

The second officer gave a safety briefing to the lifeboat crew, during which the surveyor was distracted by mobile telephone calls concerning the fatal accident enquiry. The surveyor intended to carry on with the enquiry after the lifeboat tests, so during the calls he explained that he was running late, but would meet them as soon as he was finished on *Fort Victoria.*

After the briefing, the lifeboat crew and the surveyor boarded lifeboat number 2, found their seats and put their harnesses on.

The lifeboat crew consisted of the second officer, a coxswain (petty officer (deck)), three able seamen and a deck cadet. There was a total of seven people on board.

After everyone had boarded the lifeboat, the coxswain gave another safety briefing. Due to conflicting evidence, it is unclear whether the surveyor restated his requirements at that time. The engine was started; the engine cover side panel had been removed, which increased the noise within the lifeboat to a high level. A seaman, seated on the port side of the lifeboat, lowered it using the winch brake remote release cable.

To comply with the surveyor's instructions, the lifeboat was stopped twice during its descent to confirm the effectiveness of the remote winch brake operation. Having done this, control of the lowering operation was passed to the CPO(Deck) and crew members who were stationed on deck at the lifeboat boarding position. Using VHF radios, the deck crew were asked to lower the boat to just above the waterline.

It was difficult for the deck crew to assess with accuracy the height of the boat above the water. They stopped when the lifeboat's conning tower was about level with *Fort Victoria*'s black boot topping.

The coxswain looked at the surveyor and said "OK"? The surveyor did not want to interfere, with the crew being in charge of the operation, but he reluctantly removed his harness and, from the vicinity of his seat, looked out of the open starboard hatch. He indicated that the lifeboat needed to be lowered "a few feet further". The surveyor retook his seat and the coxswain directed him to replace his harness.

The deck crew then gradually lowered the boat further, and then further still under the direction of the second officer with the VHF radio. The coxswain turned to the surveyor for his approval to operate the release gear. The surveyor remained unwilling to be directly involved in the conduct of the drill, despite suspecting that the boat was still probably a little bit too high out of the water. However, although he could not see outside of the boat to gauge its actual height above the water, he did not think that it was in a position whereby activation of the on-load release gear might be dangerous.

The coxswain assumed that, as the surveyor had not refused permission, it was OK for the release gear to be operated. The second officer loosened his harness, so that he could reach the on-load release gear, he removed the locking pin and removed the cover to obviate the need to break the emergency glass. Then the coxswain informed those on board that the lifeboat was about to be released.

After a significant delay, caused by the interlock lever and release handle not being operated simultaneously, the hooks were released successfully.

The release was sudden and the lifeboat dropped about 1.2m. There was a heavy impact with the water, and the crew subsequently reported that their backs took the full brunt of the force.

The seaman seated at the starboard outboard position released his harness immediately and lay down by the starboard access hatch, in pain.

The coxswain shouted up to the deck crew that one of the lifeboat crew had been injured, and requested medical assistance. The coxswain then steered the boat across to a pontoon where the second officer and surveyor administered first-aid to the injured crewman.

With the assistance of a repair yard crane, the lifeboat was lifted out of the water to enable safe recovery of the injured crewman. He was then taken to hospital.

In addition to the injuries sustained by the seaman, the surveyor suffered tissue damage and slight compression to his vertebrae, which required medical attention and time off work. The boat also incurred minor damage.

1.7 THE DAMAGE TO THE LIFEBOAT

Damage sustained to number 2 lifeboat consisted of:

- A longitudinal fracture approximately 1m long in the seat adjacent to the starboard aft access hatch, and which formed part of the buoyancy tank;
- A transverse fracture approximately 60mm long in the seat adjacent to the starboard aft access hatch, and which formed part of the buoyancy tank **(Figure 5)**;
- A longitudinal fracture approximately 150mm long in the canopy adjacent to the starboard aft access hatch;
- A stanchion, starboard aft of the longitudinal seating, separated from the canopy.

Notwithstanding the above, the damage sustained by the lifeboat would not have affected its operational capabilities.

Figure 5

Crack in seating

1.8 THE MCA IN FALMOUTH

Before joining the MCA, the surveyor had gained considerable experience in the marine industry both at sea, as a master mariner, and ashore. His employment with the MCA began in 1992. He had spent 6 years as a main grade surveyor before being promoted to principal surveyor in 1998, based in Falmouth.

At the time of the accident, his support staff included one main grade surveyor and one domestic passenger vessel surveyor. In addition, a number of administrative staff dealt with the day to day running of the Falmouth marine office.

Vessel inspections, witnessing equipment testing, drilling of crew and associated paperwork for the purpose of seeing that the Merchant Shipping Acts and Regulations are being complied with, are part of the work of an MCA surveyor.

The workload for the surveyors in Falmouth varies throughout the year. The winter and spring are the busiest periods, when large ro-ro passenger ferries, among others, carry out their yearly refits. In addition, both the principal and the main grade surveyors carry out survey work and vetting for foreign administrations. This usually involves being away for, perhaps, one week in four, often at relatively short notice. Prior to the accident on *Fort Victoria*, the principal surveyor had travelled abroad twice in the previous few months at the behest of a foreign administration.

The pairing of Falmouth and Plymouth marine offices, and the sharing of surveyors between them, enables the surveyors to divide external work, and to provide additional cover during busy periods or times of sickness or leave.

1.9 MCA GUIDANCE

As a result of previous maritime accidents, further guidance was provided to MCA surveyors in the 'Inspection and Enforcement Policy' instructions. These instructions require surveyors to be proactive in assessing the efficiency of the emergency organisation of the ship, including requesting a drill to be carried out to witness the capabilities of the crew.

The instructions provide guidance to the surveyors on the conduct of abandon ship drills and the use of lifeboat on/off load release gear, and state: "use of this gear should be demonstrated as the lifeboat enters the water". MCA surveyors are expected to take a pragmatic and sensible approach to requesting and witnessing emergency drills or other tests. They are required to advise crews that the role of the MCA surveyor is to witness the emergency drill or test, but they are expected to suspend or stop a drill if a dangerous situation develops.

In this respect, the MCA's *Surveyor's Health and Safety Booklet* explains, on page 12:

> *When witnessing operations, you should make it clear that you are only acting as an observer and that the ship's or the shipyard's staff remain in charge of all such operations. Do not instruct them to take action directly, as this may imply you are in charge and take responsibility. However, where you identify a potentially unsafe action you should raise your concern with a responsible person.*

1.10 ROYAL FLEET AUXILIARY

1.10.1 Lifeboat operations/procedures

The lifeboat crew were experienced in the operation of lowering and recovering lifeboats. Practice drills were held frequently, but RFA produced no standard operational procedures (SOPs) to guide the lifeboat crews. There was no documented risk-assessed method of testing the on-load release gear.

Short, generic instructions on the operation of the lifeboats were posted near the release gear, together with warning notices for the operation of the release gear.

Safety briefings were generally held before any lifeboat operations were carried out. These, typically, described the planned operation, the specific duties of those involved, who was in charge of the operation and the use of personal safety equipment.

1.10.2 Lifeboat crew

The second officer joined RFA in 1989, after serving 6 years in the army. He began as a seaman, and was promoted from leading hand (helicopter control) to third officer, in about 1996, and to second officer in 1999. He had served on board *Fort Victoria* for 2 months on this tour of duty.

He had been involved in a number of lifeboat operational trials during his time with RFA, including the mandatory drills. He had also worked with MCA surveyors during safety equipment surveys on a number of previous occasions.

The lifeboat coxswain (petty officer (deck)) had worked on RFA vessels for a number of years. Although regularly involved in lifeboat drills, he had never carried out an on-load gear test.

1.11 ON-LOAD RELEASE GEAR TESTS

Lifeboats, their associated davits, winches and release gear are required to be load tested every 5 years. During this test, the boat is loaded with 110% of its designed load and, among other things, the on-load release gear is operated when the boat is just above the water. The usual method of safely accomplishing this is by lowering the boat to the water level without any personnel on board. When the boat is seen to be touching, or almost touching the water, one person boards it and operates the release gear. Guidance on how this test should be carried out is contained in Merchant Shipping Notice 1655 which also details alternative equivalent means of load testing which do not require the lifeboat to be suspended from the falls or to have the crew embarked.

On 10 September, the MCA surveyor required a functional test of the crew's ability to carry out an on-load release drill, and not a test of the equipment. Neither the MCA, nor RFA produce operational guidance for this type of drill.

1.12 OTHER RELEVANT REQUIREMENTS

The Merchant Shipping (Life Saving Appliances) Regulations 1999, provide the requirements for, among other items, the construction of davit launched lifeboats. Within this section are the requirements to withstand impact against the side of the vessel, and also when dropped into the water.

> As far as dropping the lifeboat into the water is concerned, the lifeboat must *be of sufficient strength to withstand, when loaded with its full complement of persons and equipment …….. a drop in to the water from a height of at least 3 metres.*

The manufacturer carries out these tests using a prototype to ensure the design and construction meet the requirements.

1.13 INTERNATIONAL MARITIME ORGANIZATION

1.13.1 MAIB Safety Study

In 2001, the MAIB published its safety study 'Review of Lifeboat and Launching Systems' Accidents'. It concluded that, although these systems complied with SOLAS requirements, their complexity caused accidents.

The MAIB study recommended that IMO, as the umbrella organisation for international maritime safety, should undertake a study on the present value, need and desirability of lifeboats. The recommendation went on to say that if the study concluded that lifeboat launching systems are necessary, the study should extend to consider formulating the requirements for safe lifeboat launching systems.

1.13.2 SOLAS Amendments

Co-operation between the IMO and the International Lifesaving Appliance Manufacturers' Association (ILAMA), has resulted in amendments to SOLAS Chapter III (Life-saving appliances and arrangements) to reduce the number of accidents involving lifeboats. The IMO noted that these accidents were caused by, among other things, inadequate maintenance, lack of familiarity with the equipment and unsafe practices during drills and inspections.

The amendments to Regulation 19 (Emergency Training and Drills) and Regulation 20 (Operational Readiness, Maintenance and Inspections) relate to the conditions in which the lifeboat emergency training and drills should be conducted. The amendments introduce changes to the operational tests to be conducted during the weekly and monthly inspections, to obviate the need for crew to be on board the lifeboat in all cases.

These amendments were adopted in May 2004 and come into force on 1 July 2006. They have been supplemented by guidelines (Marine Safety Committee (MSC) Circular 1093 – Guidelines for Periodic Servicing and Maintenance of Lifeboats, Launching Appliances and On-load Release Gear) published in June 2004.

MSC Circular 1093 contains guidelines for an operational test of on-load release gear which state (Section 2.6.1):

> *Position the lifeboat partially into the water such that the mass of the boat is substantially supported by the falls and the hydrostatic interlock system, where fitted, is not triggered.*

SECTION 2 - ANALYSIS

2.1 AIM

The purpose of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 PROCEDURES FOR THE EXERCISE

The surveyor had overseen many lifeboat drills during his career with the MCA, including a number of on-load release gear tests. Frequently, lifeboat service contractors and manufacturers' representatives had also attended drills to provide guidance and training to the crew. It is not unusual for MCA surveyors to ask to see the on-load release gear being tested.

Some guidance exists on how to carry out the required 5-yearly testing of lifeboats, including an on-load release with 110% of the designed maximum loading on board. However, the MCA did not have a precise recommended method for carrying out a routine on-load gear release test above water, but one had evolved as an unwritten procedure. The surveyor understood it to be as follows:

1. Lower the lifeboat into the water so that the hydrostatic valve operates the on-load release lever;
2. Raise the lifeboat just enough so that the hydrostatic release valve drains and the on-load lever resets;
3. Operate the on-load lever manually in conjunction with the off-load lever to drop the lifeboat.

The surveyor had also witnessed routine tests where the lifeboat had been released from just above the water, without any detrimental effect.

The surveyor had not been specific in his instructions for the operation that he had requested; this followed the guidance provided to surveyors that they were only to witness shipboard operations and only raise their concerns in the event of a potentially unsafe action.

The RFA had no SOPs for lifeboat launching or recovery and, in any case, routine practical tests of the on-load release gear were not generally carried out. The crew, although experienced in standard lifeboat operations, had not carried out a practical test of the on-load release gear before 10 September. However, individual crew members knew the necessary procedures to operate the on-load release gear during an emergency, because these are covered in the Certificate in Proficiency in Survival Craft (CPSC) courses which they all would have attended.

There is conflicting evidence as to whether the surveyor had been told of the fact that the crew had no practical experience in the intended operation.

This was not a standard procedure and, as such:

1. The surveyor should have paid special attention to the crew's intentions at the safety briefing, and he should have given guidance as necessary to ensure the operation was safe.
2. The second officer should have checked with the surveyor that what he was intending was safe, and was what was wanted.

Lifeboat drills are hazardous, and every precaution should be taken to ensure that they are carried out in safety. The MCA should issue its surveyors with clear guidance on how such tests should be carried out and they, in turn, should ensure that ship's crew conduct them in accordance with a recognised safe procedure.

Many crew members have received injuries while participating in standard lifeboat drills and inspections. It would therefore seem appropriate that lifeboats be considered as high risk equipment under the International Safety Management (ISM) Code, and that RFA should produce appropriate SOPs.

2.3 THE ERGONOMIC DESIGN OF THE LIFEBOAT

2.3.1 Lifeboat testing and impact forces on the human body

The construction of conventional lifeboats is tested by dropping an unmanned prototype of the design into water from a height of 3 metres. This test, as detailed under the International Life-Saving Appliance (LSA) Code, only requires the construction of the lifeboat to be tested; the effect on the people on board, of dropping the boat from this height, is not considered.

The on-load release gear is designed to ensure that both hooks release when required, even if the off-load gear has not worked properly. In an emergency, it can also be used to release the lifeboat to allow it to drop into water, for example if the falls had jammed, or if the boat is at wave top height in rough conditions. This accident clearly indicates that injuries can occur even if the lifeboat is dropped onto smooth water from as little as 1.2 metres.

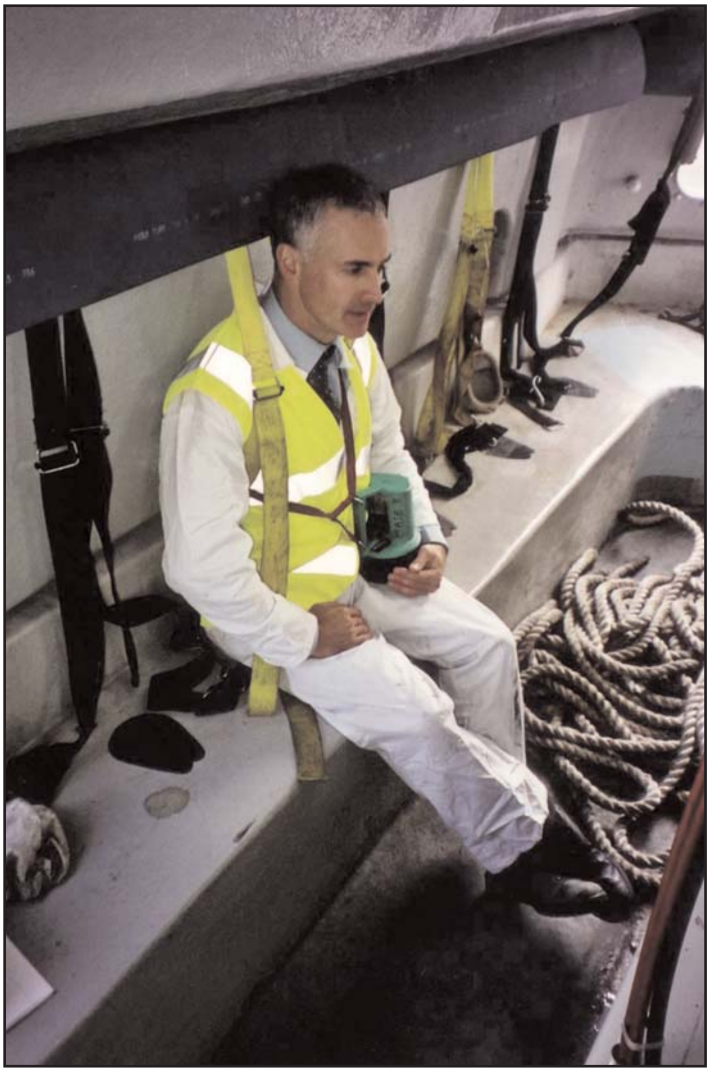
No one was in a position to accurately assess the height of the lifeboat above the water. None of those on board the lifeboat on 10 September considered that the approximate height from which it was dropped was a cause for concern. Even after the event, when the height was known to be 1.2m, they expressed surprise at the forces that had been generated by the impact of the fall.

This accident has demonstrated the danger of dropping a near flat bottomed boat onto a smooth water surface. In this situation there is little hull shape to deflect the water on impact **(Figure 6)** and this leads to large forces being transmitted to the boat and its occupants even when the drop height appears to be small.

Figure 6

Aft view of bottom of lifeboat showing shallow deadrise

Figure 7



Example of harness and seating in use opposite the release gear

If the lifeboat is to be dropped from above the water surface, lifeboat occupants must be securely harnessed. If they are not, they can become separated from their seat and float between the harness straps and seat as the boat falls. When the lifeboat impacts on the water such occupants are likely to suffer the effect of “dynamic overshoot” or “secondary impact” as the lifeboat begins to rebound. This secondary impact can be more severe than the original impact.

It is also important for the occupants to be seated in an upright position **(Figure 7)**. Lifeboat manufacturers should bear in mind that occupants will be wearing hard hats and bulky lifejackets which, when combined with the effect of head padding, might cause them to have to lean forward slightly in the seated position.

As part of the investigation, the MAIB obtained advice from an expert in aircraft crash tests from QinetiQ, Farnborough. Research has indicated that the acceleration responses measured during a vertical drop test of an aircraft composite fuselage section, on to water from a height of just under 3m, achieved typically 20-g in magnitude, approximately three times that of the entry forces of a lifeboat designed to freefall bow-first into the water.

The lower lumbar vertebrae support a major part of the body's weight, so are comparatively large and strong. In a correct vertical posture, the spine can absorb in the region of 23-g before damage results. However, if the spine is curved, due to poor seating or for some other reason, compression injuries can occur at lower forces.

The expert provided information on spinal injuries sustained by RAF crews during the operation of aircraft ejection systems. This shows a high incidence of injuries in the region of the L1 (lumbar) vertebra **(Figure 8)**. The spinal injury sustained by the crew member on board the lifeboat, occurred in the same position as the majority of the injuries sustained by RAF crew who eject from an aircraft.

The expert considered all these facts, along with the age, weight and physical condition of the seaman and, assuming that he was securely strapped in and sitting in an upright position, concluded that his body had been subjected to a vertical impact of at least 20g.

The lack of seat padding in the lifeboat probably exacerbated the transmission of the impact force to the spines of those on board. Although padding is provided to protect the head against the side of the lifeboat, the inclusion of seat padding

Figure 8

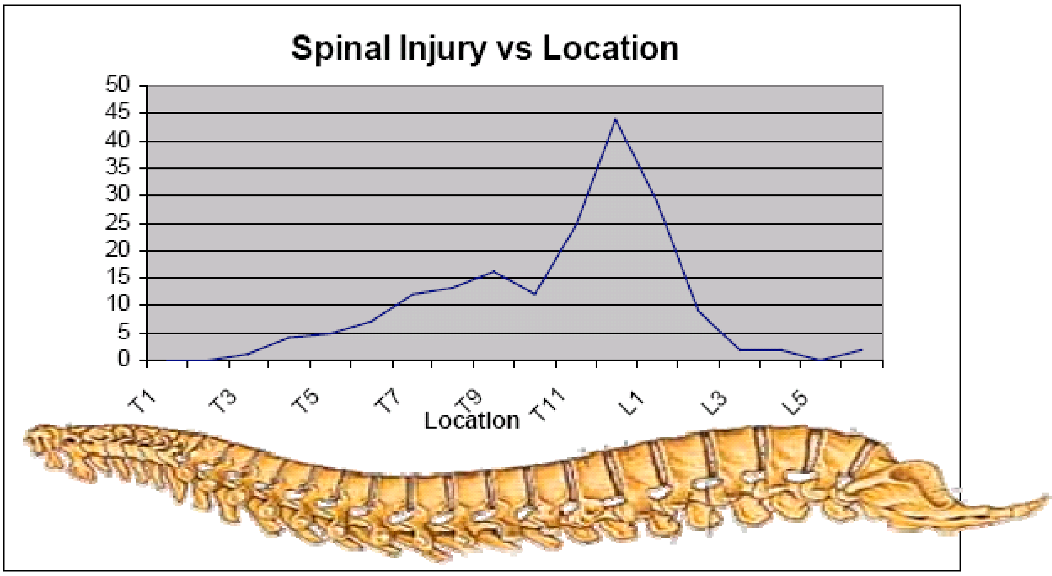


Figure 1: Spinal injury distribution (from ref 2)

2. D J Anton, The incidence of spinal fracture on RAF ejections 1968-1983, RAF IAM Aircrew Equipment Report No 529, February 1986

would have been a desirable option given the circumstances of the accident. Despite not being required by SOLAS Regulations, lifeboat manufacturers may consider including seat padding in future lifeboat designs, if space permits, although it should be borne in mind that the sort of forces experienced by *Fort Victoria*'s lifeboat crew would not be encountered during normal operational conditions.

2.3.2 Other accident investigations

Other accident investigations have reached similar conclusions. In 2000, two sister vessels (*Washington Trader* & *Pacmonarch*) suffered lifeboat accidents in very similar circumstances to each other during launching. The Transportation Safety Board of Canada (TSB), which investigated the *Pacmonarch* accident (www.tsb.gc.ca), noted that no measure had been taken to soften the effect of a freefall impact on the occupants of the lifeboat, although the boat was apparently designed to freefall from a height of 3 metres. Tests carried out by TSB investigators found that jarring of the spine occurred at about a 0.5 metre drop. They further noted that, while strapped in and wearing lifejackets, the occupants would have had to bend their necks forward at an awkward angle, due to the padded headrest. The uncushioned seating arrangements were also not conducive to crew comfort, and could lead to injuries, particularly when the occupants may be required to spend a considerable time on board following abandonment.

2.3.3 Warning signs

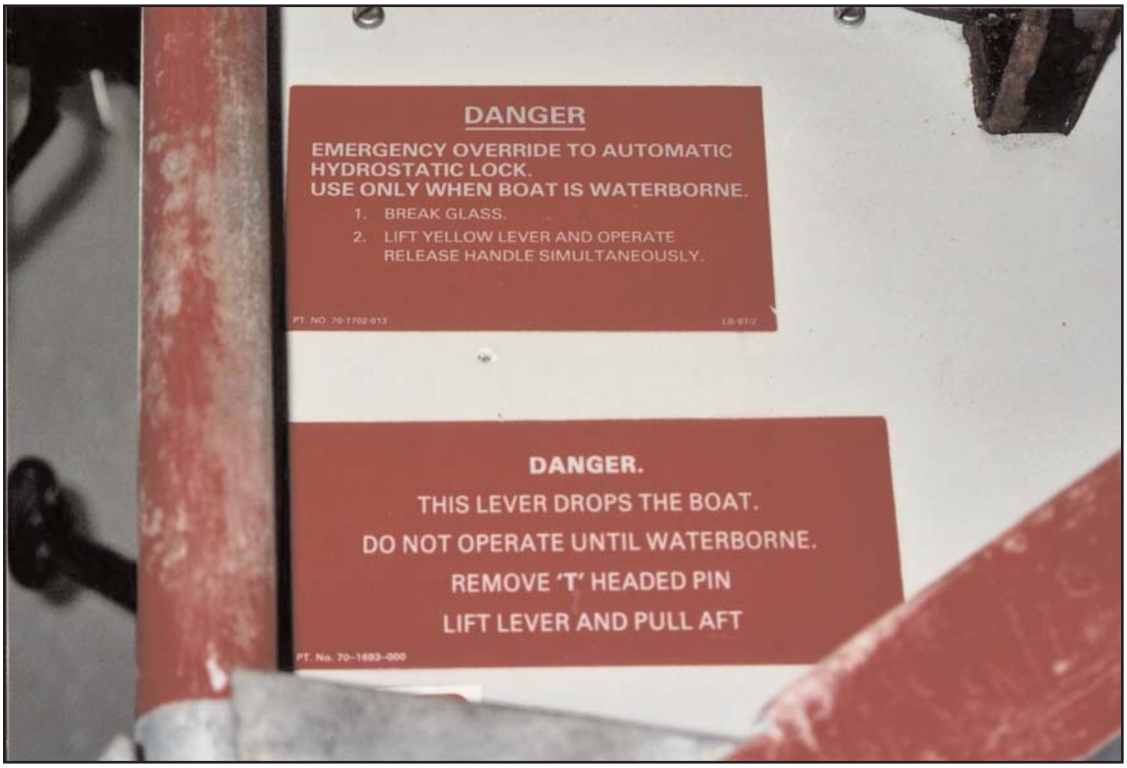
The signage within number 2 lifeboat was clear in its warning to only operate the off-load release when the lifeboat was waterborne **(Figure 9)**. However, it did not give adequate warning that serious injuries could result if the on-load release was operated when the lifeboat was hanging even 1m above calm water.

There appears to be a general lack of clear understanding about when the on-load release gear should be used in an emergency. The signage in the lifeboat does not allow for the commonly held opinion that the gear could be used when deploying the lifeboat in an emergency in rough sea conditions after first lowering to wave top height. The MAIB believes that the signage could be improved in this respect, and that it should provide clear indications of the potential for serious injury to result from using the lifeboat on-load release gear when suspended above calm water.

2.3.4 Position of on-load release

To enable the second officer to operate the on-load release lever, he had to slacken his harness in order to reach it. The on-load release lever only needs to be operated under extreme emergency conditions and it is an indication of poor ergonomic design that a crewman needs to release his harness to operate it at such a time. The MAIB believes that lifeboat manufacturers should review new lifeboat design to ensure that the on-load release can be operated by a seated and strapped in crew member.

Figure 9



Warning notices for release gear

2.4 MANAGEMENT OF THE EXERCISE

2.4.1 Risk assessment

Neither the MCA nor RFA *Fort Victoria* had a formal procedure for a practical on-load release gear test. The lack of formal procedures led to the risks involved in this operation being inadequately assessed. This was apparent in this accident with regard to the management of the lifeboat's height above the water, and management of command responsibility during the exercise, and was a causal influence on this accident.

2.4.2 Communications and the safety briefing

Communication failures also played a part in this accident. Approximately 1 week before the accident, the surveyor briefed RFA *Fort Victoria*'s third officer as to his requirements for operational testing of the boats and their crews. As a result, when the surveyor attended the vessel on the afternoon of 10 September, he believed that the crew had received adequate warning of his request in order to plan and carry out an effective lifeboat drill, including an on-load release test. However, the requirement for an on-load test appears not to have been fully explained to the relevant lifeboat crew. The reasons for this failure of communication are not clear, but the consequence was that the crew did not have an opportunity to consider how the test should be conducted and what, if any, safeguards should have been in place.

There is no formal system for issuing this type of tasking, nor is it usual for such taskings to be provided in written format. Had the request been put in writing, it is more likely that it would have been cascaded appropriately through to the lifeboat crew of RFA *Fort Victoria*. This would have provided opportunities for senior officers on the vessel to be aware of the nature of the tests requested, for the lifeboat crew to prepare for the test, and for the MCA to provide a statement of their surveyor's precise role during the test period. However, as MCA surveyors give out such taskings frequently, requiring such a system might be deemed to be overly bureaucratic. To improve the current procedure, the MCA should take steps to improve the clarity and detail given with taskings, and RFA should improve the methods of cascading the information to the appropriate crew.

The surveyor did not attend the crew's pre-test briefing. This was contrary to his usual practice. On this occasion, he was distracted by a number of urgent incoming calls on his mobile telephone relating to the fatal accident enquiry. This error can be characterised as an inappropriate evaluation of risk on the part of the surveyor. Two factors contributed to the surveyor's acceptance of this deviation from his normal practice:

1. He appears to have had confidence in the crew. He stated that he was impressed by their conduct after boarding the vessel and felt that they understood what was required of them.
2. He assumed that the crew had an understanding of the role of the MCA surveyor in this type of test.

These factors were compounded by the high task demand that the surveyor was experiencing. This included balancing the requirements of a separate fatal accident investigation with the need to complete the tests on RFA *Fort Victoria*. The surveyor believed there was pressure to complete the lifeboat tests that day in order that the shipyard might release the vessel to the RFA in time for a weekend sailing. It seems likely that this perceived operational pressure was also a direct contributor to his decision to continue with the test, despite the fact that the lifeboat maintenance contractor, whose presence at the test he had requested, had left. Although the lifeboat contractor had left the shipyard the previous day, the surveyor had not been informed by the ship repairers and, therefore, assumed that the contractor would still be available to take part in the drill. Had the surveyor been informed, it is possible that the drill could have been postponed until the contractor was available.

Thus, several potential risk mitigation mechanisms were removed. First, the surveyor missed the opportunity to gain an appreciation of the crew's level of understanding of what was required of them during the drill. Second, he was not able to clarify his role in the trial and to satisfy himself that the crew had an adequate plan for responsibility management. Third, there was no opportunity for the lifeboat contractor to contribute to the conduct of the drill.

2.4.3 Control of the exercise

In analysing the sequence of events that led up to the dropping of the lifeboat, it is useful to consider, separately, failures associated with the management of the lifeboat's height above the water and the final decision to operate the on-load release gear.

Written statements from crew members involved in the accident suggest that members of the crew, who were controlling the lowering of the lifeboat, might have had a different understanding of the required procedure. The second officer believed that the lifeboat was to be lowered "to just above the waterline". However, the CPO(D), who was part of the lowering team, believed that "the lifeboat would be lowered….until the lifeboat was approximately 3 feet off the water". The second officer's recollection is in-line with the surveyor's belief that he asked for the lifeboat to be lowered to "just above the water". This lack of clarity was probably caused by a number of factors, including the lack of any written procedure, lack of crew training and experience in the use of the interlock lever, and the earlier lack of communication of the surveyor's requirements to the lifeboat's crew, which, in turn, led to the necessity to plan and brief the procedure at the last minute.

The management of command responsibility within the lifeboat also played a part in the accident. The surveyor believed that the crew understood that his role was merely to act as an observer. The surveyor's view was that the senior person on board the lifeboat, the second officer, had command responsibility. It appears, however, that the lifeboat crew were not clear on this point. Moreover, the surveyor's initial intervention and request for the lifeboat to be lowered further, instead of directing the second officer to take charge, probably reinforced their impression that they could expect operational direction from him. Without the line of command being firmly agreed and clarified, the exercise of control fell short of that which should be manifest when personnel are engaged in operations such as the testing of the on-load release gear.

Following his request for the boat to be lowered further, the surveyor reports that he decided not to intervene again in the way the exercise was being conducted. He stated that, from where he was seated, he suspected they were still too high, but believed it would be safe to drop the boat. Members of the crew might have had concerns about the boat's height above the water, but none were voiced. Everybody appears to have underestimated the level of hazard involved in dropping a near flat-bottomed boat into relatively still water.

Having positioned the lifeboat at an inappropriate height, the final error was the operation of the on-load release mechanism. The second officer and the coxswain, who were both involved in this operation, were not fully aware of the risks involved. Statements provided by members of the crew suggest that the surveyor's consent to release the boat was sought and given. Some crew members were slightly concerned about operating the release mechanism at that height. However, no one intervened or questioned the decision. The most likely reason for this lack of intervention was the belief that the surveyor was in control of the test, and there might have been some trepidation in questioning his decision.

2.4.4 Delegation of responsibility

In seeking an explanation of why no one intervened or expressed doubt, it is possible to draw upon general principles from social psychology.

When individuals join a group, they tend to feel less responsible for their actions than when they are alone. This perception, that responsibility is diffused, is thought to be at the root of a number of group-level phenomena: for example, the tendency for groups to take more extreme decisions than their members would reach working alone. Diffusion of responsibility also appears to affect the likelihood that group members will intervene when action needs to be taken. Where the pressure to act is not focused on one operator, but is shared among the group, the individuals comprising that group are less likely to intervene. This effect can be amplified by the presence of a rank structure within the group, whether real or perceived. In the case of the lifeboat trial, the perception was that the surveyor was in control of the test. This, combined with the formal rank structure of the RFA personnel on board, probably led crew members to feel less responsibility than they would, had they believed everyone in the boat to bear equal accountability.

The likelihood that someone would intervene was probably reduced further by the natural tendency for individuals to follow the actions of other group members. People often look at the behaviour of others when making decisions about how to act themselves, particularly in situations that are novel or potentially threatening. This effect is increased when individuals believe that other group members have knowledge or expertise pertinent to the current situation that exceeds their own. In this case, had one individual voiced concern, it is quite possible that others would have added their support.[1]

[1] It is interesting to note that this latter principle, the tendency to look to others' behaviour to legitimise one's own was probably also a contributory factor in the adoption of the unwritten procedure for testing the on-load release mechanism. The logic is that 'it must be appropriate because other people do it'.

2.5 FATIGUE AND SURVEYOR WORKLOAD

Evidence provided to the investigation was analysed to assess whether the surveyor's performance, on the day of the accident, might have been affected by fatigue. Several factors were considered.

1. The accident occurred during normal working hours when the normal circadian rhythm would have indicated a reasonable degree of wakefulness.
2. The surveyor does not appear to have been suffering the effects of a sleep deficit. He reported that he had received normal sleep on the two nights preceding the accident. The investigation also noted that, on the evening before the accident, the surveyor had spent several hours after work maintaining his own boat. This activity would have involved moderate physical exertion. It is unlikely, however, that this would have caused him to experience lowered levels of alertness the following day, or have materially affected his sleep.
3. The possible effects caused by the time the surveyor had been working, were considered. Long periods of work without a break can lead to performance degradation and, at the time of the accident, the surveyor had been working for several hours with only a short break. The extent to which this break would have been recuperative is not clear. However, it is possible that the fact that he was undertaking a range of tasks would have compensated. Since long, uninterrupted, periods on task can lead to reduced performance, it is recommended that those in safety critical roles manage their time effectively to ensure that breaks can be taken.

Neither fatigue nor sleep deficit appear to have contributed as significant causal factors in this accident. The most pertinent factor impinging on the surveyor's performance appears to have been workload, rather than fatigue.

It is clear that, at the time of the accident, the surveyor was experiencing a period of excessive workload, and felt under pressure to meet the requirements of both the fatal accident enquiry and the operational testing on *Fort Victoria.* Moreover, on the day of the accident, there was no other surveyor available to provide him with support. The surveyor had made a request for support from the Plymouth office on the morning of the accident, but this was too short notice for an additional surveyor to be sent to help. It is possible that, had the surveyor been able to take an objective view of his work situation, he would have sought postponement of the lifeboat operation. In the event, he did his best to balance competing demands, but had to compromise in two critical areas:

i. Proceeding without the lifeboat contractor;

ii. Missing the pre-exercise briefing.

No fatigue issues have been highlighted on the part of the officer and crew of the lifeboat.

SECTION 3 - CONCLUSIONS

3.1 SAFETY ISSUES

The following safety issues have been identified in the foregoing analysis. They are not listed in any order of priority.

1. Neither the MCA nor the RFA had a well documented and understood procedure for a routine practical test of the on-load release gear. [2.2]
2. The surveyor may have been unaware that the lifeboat crew had not carried out an on-load release gear test before. [2.2]
3. Impact injuries occurred when the lifeboat was dropped onto smooth water from a height of 1.2m. [2.3.1]
   - No one was in a position to accurately assess the height of the lifeboat above the water. [2.3.1]
4. Nobody on board the lifeboat realised that dropping a lifeboat from 1.2m was likely to cause injury. [2.3.1]
5. The injured seaman's body had been subjected to a vertical impact of at least 20-g. [2.3.1]
6. The lack of seat padding in the lifeboat probably exacerbated the transmission of the force to the spines of those on board. [2.3.1]
7. The signage within the boat did not adequately warn of the dangers of operating the on-load release gear when suspended above the water. [2.3.3]
8. A crew member had to release himself from his harness in order to operate the on-load release lever. [2.3.4]
9. No risk assessment had been carried out for a routine on-load release gear test. [2.4.1]
10. The surveyor's instructions regarding the required tests were not fully explained to the lifeboat crew, consequently, they were unable to properly plan the exercise. [2.4.2]
11. The surveyor was distracted by mobile telephone calls and a heavy workload during the pre-exercise safety briefing. [2.4.2]
12. It was not clear who was in control of the exercise. [2.4.3]
13. Although some crew members were slightly concerned about the height of the boat before it was dropped, no one intervened or questioned the decision. [2.4.3]
14. The surveyor's actions were affected by a heavy workload, but he was not fatigued and he was not suffering from a sleep deficit at the time of the accident. [2.5]

SECTION 4 - ACTION TAKEN

The Maritime and Coastguard Agency has issued an OAN to surveyors, reminding them of their responsibilities when lifeboat tests are carried out, and stressing that:

- They should make it clear that they are only acting as an observer and that the ship personnel or shipyard staff are to remain in charge of the operation;
- They should ensure that a safety briefing is carried out and that they attend;
- At the briefing, the surveyor should explain what is necessary for a satisfactory test and that the person in charge should consult them at any time;
- The number of people in the boat should be kept to a minimum;
- On-load release gear tests should only be carried out with the boat touching the water or just clear of the water - 1 metre above the water is not a safe height;
- Test procedures should include positive reporting of the boat's height before release, and the engine should not be run during descent to facilitate better communications.

The Royal Fleet Auxiliary has:

- Carried out a risk assessment of on-load release gear tests and produced a Standard Operating Procedure (SOP) for its vessels;
- Updated the vessels' safety management systems with instructions about the line of authority when lifeboat drills are undertaken and, in particular, the role of the MCA surveyor as being that of just an observer.

And intends to:

- Provide working models of on-load release gear for the instruction of ship's staff.

SECTION 5 - RECOMMENDATIONS

The International Lifesaving Appliances Manufacturing Association (ILAMA) is recommended to circulate to its relevant members advice on:

151/2005 The ergonomic design of lifeboats with respect to the positioning of the on-load release lever to prevent an operator having to release his/her harness to reach and operate it;

152/2005 Providing signage within the lifeboat that clearly explains how the emergency release gear is to be operated, and that provides a warning of the likely dangers when operating the equipment if the lifeboat is more than 0.5m above smooth water.

Marine Accident Investigation Branch
May 2005

Safety recommendations shall in no case create a presumption of blame or liability