ACCIDENT REPORT

Report on the investigation of the foundering of the fishing vessel

Louisa SY30

while at anchor off the Isle of Mingulay

in the Outer Hebrides

on 9 April 2016

resulting in three fatalities

VERY SERIOUS MARINE CASUALTY REPORT NO 17/2017 JULY 2017

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2012 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 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 14(14) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AIS	Automatic Identification System
ALB	All Weather Lifeboat
ARCC	Aeronautical Rescue Co-ordination Centre
BOSIET	Basic Offshore Safety Induction and Emergency Training (course)
CERS	Consolidated European Reporting System
CGOC	Coastguard Operations Centre
cm	centimetre
CO_2	Carbon Dioxide
DLA	Deputy Launch Authority
EC	European Community
EFF	European Fisheries Fund
EMSA	European Maritime Safety Agency
EPIRB	Emergency Position Indicating Radio Beacon
GEOLUT	Geostationary Local User Terminal
GEOSAR	Geostationary Search and Rescue (satellite)
GNSS	Global Navigation Satellite System
HMCG	HM Coastguard
hr	hour
HRU	Hydrostatic Release Unit
IAMSAR	International Aeronautical and Maritime Search and Rescue (Manual)
IHAC	(Department for Transport) In House Analytical Consultancy (team)
IMDatE	Integrated Maritime Data Environment
IMO	International Maritime Organization
kg	kilogram
kt	knot
kVA	kilo-volt-ampere
kW	kilowatt

LEOSAR	Low Earth Orbiting Search and Rescue (satellite)
LOA	length overall
LSA	Lifesaving appliances
LUT	Local User Terminal
m	metre
MCA	Maritime and Coastguard Agency
MCC	Mission Control Centre
MGN	Marine Guidance Note
MHz	Megahertz
mm	millimetre
MOO	Maritime Operations Officer
MRCC	Maritime Rescue Co-ordination Centre
MSN	Merchant Shipping Notice
N	Newton
NMOC	National Maritime Operations Centre
nm	nautical mile
ORC	Offshore Racing Council
PDF	Protected Data Field
PFD	Personal Flotation Device
RAF	Royal Air Force
RNLI	Royal National Lifeboat Institution
rpm	revolutions per minute
RTD	Reference Test Device
s	second
SAR	Search and Rescue
SFF	Scottish Fishermen’s Federation
Sitrep	Situation report
SMOO	Senior Maritime Operations Officer

SOLAS	International Convention for the Safety of Life at Sea 1974, as amended
t	tonne
UKMCC	United Kingdom Mission Control Centre
UTC	Universal Co-ordinated Time
VHF	Very High Frequency
VMS	Vessel Monitoring System

TIMES: all times used in this report are UTC unless otherwise stated

SYNOPSIS

Early on 9 April 2016, the fishing vessel *Louisa* foundered, with the loss of three lives, while anchored close to the shore in Mingulay Bay in the Outer Hebrides.

The skipper and crew, who had been working long hours before anchoring late the previous evening, had woken suddenly as the vessel was sinking rapidly by the bow. They were able to escape to the aft deck, activate the emergency position indicating radio beacon (EPIRB), and to don lifejackets. However, they were unable to inflate the liferaft as they abandoned the vessel.

At 0232, an alert from *Louisa*'s EPIRB was detected by a geostationary search and rescue satellite and forwarded through the Cospas-Sarsat system to the United Kingdom Mission Control Centre (UKMCC). The UKMCC relayed the alert to HM Coastguard, but confusion over terminology resulted in delays before search and rescue units were sent to the scene.

When Barra lifeboat arrived in Mingulay Bay, the crew were able to assist one crewman, who had swum to the shore and climbed onto rocks. They located the uninflated liferaft and beside it found the skipper and one crewman unresponsive and face down in the water, despite wearing approved abandonment lifejackets. The other crewman had attempted to swim to the shore and was found, also face down and unresponsive, still wearing his lifejacket, close to the beach. The skipper's body was lost as the lifeboat crew attempted to recover him and remains missing.

The MAIB investigation included salvaging the wreck to determine the cause of flooding, inspection and testing of the liferaft, lifejacket trials and testing, and a review of the search and rescue response.

The Maritime and Coastguard Agency has since taken action to enhance its guidance in respect of liferaft servicing requirements.

The circumstances of this accident, and subsequent trials and testing undertaken, have raised concerns about the effectiveness of the lifejackets worn by *Louisa*'s skipper and crew.

Recommendations have been made to *Louisa*'s owners regarding vessel maintenance, safety equipment servicing and risk assessments, and to the liferaft servicing company and its sub-contractor in respect of work processes.

The Maritime and Coastguard Agency has been recommended to: urgently conduct research designed to confirm or otherwise the suitability of lifejacket water performance test requirements, and to bring any shortcomings identified to the attention of the International Maritime Organization; and to update and enhance its response to satellite distress beacon alerts.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *LOUISA* AND ACCIDENT

SHIP PARTICULARS	
Vessel's name	*Louisa*
Flag	United Kingdom
Classification society	Not applicable
IMO number/fishing numbers	SY30
Type	Vivier creel boat
Registered owners	Privately owned
Manager(s)	Not applicable
Construction	Steel
Year of build	2008
Length overall	14.95m
Registered length	14.15m
Gross tonnage	32
Minimum safe manning	Not applicable
Authorised cargo	Not applicable
VOYAGE PARTICULARS	
Port of departure	Uig, Isle of Skye
Port of arrival	Uig, Isle of Skye (intended)
Type of voyage	Commercial
Cargo information	Shellfish
Manning	4
MARINE CASUALTY INFORMATION	
Date and time	09/04/2016 0232 UTC
Type of marine casualty or incident	Very Serious Marine Casualty
Location of incident	Isle of Mingulay
Place on board	Hold
Injuries/fatalities	3 fatalities
Damage/environmental impact	Constructive total loss/none
Ship operation	At anchor
Voyage segment	Anchored
External & internal environment	Night, visibility good, wind light airs variable direction, sea state slight. Sea temperature 10ºC, air temperature 8ºC.
Persons on board	4

Photograph courtesy of Trawlerphotos.co.uk

Louisa

1.2 BACKGROUND

Louisa generally operated around the Western Isles fishing for lobster, crab and prawns. Each trip was usually 6 days' duration, departing on a Monday afternoon and landing the catch on the following Sunday, during which time the catch was kept alive in a vivier tank. The intensity of fishing varied depending upon quantity of catch, weather conditions and the skipper's preference. The relief skipper normally aimed to recover and shoot each string of creels twice during the trip, whereas the regular skipper aimed to recover and shoot each string three times per trip. The intention on this trip was for each string to be recovered and relaid three times, which could amount to hauling about 1,000 creels per day. Catch was normally landed at the port of Uig on the Isle of Skye, with a weekly call into Stockinsh on the Isle of Lewis to allow the owners to carry out any maintenance required. The crew generally completed 3 weeks on board, followed by a week of leave, but the regular skipper could spend several months on the vessel without a break. There was a pool of seven crew (including the relief skipper) with either the skipper plus three, or occasionally four, crew on board during each fishing trip.

1.3 NARRATIVE

1.3.1 The accident

On Sunday 3 April 2016, *Louisa* berthed in Uig to discharge catch and conduct a crew change during which the relief skipper left and Paul Alliston, the vessel's regular skipper, took over. Another crew member left at short notice, and sailing was delayed while a relief crewman travelled from the mainland to join the vessel.

Louisa sailed late evening on Monday 4 April, and motored for about 7 hours to reach the first string of creels. Fishing then continued through Tuesday, Wednesday and Thursday, with the live catch being loaded into the vivier tank. The vessel berthed at North Bay on the Isle of Barra to load an additional 20 boxes of fish offal as bait. Having loaded the bait, the vessel returned to its fishing grounds. Some of the boxes of bait were stored in the port bait locker, a refrigerated compartment in the hold. The remainder of the boxes were stowed in various locations on the main deck with a number placed directly aft of the hold hatch coaming.

Fishing continued into Friday evening when *Louisa*'s skipper recognised that the crew, who had been working for approximately 20 hours per day, were too tired to continue safely. He decided to anchor in Mingulay Bay (a recognised anchorage off the uninhabited Isle of Mingulay), to enable the crew and himself to rest. At approximately 2230, he anchored *Louisa* about 200m from the shore. He and the crew then set about tidying the working deck and hosing down using the deck wash pump, while a meal was prepared. When the meal was ready the skipper and crew went to the mess room to eat it, after which they all went to bed in the accommodation.

The crew woke suddenly in the early hours of Saturday morning, 9 April, to find the vessel significantly down by the head and apparently foundering bow first. Wearing only light clothing they quickly exited the accommodation via the wheelhouse and onto the aft deck, by which time the vessel's bow was fully submerged and water was encroaching on the wheelhouse windows **(Figure 1)**.

The skipper told the crew to launch the liferaft and activate the EPIRB while he collected lifejackets from a locker located in the wheelhouse. One of the crew released the liferaft canister from its cradle and unsuccessfully attempted to inflate the liferaft by pulling on the painter. The canister was then removed from the cradle and its securing straps cut to remove the uninflated liferaft. Further attempts were then made to operate the liferaft's CO_2 inflation cylinder, all of which failed.

By this time, the crew were standing on the aft bulkhead of the wheelhouse with the vessel almost vertical and foundering rapidly. The crew then worked together to place some plastic buoys inside the liferaft to give it buoyancy, and then pushed it into the water. By now, the skipper and crew had all donned lifejackets. Two of the crew jumped onto the liferaft, which initially supported their weight but, as the others jumped on, it began to sink. Martin Johnstone immediately decided to attempt to swim to the shore. The skipper and remaining crew, conscious of their sea survival training, decided to remain with the partially floating liferaft. After several minutes it became apparent that the liferaft was drifting further out to sea. After discussing their options, one of the remaining crew also decided to attempt the swim to shore while the skipper and Christopher Morrison chose to remain with the liferaft.

Louisa foundered and sat on the seabed in approximately 10m of water.

1.3.2 Emergency response

At 0232 UTC, an alert from *Louisa*'s EPIRB was detected by geostationary search and rescue (GEOSAR) satellite MSG3, which automatically forwarded it to the French geostationary local user terminal (GEOLUT). The information then

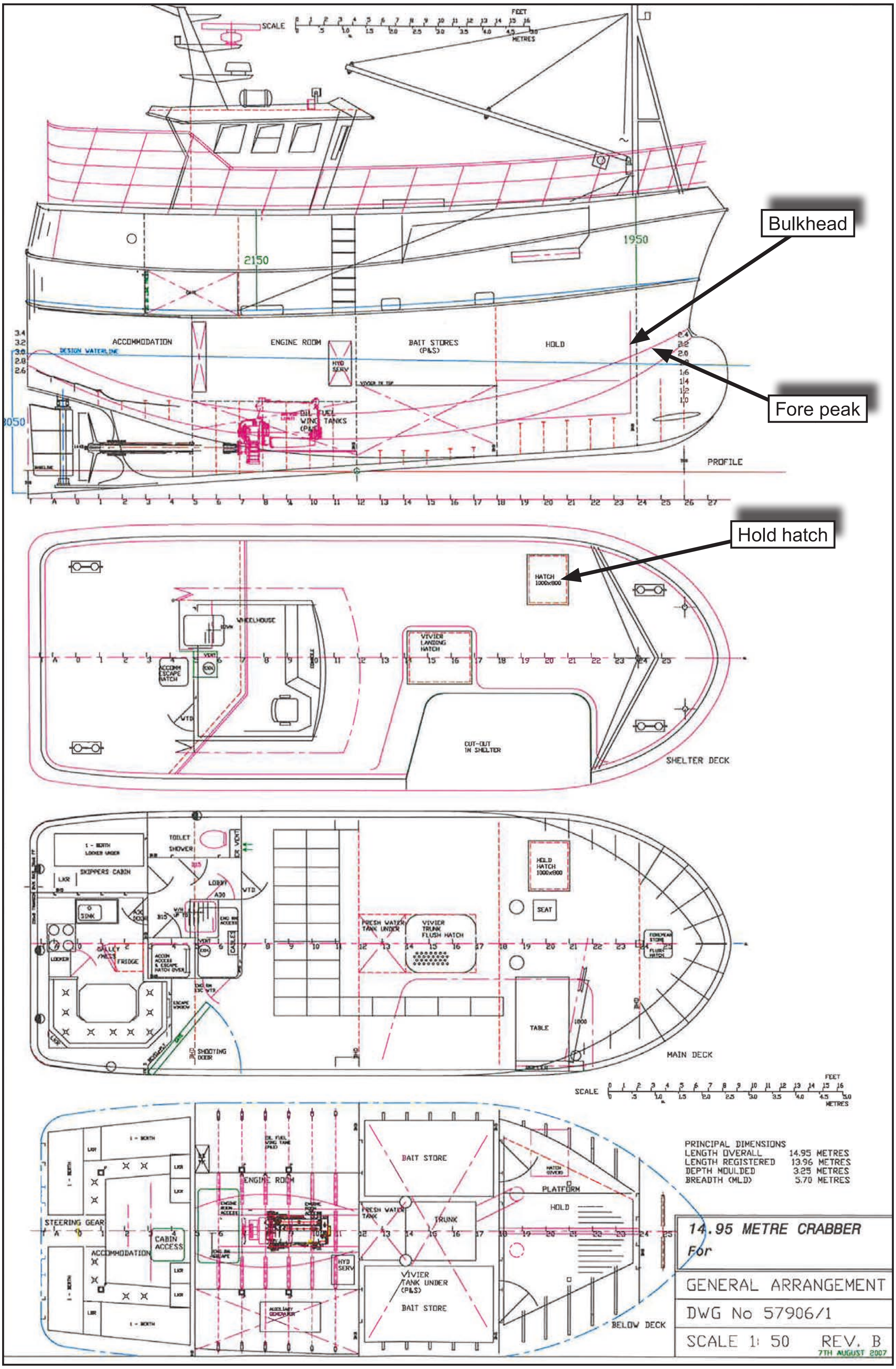

Figure 1: *Louisa* - general arrangement

automatically passed to the United Kingdom Mission Control Centre (UKMCC). The information included a position for the beacon of 56º 45.00’N, 007º 30.00’W **(Figure 2)**.

By 0239, UKMCC had initiated a new incident on the HM Coastguard (HMCG) live information system (Vision 4) and had informed Coastguard Operations Centre (CGOC) Falmouth via fax and telephone call that the alert had been received. The alert was initially logged as an unresolved 406 alert. At 0244 UKMCC entered the position for the EPIRB into Vision 4. The EPIRB’s details were then entered and, by 0250, UKMCC had passed co-ordination of the incident response to CGOC Falmouth.

At 0251, CGOC Falmouth made CGOC Stornoway aware of the alert and requested it attempt to contact *Louisa* by all available means. Despite numerous calls to the registered emergency numbers associated with the EPIRB and very high frequency (VHF) radio calls to the vessel, CGOC Stornoway was unable to establish contact with *Louisa* or its owners.

At 0241, an alert from *Louisa*’s EPIRB was detected by GEOSAR satellite MSG2 and passed to the Greek GEOLUT. This information, which was again automatically passed to UKMCC, included an updated position for the beacon of 56º 48.73’N, 007º 37.40’W. It is reported that UKMCC received this information at 0251. However, the refined position did not appear on Vision 4 until 0312 when it became visible to CGOC Falmouth.

At 0306, the National Maritime Operations Centre (NMOC) noted on Vision 4 that it was aware of the EPIRB alert and was monitoring the narrative.

During a telephone conversation between CGOC Falmouth and UKMCC, UKMCC staff expressed uncertainty as to the accuracy of the updated position and that a low earth orbiting search and rescue (LEOSAR) satellite pass would be able to confirm the position. With the next LEOSAR satellite pass not scheduled until 0410, CGOC Falmouth staff pressed for confirmation that the EPIRB alert included a Global Navigation Satellite System (GNSS) position. After further discussion, UKMCC staff confirmed that the updated position of *Louisa*’s EPIRB was accurate to within 120m.

At 0316, CGOC Falmouth passed responsibility for co-ordinating the Search and Rescue (SAR) response to the incident to CGOC Stornoway, and confirmed that the updated position for *Louisa*’s EPIRB was accurate to 120m.

At 0322, CGOC Stornoway staff paged Barra all weather lifeboat (ALB) deputy launch authority (DLA), who telephoned them to obtain further information about the incident. He then authorised an immediate launch of Barra ALB and requested that CGOC Stornoway page the lifeboat’s crew. The lifeboat crew were paged at 0333 and the ALB launched at 0340.

At 0327, CGOC Stornoway staff contacted the Aeronautical Rescue Co-ordination Centre (ARCC) and requested the launch of a SAR helicopter. ARCC staff requested Stornoway CGOC page the crew for aircraft R948. At 0344, CGOC Stornoway recorded in Vision 4 that it had paged the aircraft crew and that a fault with the communication equipment had caused a delay in activating the pagers.

Reproduced from Admiralty Chart BA 1796-0 by permission of the Controller of HMSO and the UK Hydrographic Office

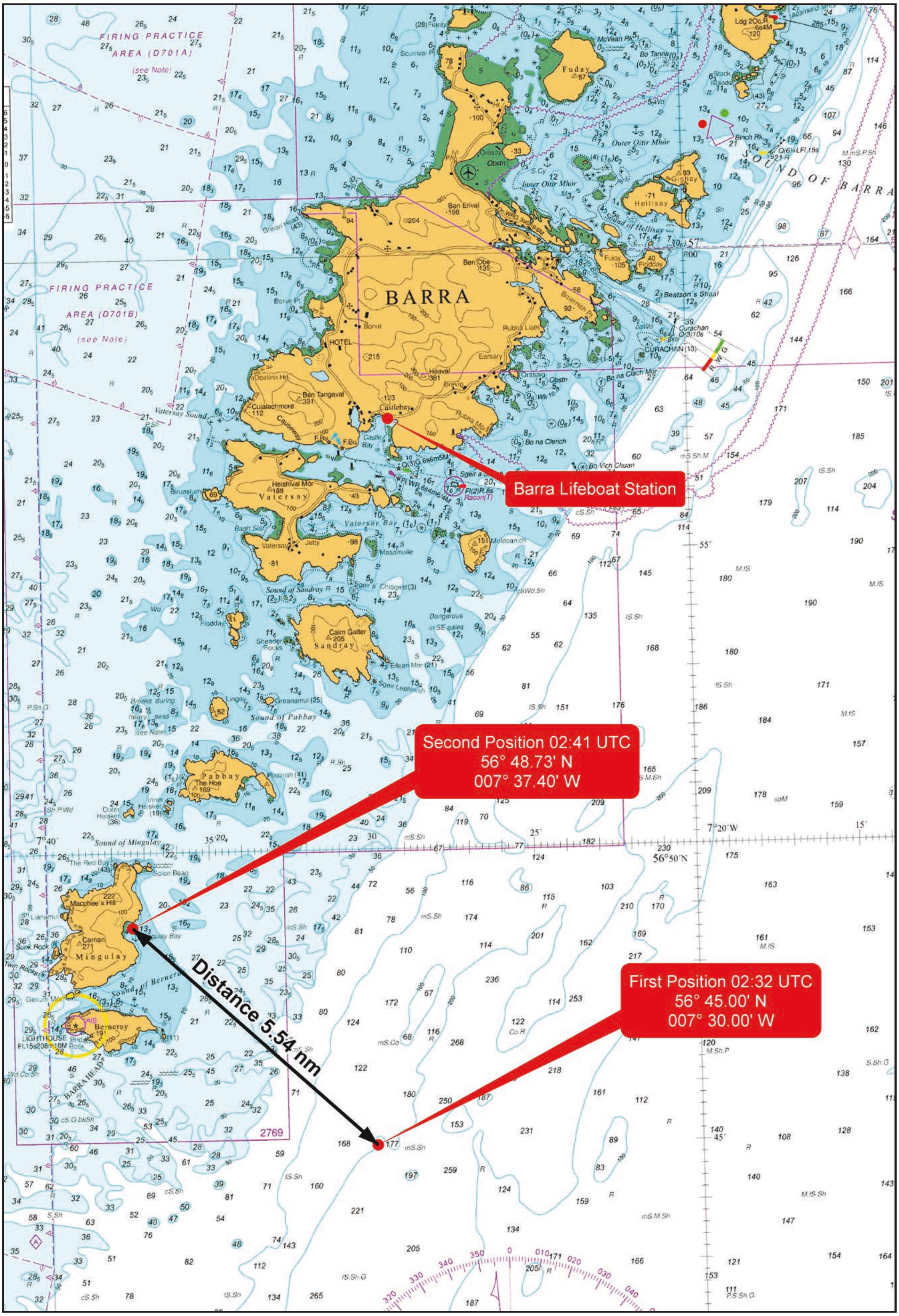

Figure 2: Accident location and positional information

At 0356, CGOC Humber staff contacted CGOC Stornoway to advise that a position taken from the European Maritime Safety Agency (EMSA) IMdatE[1] system placed *Louisa* in Mingulay Bay at 0140 that morning.

Barra ALB proceeded to Mingulay Bay and arrived on scene at 0413. The crew immediately set off white parachute flares to illuminate the area. There was no sign of *Louisa*, which by then had foundered in 10m of water. The ALB's crew saw and headed towards a white flashing light, which was attached to *Louisa*'s uninflated liferaft. At 0424, near to the liferaft, the ALB crew found the skipper and Chistopher Morrison, both unresponsive and face down in the water. While recovering the casualties, the skipper's body slipped from his lifejacket and was lost. Christopher was recovered from the water but was later declared deceased caused by drowning.

After a further 30 minutes of searching, the lifeboat's crew saw another light to the north of the bay. This light was attached to the lifejacket of a surviving crewman who had swum ashore and was clinging to the rocks. The ALB despatched its tender and landed a crew member on the rocks to provide warm clothing to the survivor.

The ALB then continued searching and used its tender to recover Martin Johnstone, who was unresponsive and face down in the water, approximately 50m from the shore. Martin was later declared deceased caused by drowning

At 0425, R948 reported that it would be on scene at 0510. By 0539, R948 had recovered the surviving crewman from the rocks. The survivor confirmed that there had been four persons on *Louisa*, all of whom were now accounted for. The skipper's body remains missing.

1.4 CREW

The skipper, Paul Alliston, was 42 years old. He had been associated with *Louisa* since build, initially as crew, and had taken over as skipper approximately 6 years before the accident. He held a Seafish[2] Under 16.5m Skipper Certificate (unrestricted), which included both bridge and engine room watchkeeping certificates and Intermediate Stability Awareness. He had also completed the mandatory basic safety training courses.

Martin Johnstone was 29 years old. As well as working as a fisherman he had served in the UK military. Of the mandatory basic safety training courses, he had completed Basic Fire-fighting and Prevention, Basic First-aid, and Safety Awareness and Risk Assessment courses, but not the required Basic Sea Survival course. He had undertaken the Basic Offshore Safety Induction and Emergency Training (BOSIET) course when looking for work in the offshore industry, but this was not recognised as an equivalent to the Basic Sea Survival course.

Christopher Morrison was 27 years old. An experienced fisherman and a regular member of *Louisa*'s crew, he had completed all the mandatory basic safety training courses.

[1] The Integrated Maritime Data Environment (IMDatE) is a technical framework that collects and combines data from EMSA's maritime applications and other external sources to provide a comprehensive and configurable service to users. It supports the relay of data from Vessel Monitoring Systems (VMS) and Satellite AIS between maritime applications.

[2] Seafish is an executive non-departmental public body, sponsored by the Department for the Environment, Food and Rural Affairs.

The fourth and only surviving crew member was 27 years old. He was an experienced crab fisherman and regular member of *Louisa*'s crew. He had completed the mandatory basic safety training courses and was the only member of the crew to have completed the 1-day Basic Health and Safety course.[3]

Louisa's skipper and crew were share fishermen, which meant that they were not employed under a contract of service and, instead, received a share of the vessel's profits as remuneration.

1.5 VESSEL AND OPERATION

1.5.1 Vessel description

Louisa was built for static gear creel fishing and was designed with a vivier system to keep the catch alive **(Figure 3)**.

As required under Merchant Shipping Notice (MSN) 1813 (F), The Fishing Vessels Code of Practice for the Safety of Small Fishing Vessels, *Louisa* was built in accordance with the Seafish Construction Standards for new fishing vessels less than 15m length overall.

Prior to registration, the vessel was subject to a Maritime and Coastguard Agency (MCA) inspection of safety equipment and crew qualifications. This inspection was required to be repeated every 5 years, with the vessel's owners completing annual self-certification of compliance in the intervening years.

As recommended by MSN 1813 (F), a freeboard and stability information booklet was produced for *Louisa* by the vessel's designer following a lightship inclining experiment. The booklet contained a section entitled 'Working Instruction' in which the following was stated:

> *'The accumulation of free water in the hold must be avoided as this will cause loss of stability due to its transverse movement. Non-watertight pound divisions will not effectively prevent this. Check bilge levels frequently and pump out as necessary, the functioning of the hold bilge alarm should also be verified at the start of each trip.'* [sic]

Louisa's normal operating pattern was broadly consistent with the voyage cycle assumption in the freeboard and stability information booklet, which assumed a ½ day voyage between departure port and fishing grounds, 5 days on the fishing grounds and a further ½ day return voyage from the fishing grounds to arrival port.

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[3] Following the discovery that many experienced fishermen who joined the UK fishing industry after 1 January 2005 had not completed the mandatory Basic Health and Safety course, the MCA decided that:

'*Fishermen who joined a UK fishing vessel for the first time after 1 January 2005 and before to 1 June 2014 and did not undertake the Basic Health and Safety course do not have to complete this course provided that they;*

a) have completed the Safety Awareness and Risk Assessment course and

b) can demonstrate the date of joining a UK vessel prior to 2014 to the satisfaction of an MCA surveyor.

Fishermen who joined a UK fishing vessel for the first time after 1 June 2014 and did not undertake the UK Basic Health and Safety course must complete this course within a time specified by an MCA surveyor. This applies regardless of whether the fisherman holds the Safety Awareness and Risk Assessment Course.'

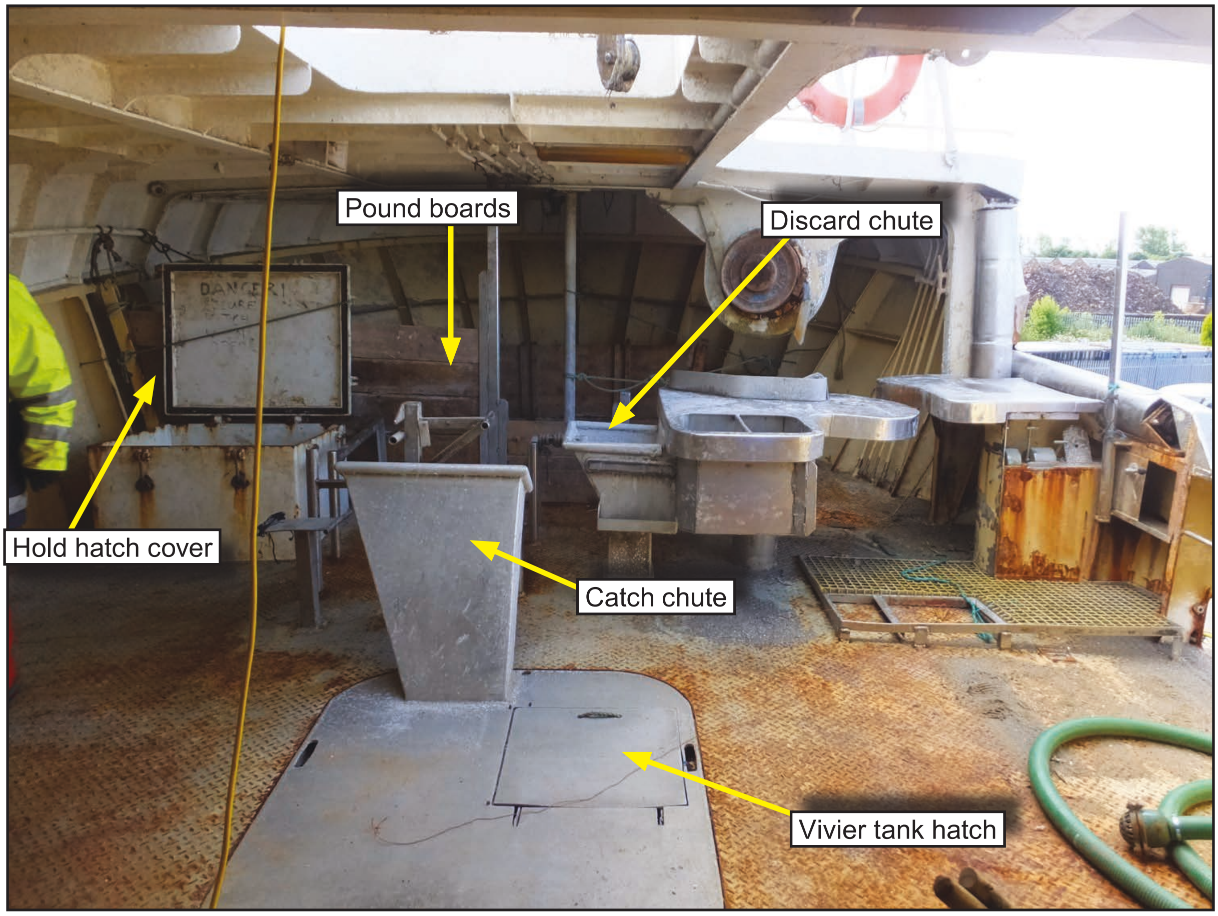

Figure 3: *Louisa* - working deck

The booklet required that the vivier tank remained full with the water level pressed up the access trunk to the overflows. It stated:

> *'If the water level dropped, a large free surface would develop and the vessel's stability would be dangerously reduced.'*

1.5.2 Vivier system

The purpose of a vivier system is to keep the vessel's catch alive once removed from its natural environment, as the quality of shellfish degrades rapidly after death. To achieve this, circulation pumps maintain a steady flow of clean, aerated sea water throughout the system.

On *Louisa*, the vivier system consisted of a tank with a capacity of 22t located in the centre of the vessel. The tank boundaries comprised the forward bulkhead of the engine room, the aft bulkhead of the forward hold and the vessel's sides up to the level of the bait locker decks. A trunking led from the top of the vivier tank to finish flush with the main deck. Within the trunking were port and starboard overflow pipes.

In the bottom of the vivier tank was a grid of perforated pipes through which the sea water was pumped by one of two dedicated pumps. Both pumps were non-self-priming and had a capacity of 125t/hr at 1,500rpm. The port pump was powered by an electric motor and the starboard by a hydraulic motor. The electric pump was rarely used as it generated excessive noise and vibration. The starboard pump was driven via a power take off from either the main engine (when at sea) or the starboard auxiliary engine (when in port or at anchor). The deck wash pump could also be configured to feed the vivier tank, at a reduced throughput of approximately 35t/hr.

1.5.3 Engine room

The engine room was located aft of amidships and forward of the accommodation. It was accessed via a door from the accommodation.

The main engine produced 230kW at 2,000rpm and turned the vessel's propeller through a gearbox, which incorporated a slipping clutch. This arrangement could be used in conjunction with the throttle to control ahead and astern propulsion. At the forward end of the engine, driven from the crankshaft, were power take offs to provide hydraulic power for the steering gear and the vivier system's main pump.

The engine room contained two auxiliary engines to provide electrical power for the vessel. The starboard auxiliary provided 45kVA at 1,500rpm and had a power take off to drive the hydraulic vivier system pump when the main engine was shut down. A smaller air-cooled engine had been retrofitted to *Louisa* by the owners to provide a level of redundancy. However, this was out of commission at the time of the accident and was planned to be replaced in May 2016.

Also in the engine room was a general service pump (known on board as the deck wash pump), which could be configured to pump the bilges, supply the deck wash hose or supply the vivier system. The pump was powered by an electric motor and had a capacity of 35t/hr at 2,900rpm.

1.5.4 Bilge system

As required by MSN 1813 (F), *Louisa* was equipped with a bilge pump and a bilge level alarm, with sensors (float switches) in the hold and engine room to provide warning to the crew when working inside or outside the wheelhouse.

The general service pump could pump water from the engine room and/or the hold via fixed pipelines running to dedicated bilge wells in each of these compartments. In addition to the general service pump, the owners had fitted stand-alone electric bilge pumps in both the engine room and hold bilge wells.

The bilge alarm float switches in the hold and engine room bilge wells were connected to an audible/visual alarm panel in the wheelhouse. Following a previous pipe failure, which had resulted in the engine room flooding, the owners had fitted a remote alarm sounder in the crew cabin to alert the skipper and crew that the bilge alarm had activated in the event the wheelhouse was unmanned.

During the investigation, the alarm sounder in the crew cabin was found to have been disabled. It was reported that small quantities of melt water from the refrigerated bait storage lockers routinely collected in the hold bilge well, which caused the hold bilge alarm to sound when the vessel rolled. The alarm sounder in the crew cabin had regularly disturbed the skipper and crew, and consequently they had disabled it.

1.5.5 Hold and fore peak

The hold was located forward of the vivier tank. Incorporated within the hold were two refrigerated bait storage lockers: one on the port side and one on the starboard side outboard of the vivier tank trunk. The lockers could each hold approximately 2t of bait and were accessed via insulated, but not watertight, doors in the hold. The hold was used for general storage of ropes and other spares and also included a small domestic chest freezer.

The fore peak was located forward of the hold and included the bulbous bow. Although separate compartments, the fore peak and hold were interconnected by way of a small (30mm diameter) drainage hole located in the bilge.

1.5.6 Accommodation

The accommodation comprised a galley/mess room and a single berth skipper's cabin at main deck level, and a four-berth cabin for the crew on the deck below the galley and aft of the engine room.

The designated skipper's cabin on the main deck was only used for storage; the skipper and crew all slept in the lower four-berth cabin.

The vessel's hydraulic steering gear was located in the four-berth cabin, which also contained a fire detector/alarm and a bilge alarm sounder (that had been disabled, see 1.5.4).

1.6 WRECK RECOVERY

To ascertain the cause of *Louisa* foundering, the wreck was salvaged and placed ashore in a secure facility to allow a thorough examination.

A pre-salvage dive survey found no evidence of damage or breaches to the hull; that all visible doors and hatches were open; and that those freeing ports that could be seen were clear. The divers observed through the wheelhouse windows that the main engine controls were set with the propeller engaged and set to run astern at apparently low speed.

After large amounts of loose rope had been cleared from around the vessel, lifting slings were placed beneath the vessel's hull and it was lifted onto a crane barge.

The wreck was then secured to the barge and transported to a facility on the River Clyde, where it was prepared for inspection **(Figure 4)**.

Extensive cleaning of the vessel was required to remove the remnants of the catch (approximately 4t of dead shellfish) and other detritus to make it safe for access.

Figure 4: *Louisa* - transporting to River Clyde

1.7 VESSEL EXAMINATION

1.7.1 Vessel status

The initial focus of the examination centred on checking and recording the positions of all system valves and machinery controls. As identified during the dive survey, the main engine controls were found set to run at apparently low speed with the propeller engaged astern **(Figure 5)**.

The vivier system valves and power supply were configured to operate the system using the main hydraulic pump driven from the main engine power take off **(Figure 6)**.

The status of the deck wash pump could not be ascertained because the switching arrangement provided no means for confirming whether or not the pump was being electrically powered at the time of the accident. However, the lock stop had not been activated, indicating that the pump was probably running.

All machinery space and accommodation doors were found open. The hold hatch cover was found closed but not secured, and some lengths of rope were between the hatch cover and its coaming. It was reported that, prior to the accident, the hatch cover was open and secured against pound boards located forward of the hatch coaming, and that a number of bait boxes were stacked aft of the hatch coaming. It was not possible to check this information as the pound boards had become detached during the foundering and the bait boxes had moved.

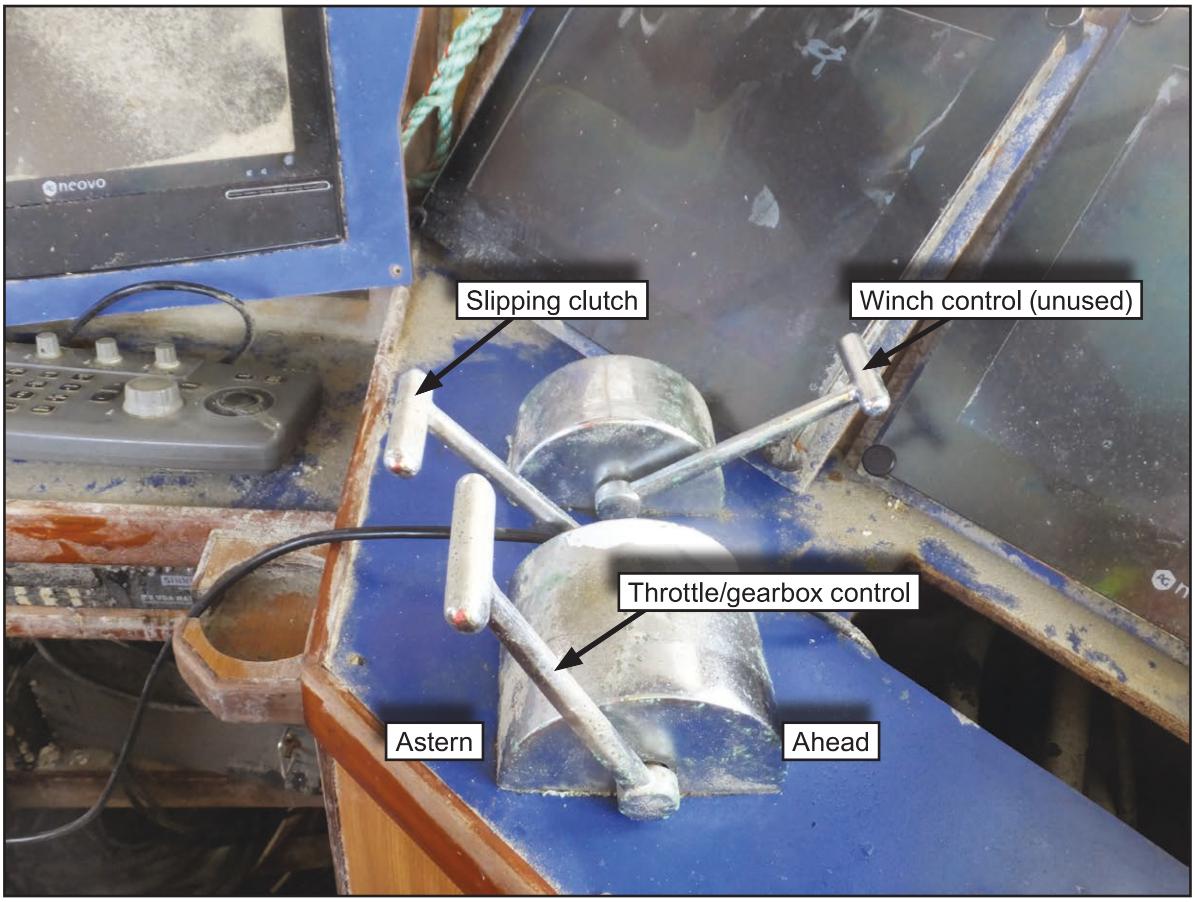

Figure 5: *Louisa* - engine controls as found

1.7.2 Hull and structure integrity

There was no evidence of external damage to *Louisa*'s hull and structure. To test its integrity, the vivier system's inlet and outlet valves were closed and the tank was filled to the level of the overflow pipes in the trunking. Tank boundaries and pipelines were examined for signs of leakage. No leakage was observed and the water level remained constant.

The vivier tank was then emptied and the hold filled. Hold boundaries (which included the engine room) and pipe runs were examined, but again no leakage was observed. It was noted at this stage that the fore peak filled at the same time as the hold, and this subsequently led to the discovery of the drainage hole between the two compartments.

The vivier overflow pipes and the discard chute ran through sections of the hold. The overflow pipes and discard chute were blanked off at their hull outlets and filled with water, but again no leakage into the hold was observed.

1.7.3 Pipe systems

To test *Louisa*'s piping, connection boxes were welded over the sea water inlets on the vessel's hull and the systems were tested under pressure using a portable pump. The systems tested included:

- Bilge system (engine room and hold)
- Engine and generator cooling system

- Refrigeration condenser
- Vivier system
- Deck wash line
- Redundant prawn wash line.

All systems were confirmed as being intact, with no leakage noted.

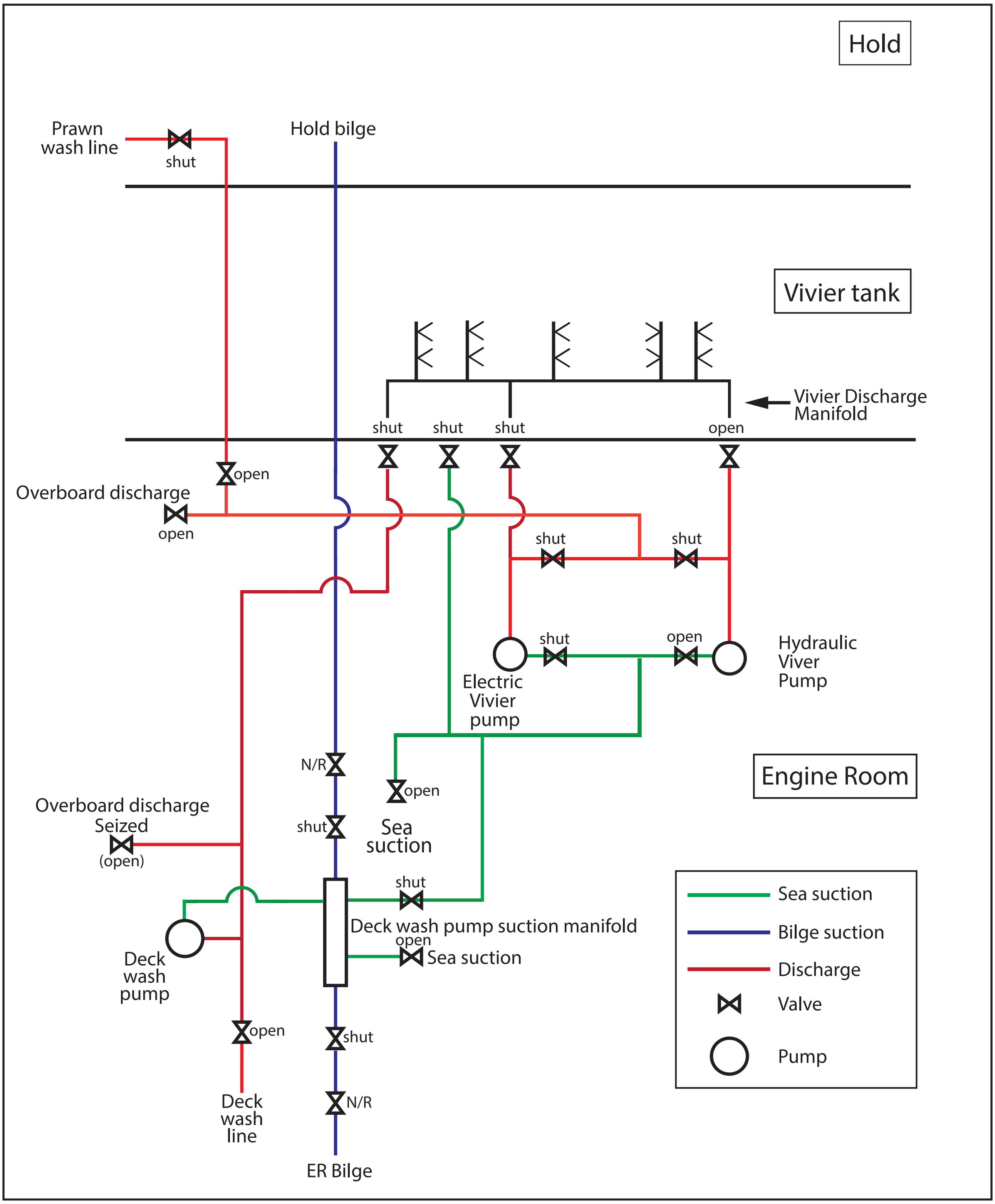

Figure 6: System drawing (valves as found)

1.7.4 Refloating

Once all testing had been completed, *Louisa* was craned back into the water and the vivier tank refilled to replicate as far as possible the vessel's condition at the time of the accident. The vessel was left floating for approximately 4 hours, remaining in a stable condition with no ingress of water, before being lifted ashore once more.

1.8 MODELLING OF FOUNDERING SCENARIOS

1.8.1 General

A Wolfson HST computer model was used to explore the likely flooding scenarios that could have led to *Louisa*'s foundering. The model included the hull, tanks and watertight bulkheads. The fore peak was assumed to be part of the hold as they were connected via a 30mm diameter pipe. The forward section of sheltered deck space was also modelled to allow flooding on deck to be simulated. Hatch openings and freeing ports were included as warning points in the model to establish when they became submerged.

The loading of the vessel at the time of loss was estimated from information derived from interviews and from the vessel's freeboard and stability information booklet. Table 1 shows the loading condition assumed at the time of loss.

Item	Quantity (t)	Notes
Fuel tanks (port and starboard)	2.7 in each	85% full, not cross connected
Daily service fuel tank	0.227	Full
Vivier tank	22.87	Full (any catch would displace water so no net effect)
Fresh water tank	1.68	80% full
Bait and boxes	2.0	As per freeboard and stability booklet
Crew (4)	0.3	
Stores	0.5	As per freeboard and stability booklet

Table 1: Loss condition estimated loading

1.8.2 Engine room flooding

Given the most likely sources of internal flooding were within *Louisa*'s engine room, flooding of that space was modelled first. With the engine room free to flood, the model remained afloat with a small stability margin and with a stern trim.

1.8.3 Hold flooding

With 35t of flood water in the hold, which equated to 60% of the compartment's volume, the model became heavily trimmed by the bow with negligible stability remaining. There was still positive freeboard forward and no downflooding points were submerged.

1.8.4 Hold flooding in combination with water on deck

The effect of water on deck was explored. However, for water to collect on the main deck, the vessel required a significant bow trim (of 0.5m between the draught marks) to prevent the forward-most freeing ports from shedding water overboard. *Louisa* normally operated with a stern trim. It was estimated that to achieve such a bow trim required 15t of water in the hold. A further 5t of water, equating to a depth of 0.5m, was then required on the main deck for the model's stability to become marginal.

Consideration was given to whether the propeller driving slowly astern while *Louisa* was at anchor would induce sufficient bow trim to allow water to collect on the main deck. Approximate calculations indicated a bow trim of 0.07m might result from the propeller driving astern with the main engine idling. Considering that a trim change of over 1m was required to cause water to collect forward, the probability of this effect was considered to be negligible.

1.9 LIFESAVING APPLIANCES

1.9.1 Lifesaving appliances carried on board *Louisa*

Louisa was equipped with the following lifesaving appliances:

- 1 Oceanic 8, Lifeguard marine liferaft
- 5 Cosalt Premier (32kg or more) solid-filled lifejackets
- 1 McMurdo Smartfind 406MHz EPIRB
- 5 Mullion Compact 150N personal flotation devices (PFDs).

The Mullion PFDs had been issued free of charge by the Scottish Fishermen's Federation (SFF) under the Personal Flotation Device (PFD) initiative supported by the European Fisheries Fund (EFF). The PFDs were designed for use by fishermen in the working environment and aimed to combat the ongoing loss of life through crew falling overboard during normal fishing operations. The PFDs supplied to the crew of *Louisa* had remained in their original packaging, were stored in the skipper's cabin, and were out of date for their required annual servicing.

1.9.2 Liferaft

MSN 1813 (F) required *Louisa*'s owners to ensure that safety equipment carried on board the vessel was suitably maintained and serviced in accordance with manufacturers' instructions. *Louisa* was required to carry a liferaft, and the Code recommended it should either be float free or fitted with a Hydrostatic Release Unit (HRU). Marine Guidance Note (MGN) 499 (M+F)[4], required the liferaft to be serviced at least annually at a service station accredited by the manufacturer.

Louisa's Oceanic 8, Lifeguard marine liferaft had been manufactured in 1990 to Offshore Racing Council (ORC) standards[5]. The liferaft was located on the wheelhouse roof and secured in a cradle, incorporating an HRU. The HRU was designed to release the liferaft from its cradle if the unit was submerged to a depth of between 2m and 4m.

Louisa's owners had hired the liferaft from Premium Liferaft Services on a 3-year contract that had commenced on 23 April 2014. The hire contract allowed for the liferaft to be replaced annually to meet the servicing requirements. The last recorded service of the liferaft was on 7 March 2014, just prior to the beginning of the contract. Furthermore, at the time of the accident, Premium Liferaft Services' accreditation from the manufacturer to service this brand of liferaft had lapsed despite the company's efforts to secure continuation training for its technicians.

1.9.3 Post-accident inspections of the HRU and liferaft

During examination of the recovered vessel, MAIB inspectors noted that the HRU had an expiry date of March 2015, and it had not been rigged correctly. The liferaft's painter, which should have been secured via a weak link (designed to part once the liferaft had inflated) had been tied directly to the cradle. In the event, these shortfalls were immaterial because the crew had deployed the liferaft manually before the vessel foundered; however, it had failed to inflate.

Following the accident, the uninflated liferaft was recovered to Barra police station, where MAIB investigators conducted an initial inspection **(Figure 7)**. Subsequent inspections of the liferaft were carried out by an independent liferaft servicing company and by the current manufacturing representatives of Lifeguard products. The findings of these examinations were that:

- The liferaft inflated successfully when subjected to a gas inflation test.
- The liferaft's condition indicated that it was suitable for use and that its condition was commensurate with its age.

1.9.4 Testing and examination of the CO_2 inflation cylinder

Inspection of the CO_2 inflation cylinder noted that it was devoid of gas but contained approximately 1.5 litres of water. Examination of the CO_2 cylinder at an independent test facility **(Annex A)**, including dye penetrant testing, revealed surface cracks in the valve attachment threads at the neck of the cylinder. Laboratory analysis of the water **(Annex B)** highlighted a high saline content indicating that this was likely to have been seawater.

4 MGN 499 (M+F) Life Saving Appliances: Inflatable Liferafts, Marine Evacuation Systems, Inflatable Lifejackets and Hydrostatic Release Units – Servicing Requirements, has now been replaced by MGN 553 (M+F) for non-SOLAS inflatable LSA.

5 ORC liferafts were introduced, following the 1979 Fastnet Race, by the Offshore Racing Council (ORC) for yachts racing under its rules. The Sydney Hobart Race in 1998 brought the durability of these liferafts into question and led to a revision of the standard. ORC liferafts are being phased out by the MCA in accordance with MGN 553 (M+F).

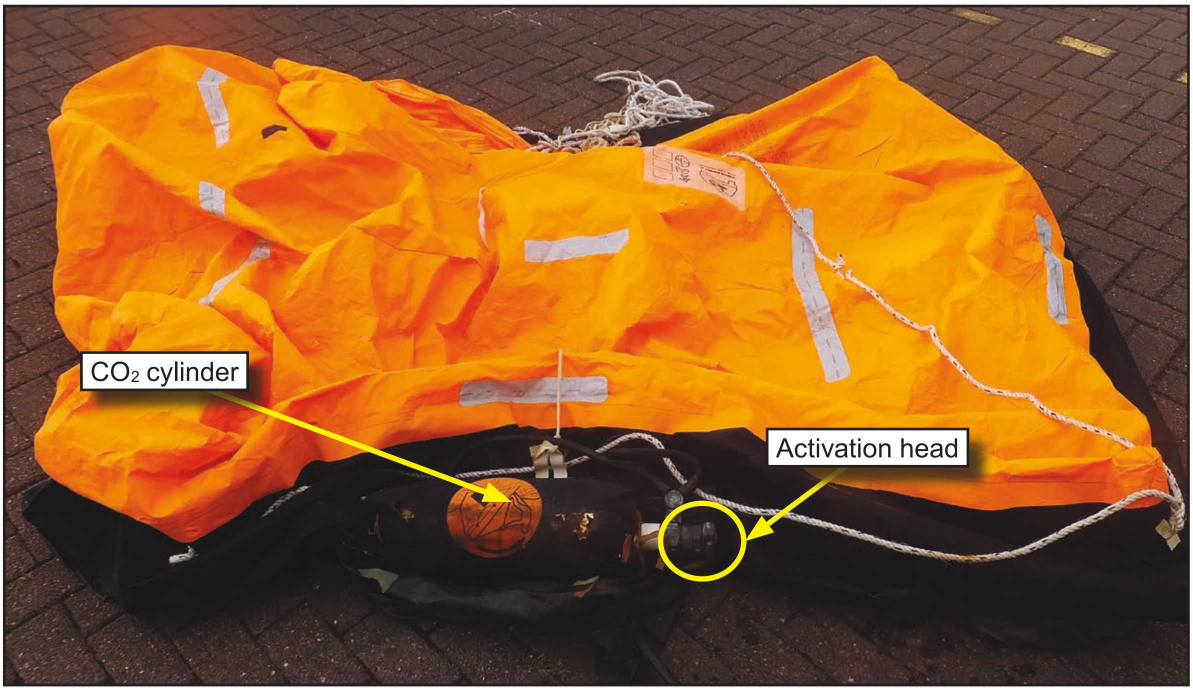

Figure 7: Liferaft at Barra police station

Examination of the valve assembly showed that the operating mechanism had been correctly activated. Further examination indicated that the valve assembly had not been tightened into the cylinder to the manufacturer's recommended torque setting.

In November 2011, Premium Liferaft Services had sub-contracted refurbishment of the cylinder to Thameside Fire Protection Company Limited. The cylinder was one of a batch of nine cylinders that had been sent for 5-yearly refurbishment and refilling. The process included cleaning, inspection, pressure testing, painting and refilling of the cylinders. Prior to filling, the shoulder of the cylinder was date-stamped to indicate that pressure testing had taken place. A label was adhered to the cylinder showing its tare weight[6], gas charge (CO_2 and N_2) and full weight, which was 8.40kg **(Figure 8)**. When the cylinder was weighed following the accident, its tare weight was 8.40kg. It was therefore concluded that, following refurbishment in 2011, the cylinder had not been refilled prior to its return to Premium Liferaft Services.

Following this discovery, MAIB inspectors arranged for the remaining eight cylinders from the batch of nine to be recalled and weighed. All were found to have been correctly filled and labelled. One of the recalled cylinders of a similar type to that of *Louisa*'s cylinder is shown in **Figure 9**.

1.9.5 Lifejackets – regulatory requirements

MSN 1813 (F) required small fishing vessels to carry an abandonment lifejacket for each person on board. The lifejackets were required either to be of the solid-filled type, or should have had automatic gas inflation and at least 150N buoyancy.

SOLAS requires that the in-water performance of a lifejacket be evaluated in compliance with the recommendations of the International Maritime Organization (IMO). The IMO's recommendations on testing lifesaving appliances are set out in

[6] Tare weight = the weight of the cylinder plus valve assembly (some companies also include label weight) measured before adding the gas charge. The gas charge is a mixture of carbon dioxide (CO_2) and Nitrogen (N_2) which is added by weight.

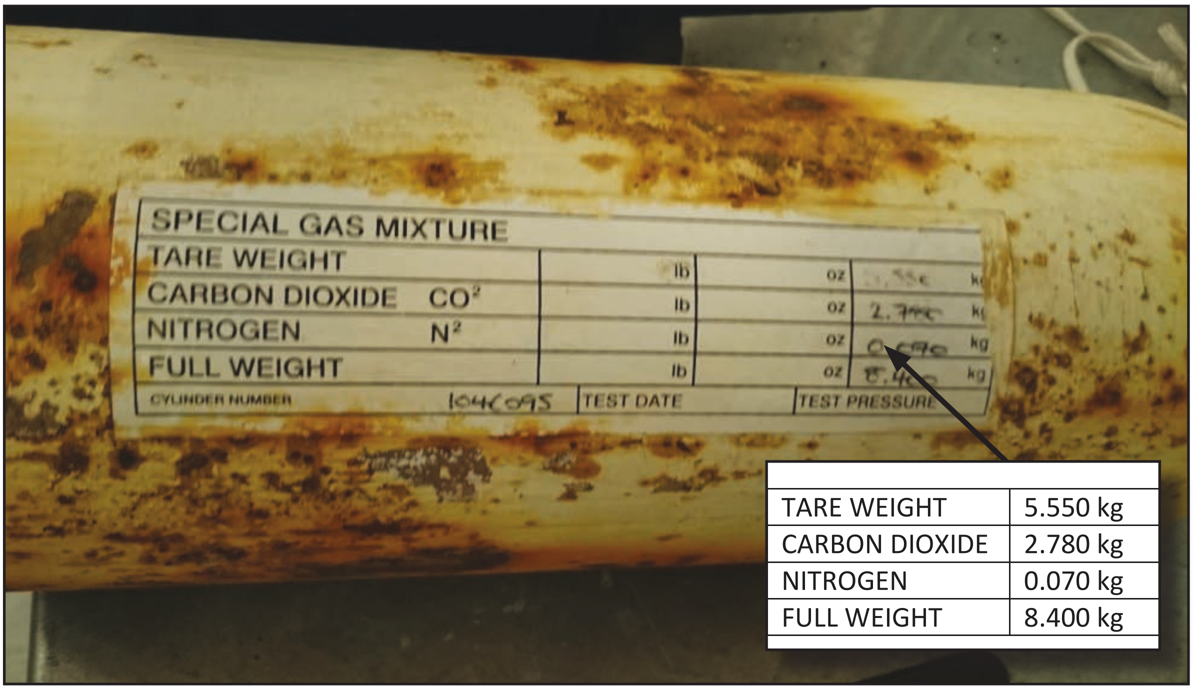

Figure 8: CO_2 cylinder as found

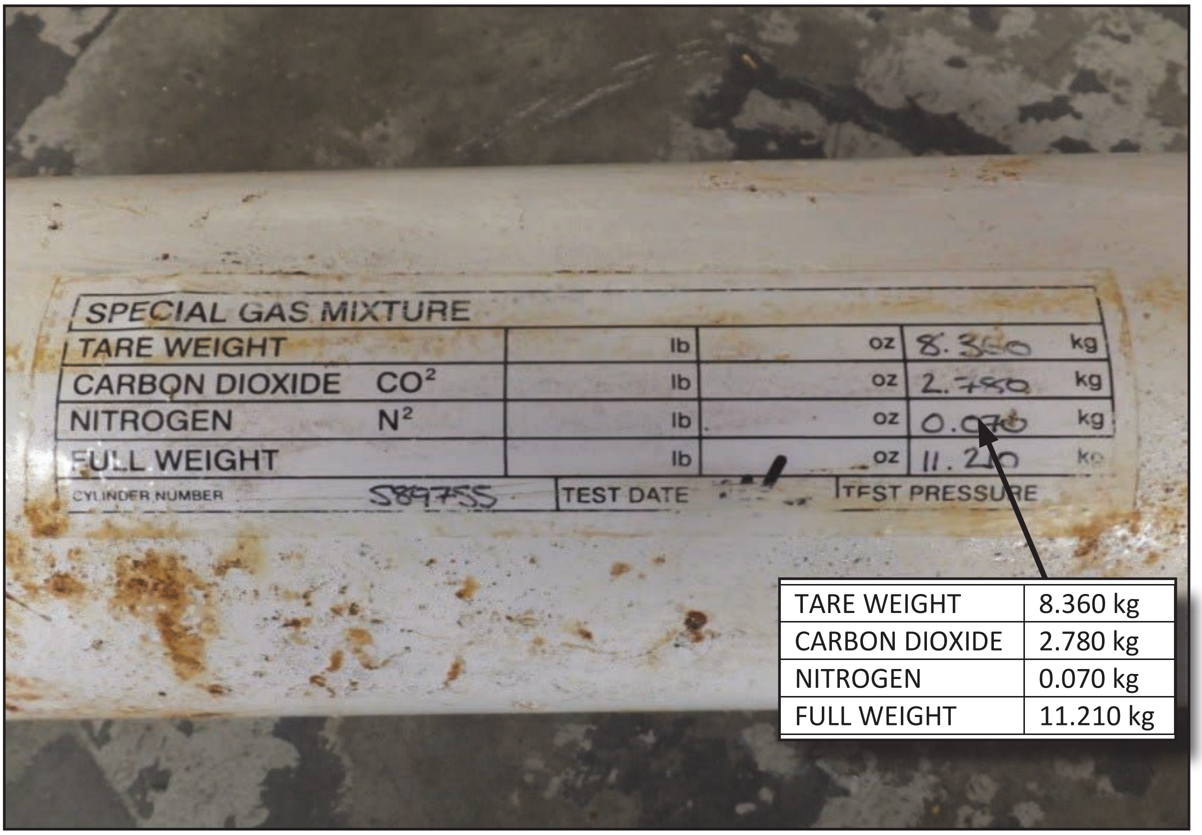

Figure 9: Recalled CO_2 cylinder of a similar type to that of *Louisa*'s cylinder

resolution A.689(17) and, for lifesaving appliances installed on board on or after 1 July 1999, in resolution MSC.81(70) (Revised recommendation on testing of life-saving appliances).

Recommendations for lifejacket water performance tests, set out in both A.689(17) and MSC.81(70), are reproduced in **Annex C**.

The water performance tests were intended to determine the lifejacket's ability to assist a helpless person or one in an exhausted or unconscious state, and to show that the lifejacket did not unduly restrict movement. The test regime required able-bodied test subjects who were all good swimmers and collectively met prescribed selection criteria in terms of gender, height and weight.

Recognizing a need to introduce more precise provisions, the IMO adopted amendments to the revised recommendation on testing of lifesaving appliances on 13 May 2005 in resolution MSC.200(80). The amended recommendations for lifejacket water performance tests, set out in MSC.200(80), are reproduced in **Annex D**. Further amendments were introduced by resolution MSC.378(93) on 22 May 2014, reproduced in **Annex E**.

MSC.200(80) introduced a requirement for the in-water performance of a lifejacket to be evaluated by comparing its performance with that of a Reference Test Device (RTD)[7]. The design and construction requirements for an RTD were amended by resolutions MSC.226(82) and MSC.378(93), reproduced in **Annex F**.

The test standards are not absolute and incorporate a risk-based approach, particularly in respect of the water performance righting tests.

In both A.689(17) and MSC.200(80), donning tests require that test subjects carry out initial tests wearing normal clothing and then a further test wearing heavy-weather clothing. However, water performance tests are carried out in fresh water under still conditions, with the test subjects wearing only swimming costumes.

Resolution A.689(17) section 2.9.8 states:

> *'When evaluating the results of a test in accordance with 2.9.5, 2.9.7 and 2.9.8, the Administration may, in exceptional circumstances, disregard the results of a test on a subject if the results show a very slight deviation from the specified criteria, provided the Administration is satisfied that the deviation can be attributed to the unusual size and stature characteristics of the test subject and the results of tests on other subjects, chosen in accordance with 2.9.2, show satisfactory performance of the lifejacket.'*

MSC.200(80) defines the requirements for test subjects (**Annex D** Table 2.1) and requires a minimum of 12 test subjects. Each subject is required to complete the righting test six times using the lifejacket and six times using the RTD. The period of time taken for the test subject's mouth to come clear of the water is measured to the nearest 1/10th second, and the highest and lowest times recorded against each device are discarded. MSC.200(80) goes on to state the following relating to the water performance test results:

> *'2.8.7 After the water tests described in 2.8.5 and.6 above:*
>
> *.1 Turning time: The average turn time for all subjects in the candidate lifejacket should not exceed the average time in the RTD, and the number of 'no-turns', if any, should not exceed the number in the RTD;*
>
> *.2 Freeboard: The average freeboard of all the subjects should not be less than the average for the RTD;*

7 An RTD is a lifejacket manufactured to a specification as detailed in Annex F.

.3 Torso angles: The average of all subjects' torso angles should not be less that the average for the RTD minus 5º;

.4 Faceplane (head) angles: The average of all subjects' faceplane angles should be not less than the average for the RTD minus 5º;

.5 Lifejacket light location: The position of the lifejacket light should permit it to be visible over as great a segment of the upper hemisphere as is practicable.'

MSC.378(93) was developed following an IMO sub-committee investigation into inconsistencies in the performance of prototype lifejackets against the RTD. The revised criteria relaxed the performance criteria against the RTD, allowing a lifejacket to turn in 1s longer than the average time of the RTD and a reduction in the required freeboard height, and faceplane and torso angles.

1.9.6 Approval process for novel lifesaving appliances

Before giving approval to a novel lifesaving appliance or arrangement, SOLAS requires an Administration to ensure that such appliances provide safety standards at least equivalent to the requirements of SOLAS and the Life Saving Appliance (LSA) Code and that they have been evaluated and tested based on the guidelines developed by the IMO in resolution A.520(13). The following is an extract:

'3.1.2 Individual buoyancy equipment should:

.8 in calm fresh water, be capable of lifting the mouth of a completely relaxed person <u>wearing normal clothing</u> at least 120 mm clear of the water;

.9 in calm fresh water, be capable of turning a completely relaxed person <u>wearing normal clothing</u> from any position in the water to one where the mouth is clear of the water within 5 s…'

1.9.7 Approval of the Cosalt Premier (32kg or more) solid-filled lifejacket

Louisa was equipped with Cosalt Premier (32kg or more) solid-filled lifejackets, which the skipper and crew all donned before abandoning the vessel **(Figure 10)**. These lifejackets were marked 'LLOYDS REGISTER APPROVED, AUTHORISED BY MCA'[8] and were of a type commonly used on passenger ships, other commercial vessels and leisure craft.

The lifejacket type was tested against A.689(17) by the Department of Transport's Newcastle Marine Office in April 1992 **(Annex I)**.

The water performance tests included a requirement for a minimum of six test subjects to complete three gentle swimming strokes, then to simulate a state of utter exhaustion with their heads down and lungs partially filled. The time from the last stroke until the mouth became clear was then noted. The time was not to exceed 5s. The test was then repeated after the subject had exhaled and, again, the time was not to exceed 5s.

[8] Lloyd's Register was authorised by the MCA to certify and approve lifejackets against IMO requirements. The MCA was not involved in testing or authorising individual products.

Figure 10: Lifejackets at Barra police station

During the first test, four of the eight test subjects exceeded 5s (albeit by up to only 0.5s) and, after exhalation, two of the eight test subjects exceeded 5s (by less than 1s).

These tests were then repeated by the Newcastle Marine Office in May 1992 **(Annex I)** using the same eight test subjects, at which time all the test subjects' airways were clear of the water within 5s during both tests.

There is no indication in either of these test reports of any modifications or improvements having been carried out to the lifejacket.

Following its initial approval, the lifejacket type underwent a number of modifications relating to material specifications, each of which resulted in partial retesting of the lifejackets.

The version of the lifejacket type on board *Louisa* was issued a 'Certificate of Type Approval' (included at **Annex I**) by Lloyd's Register on 6 May 2004 valid until 5 May 2009. The certificate and the accompanying 'EC Type Examination (Module B) Certificate' did not reference any further water performance tests and referred only to material and buoyancy tests carried out by AMTEC Laboratory and Fleetwood Testing Laboratory between 1998 and 1999 **(Annex I)**.

The lifejacket type ceased production in 2010 and was replaced by the Cosalt Premier 2010, which was designed to meet the requirements of MSC.200(80).

1.9.8 MAIB lifejacket trials and subsequent testing

In view of the RNLI reports relating to the discovery and recovery of the casualties, the MAIB undertook trials of one of the recovered Cosalt Premier (32kg or more) lifejackets and a similar and widely available solid-filled approved lifejacket, which had been produced by another manufacturer in 2014 and tested against the requirements of MSC.200(80). Also tested was a PFD of the same make and design as those available but unused on *Louisa*.

The trials used only two subjects and only loosely resembled the test protocols contained in MSC.200(80). However, they closely matched the requirements of A.689(17).

Both test subjects were approximately 176cm tall, one weighing 66kg and the other 104kg. Each subject trialled both of the solid-filled lifejackets. During the righting tests neither lifejacket was able to turn either test subject, leaving them floating face down in the water until they were forced to abort the test to take breath (in excess of 20s) **(Figure 11)**. The inflatable PFD righted a face down test subject within 2s on each occasion.

Figure 11: MAIB lifejacket trials

Following liaison between the MAIB and the MCA, the Cosalt Premier (32kg or more) solid-filled lifejacket used in the MAIB trials was transferred to the MCA for further testing. These tests were carried out by an approved testing organisation and included the testing of an additional Cosalt Premier (32kg or more) solid-filled lifejacket. The test protocols used were in accordance with MSC.81 (70). Both lifejackets failed to meet the required test standard. The MCA also commissioned the testing of a similar, widely available solid-filled approved lifejacket against the requirements of MSC.200 (80). This lifejacket also failed to meet the required test standard.

1.9.9 Emergency position indicating radio beacon

MSN 1813(F) recommends that small fishing vessels are equipped with an EPIRB. *Louisa*'s McMurdo Smartfind 406MHz EPIRB, which was fitted in a float-free housing on the wheelhouse roof, was designed to provide both alerting and location functions.

Louisa's EPIRB was manually activated by the crew and functioned correctly despite the battery having an expiry date of March 2016 and, therefore, being overdue for replacement **(Figure 12)**.

1.10 SEARCH AND RESCUE

1.10.1 EPIRB description

An EPIRB is a distress alerting device that, once activated, transmits a 406MHz digitally encoded radio message at a power of 5 Watts for a 'burst' duration of approximately 0.5s. Transmissions are repeated once every 50s until the beacon's battery is exhausted. EPIRB transmissions contain information relating to the country in which the beacon is registered and the identification of the vessel in distress. EPIRBs can be an alert only type or GNSS encoded to provide a location function.

Positional information for alert only (non GNSS) EPIRBs is obtained through Doppler processing[9] by the local user terminals (LUTs) and requires a minimum of 3 data points from the EPIRB transmissions.

GNSS enabled EPIRBs also transmit their position. The standard location protocol for a GNSS enabled EPIRB refers to **coarse** and **refined** position accuracy. For UK SAR purposes, a coarse position is assumed to have a maximum error of 15nm assuming that the GNSS position is accurate. A refined position is accurate to within 120m.

The EPIRB's transmission is arranged in two protected data fields: the first protected data field (PDF-1) contains the beacon's identification information and its 'coarse' position; the second protected data field (PDF-2) contains a correction to the beacon's coarse position to produce a 'refined' position. PDF-1 contains the maximum level of protection from signal interference and is received in the initial transmission.

[9] Prior to the introduction of GNSS enabled beacons, the Cospas-Sarsat system made location of the beacons possible by Doppler processing. LUTs detecting non-GEOSAR satellites interpret the Doppler frequency shift heard by LEOSAR satellites as they pass over a beacon transmitting at a fixed frequency. The interpretation determines both bearing and range. The bearing and range are measured from the rate of change of the heard frequency, which varies both according to the path of the satellite in space and the rotation of the Earth. This triangulates the position of the beacon. A faster change in the Doppler indicates that the beacon is closer to the satellites orbit. If the beacon is moving toward or away from the satellite track due to the Earth's rotation, it is on one side or other of the satellite's path. Doppler shift is zero at the closest point of approach between the beacon and the orbit.

Figure 12: *Louisa* EPIRB

1.10.2 Cospas-Sarsat system description

The Cospas-Sarsat system consists of LEOSAR satellites at an altitude of 850km and GEOSAR satellites at between 19,000 and 24,000km altitude. Both types of satellite detect transmissions from EPIRBs, Emergency Locator Beacons, and Personal Locator Beacons, and transmit data received from these to LUTs. LUTs process the data to identify and locate a beacon and its corresponding mission control centre (MCC), to whom the data is forwarded. The MCC then provides the distress alert information to the appropriate SAR service **(Figure 13)**.

The Cospas-Sarsat system was initially designed to work with LEOSAR satellites which provide both independent location of beacons by Doppler processing and GNSS reception of encoded beacons. Subsequently, the alerting function was incorporated into GEOSAR satellites to improve system coverage both for the

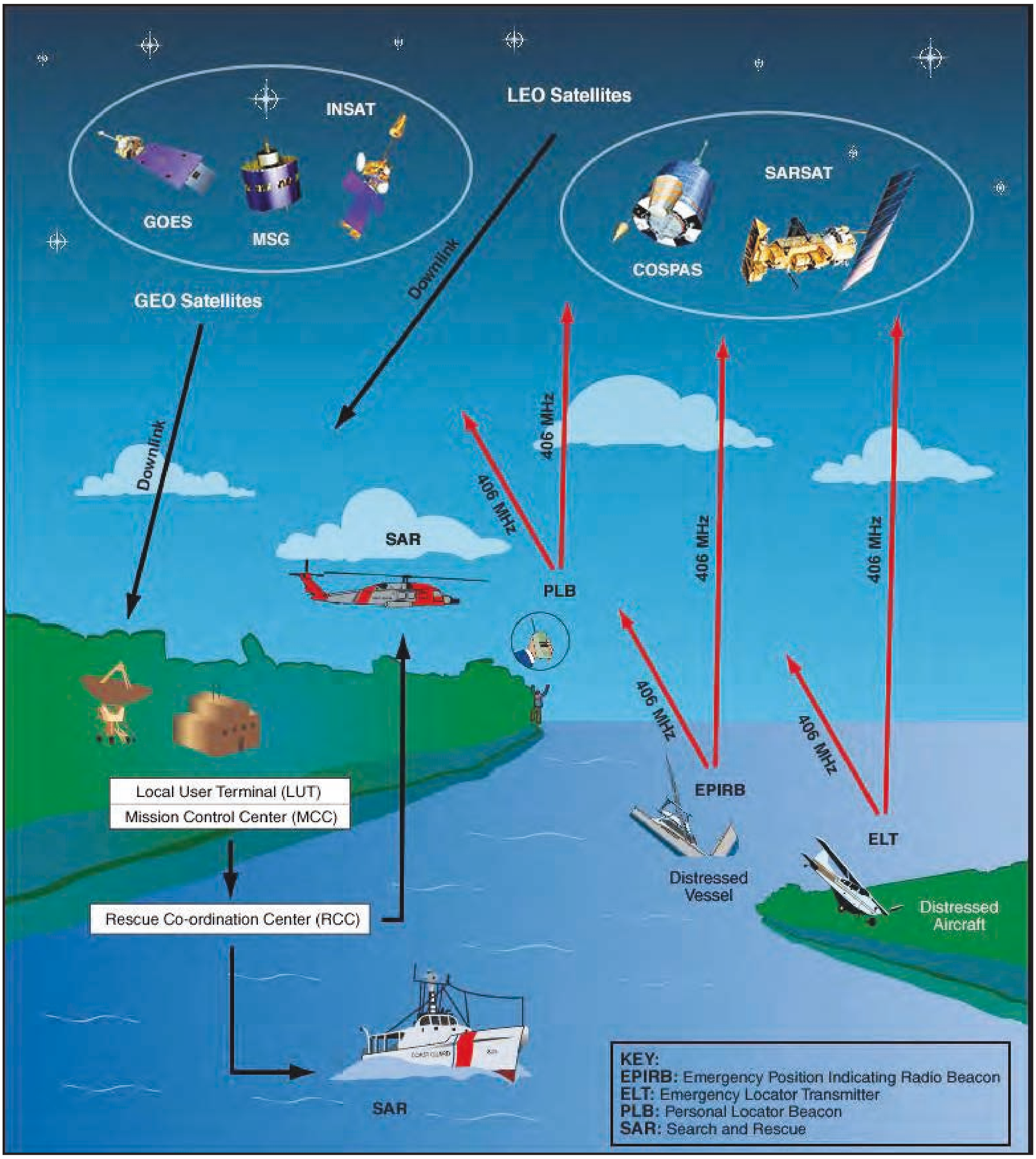

Figure 13: Cospas-Sarsat system diagram

alerting function for all beacons and the location capability for GNSS encoded beacons. Expansion of the system to include GEOSAR satellites has improved system coverage for encoded location and enhanced initial alert timeliness.

1.10.3 Terminology

In addition to **coarse** and **refined** positions, the following terminology relevant to this accident is used by operators dealing with Cospas-Sarsat beacon detections:

The GEOLUT passes the alert to the beacon's host MCC as soon as it has a **confirmed** message (valid message with complete PDF-1 field). It will also transmit **unconfirmed** messages if confirmation has not been achieved within 5 minutes. The GEOLUT will also pass updated information to the MCC as the encoded position in the beacon's transmitted alert message changes (refined position).

An EPIRB alert is categorised in terms of its type and location. The alert type is **undetermined** until it is confirmed as being **real** or **false**.

Where a satellite is unable to detect the EPIRB's location, the alert is **detect only**. This can be a non GNSS EPIRB detected by a GEOSAR or by a LEOSAR with insufficient data points.

An **unresolved** location means that a LEOSAR satellite has detected the EPIRB's location using Doppler processing, producing two possible positions: one true and one false. A **resolved** location means that a second satellite pass has validated one of the possible positions as being the EPIRB's true position.

1.10.4 UK EPIRB response

In the UK, the response to a UK EPIRB was managed by two separate organisations: UKMCC and HMCG. UKMCC was manned by RAF personnel and based in Scotland at RAF Kinloss.

Distress alerts are initially received by UKMCC through the Cospas-Sarsat system. Alerts from EPIRBs (and all other alerts over water) are then passed to HMCG, who co-ordinate the SAR response.

HMCG's point of contact for EPIRB alerts has traditionally been CGOC Falmouth, but this is now shared with the National Maritime Operations Centre (NMOC). HMCG's standard operating procedure for satellite distress beacon alerts is reproduced in **Annex G**.

On receipt of a beacon alert, UKMCC first checks that it is a new alert and not additional data relating to a previous or ongoing beacon activation. When a new EPIRB alert is received, UKMCC passes the information directly to HMCG by telephone and fax, and by initiating a new incident on the Vision 4 system.

UKMCC and HMCG check the EPIRB registration on the Consolidated European Reporting System (CERS) database for information relating to the vessel's name, its operation and emergency contact details. Both HMCG and UKMCC can update the live feed on the Vision 4 system.

Once the registration details have been recovered, HMCG attempts to contact the vessel and/or its owners through the emergency contact details listed in the CERS database. Attempts are also made to confirm the vessel's normal area of operation. Once the EPIRB's location has been confirmed, co-ordination of the incident is passed to the relevant CGOC.

Louisa's EPIRB initial alert type was categorised by UKMCC as **undetermined** and its location as **unresolved**. Subsequently, UKMCC referred to the EPIRB's updated location as a **refined** position. The position descriptors of **coarse** and **refined**, associated with GNSS enabled EPIRBs, do not feature in HMCG's standard operating procedure for satellite distress beacon alerts.

1.10.5 HMCG operational manning

HMCG has a network of 10 area CGOCs and one NMOC. The NMOC is both an operation centre in its own right and the co-ordinator of operational activities across the network. Although the CGOCs have the ability to function autonomously, the system is designed to operate as a network with each CGOC receiving support from within the network to meet its operational needs. A duty controller monitors activity levels across the network and matches the available resource to meet operational demands. The role of the duty controller expands to monitor the progress of ongoing operations and to assist, or to direct other operators to assist, as the situation develops. The duty controller is nominally based at NMOC, but could operate from any of the CGOCs. Whenever practicable, SAR activity is co-ordinated by the CGOC within whose geographical area the incident has occurred.

During the CG response to the foundering of *Louisa* there were 25 officers manning the network. Four officers (including a trainee controller) were based at the NMOC. The CGOCs had a maximum of three officers on watch, though CGOC Aberdeen and CGOC London, each had only one officer on watch.

The network had been the subject of a study by the Department for Transport's In House Analytical Consultancy (IHAC) team, which determined that the minimum manning across the network should not drop below a total of 21 suitably qualified personnel.

The network had only one duty controller covering the shift, who was based in CGOC Belfast and was on a break at the time of the alert and did not rejoin the network until 0427. His role was being covered by a trainee at NMOC who had been employed by HMCG for only 3 months. At the start of the night shift on 8 April, the duty controller had asked the senior maritime operations officer (SMOO) at CGOC Stornoway to provide SMOO cover for nine additional areas. There was a total of 10 SMOOs on duty across the network, but none located in the NMOC.

CGOC Falmouth had two officers available. The SMOO was away from her post taking a scheduled meal break during the incident. CGOC Stornoway had two officers on watch, a SMOO and a trainee Maritime Operations Officer (MOO).

Once CGOC Falmouth had received a **refined** position for *Louisa*'s EPIRB, co-ordination of the incident was passed to CGOC Stornoway. There, the SMOO and the trainee MOO attempted to deal with a wide range of tasks. These included requesting SAR support (ALB and aircraft), briefing the RNLI and ARCC, paging and tasking the ALB crew, and paging the aircraft crew. Additional workload was caused by a number of system-related deficiencies. These included a fault with the UKMCC fax machine, which had been defective for a week, and an inability to automatically transfer EPIRB data into Vision 4, a condition that had been known for 18 months and which consequently required manual transfer of data that took several minutes. These deficiencies were compounded by faults with the Vision 4 system, which resulted in terminals freezing or shutting down.

Additional communications problems included an inability of the ARCC to access the VHF radio paging system for helicopter crews, and known communications blackspots in the Barra area.

1.11 EFFECTS OF COLD WATER IMMERSION

The human body's typical reaction to immersion in cold water (under 15°C) is normally considered in four stages:

1. Cold water shock

Cold water shock takes place within the first 30s to 2 minutes and is generally associated with a gasp reflex as the body comes into contact with the cold water, along with hyperventilation and a dramatic increase in heart rate and blood pressure. If the head goes underwater during this stage, the inability to hold one's breath will often lead to water entering the lungs in sufficient quantities to cause death. The increased heart rate and blood pressure can result in cardiac arrest, especially if the casualty has an existing cardiovascular condition. Panic can cause the hyperventilation to continue even after the initial physiological effects have subsided.

2. Cold incapacitation

Cold incapacitation usually occurs within 2-15 minutes of entering the water. The blood vessels are constricted as the body tries to preserve heat and protect the vital organs. This results in the blood flow to the extremities being restricted, causing cooling and consequent deterioration in the functioning of muscles and nerve ends. Useful movement is lost in the hands and feet, progressively leading to the incapacitation of arms and legs. Unless an effective lifejacket is worn, death by drowning occurs as a result of impaired swimming.

3. Hypothermia

Hypothermia occurs when the human body's core temperature drops below 35°C (it is normally about 37°C). Depending on circumstances, this can occur after 30 minutes. Symptoms of moderate hypothermia, when the body's temperature is between 28-32°C, include inattention, confusion, difficulty moving and loss of coordination. Loss of consciousness is associated with severe hypothermia, when the body's temperature is below 28°C. The body's core temperature can continue to drop even after the casualty has been recovered from the water if the re-warming efforts are not effective.

4. Circum-rescue collapse

Circum-rescue collapse can occur just before, during or after rescue due to a variety of mechanisms that result in unconsciousness or death. Collapse just before rescue may occur when a casualty relaxes mentally resulting, among other things, in a sudden drop of stress hormones, possibly leading to drop in blood pressure.

1.12 URGENCY OF RESPONSE

The International Aeronautical and Maritime Search and Rescue (IAMSAR)[10] manual states that in water at 10ºC, the 50% survival time for a normally-clothed individual is estimated to be about 2 hours, with a recommended search time of 12 hours. The manual recognises that there are many factors that can influence survival times, including the use of survival suits, lifejackets and liferafts, and the adverse effects of wind-chill, breaking waves and strong currents. It also notes that an individual's level of fitness and body fat percentage can further influence survivability.

1.13 PREVIOUS/SIMILAR ACCIDENTS

Aquila - 20 July 2009

Aquila was a 13.4m long scallop dredger, which capsized east of the Isle of Muck, off the west coast of Scotland, with the loss of three crew.

The MAIB report[11] concluded among other things that the speed of capsize resulted in the vessel's liferaft and EPIRB becoming trapped in the superstructure. Therefore, although they had released from their stowage cradles, neither of these important safety items were able to operate as intended.

The Maritime Rescue Co-ordination Centre (MRCC) Clyde, which initially received the distress call, immediately tasked a SAR helicopter. However, when it was realised that the accident had occurred outside MRCC Clyde's area of operation, MRCC Clyde transferred co-ordination responsibility to MRCC Stornoway, in whose area the accident had occurred, and stood the helicopter down. The decision to transfer co-ordination of the incident and stand the helicopter down caused a delay of 23 minutes in a rescue helicopter reaching the accident site.

The MCA committed to make arrangements to make ARCC the single tasking authority for SAR helicopters with effect from 1 April 2010 and to commence a review of:

- The exchange of information between MRCCs and ARCC when aircraft are tasked to an incident.
- The handover of live incidents between MRCCs.
- The selection of appropriate SAR assets regardless of MRCC boundaries.
- VHF radio procedures for managing SAR assets.

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[10] The IAMSAR manual is in three volumes and its purpose is to assist States in meeting their own SAR needs and their international obligations under SOLAS.

[11] MAIB Report No 5/2010.

- The VHF radio coverage in the area of the accident.

In view of these commitments the MAIB did not make further recommendations.

Ocean Way – 2 November 2014

The 17.07m fishing vessel *Ocean Way* (FR 349), a trawler with a crew of five, capsized and sank 100nm off the north-east coast of England.

The MAIB report[12] concluded that: although accurate positional information for the vessel became available, this was not initially recognised by the SAR authority due to its cognitive bias towards information that placed the vessel further inshore; it is important that procedures are followed to avoid essential information being overlooked when staff are engaged in demanding situations; the opportunity to task a rescue helicopter at an earlier stage of the incident was missed and; the efficient conduct of SAR missions would be more effective if all UK MRCCs were equipped with computer systems capable of gaining access to essential information from all available databases.

The report also observed that the availability of contemporaneous Vessel Monitoring System (VMS) information to MRCCs would prove of great value in identifying, locating and assisting fishing vessels in distress. Had the vessel's EPIRB been fitted with an integral GNSS it is probable that a helicopter would have been tasked about 50 minutes sooner.

As a result of this incident, the MCA reported it had:

- Included a requirement that EPIRBs be equipped with GNSS in proposed new Codes of Practice for the safety of fishing vessels.

- Ensured that the computer equipment in all MRCCs was capable of accessing vessels' positional information in a timely manner.

- Updated staff training provision to ensure appropriate consideration was given to the use of all resources when responding to requests for assistance.

- Reviewed its staff training in operational procedures to ensure the correct handover of incident co-ordination is followed in the future.

The MAIB recommended[13] that the MCA:

- Take action to ensure that the EPIRBs required to be carried on UK registered fishing vessels are equipped with integral GNSS receivers.

Annie T - 4 October 2015

A crewman from the 9.15m creel fishing vessel *Annie T* (CY1) was carried overboard by the fishing gear when his foot became caught in a bight of rope while he was moving an end weight on the working deck. The skipper recovered the crewman back on board about 10 minutes later but was unable to resuscitate him.

[12] MAIB Report No 23/2015.

[13] Recommendation 2015/154.

The MAIB report[14] concluded that:

The accident occurred because the crewman was in an unsafe position and became entangled in a rope while shooting creels. Neither the skipper nor the crewman wore lifejackets during fishing although three new, unused, constant wear lifejackets were found on board the vessel following the accident.

Neither the skipper nor crewman appreciated the effects of cold water shock and, as a consequence, had not taken precautions to mitigate these effects.

The MCA was recommended[15] to:

Prioritise the introduction of legislation that will require the compulsory wearing of personal flotation devices on the working decks of all fishing vessels while at sea.

Apollo – 18 April 2016

At 0630 on 18 April 2016, a crewman fell overboard from the stern of the 23.95m fishing vessel *Apollo* (INS 179) while the nets were being hauled. The weather was rough at the time of the accident and the crewman was not wearing a personal flotation device (PFD). An extensive search was carried out by coastguard helicopters, military aircraft and *Apollo*'s crew. The crewman's body was found nearly 4 months later.

The MAIB report[16] found that following a previous fatal man overboard in 2007 the crew had been required to wear lifejackets. However, the practice had fallen into disuse and lifejackets had not been worn for several years despite constant wear lifejackets being available on board.

It also identified that fishermen generally lack awareness of the debilitating effects of cold water immersion, specifically cold shock and cold incapacitation.

The report considered similar manoverboard cases that have been reported to the MAIB since 2007. In the majority of these cases the person in the water was initially responsive and able to help themselves before they rapidly succumbed to the incapacitating effects of cold water.

Harvester - 28 April 2016

The potter *Harvester* (M999) grounded on rocks in Abereiddy Bay, North Pembrokeshire, and sank a short time later. There was no indication of any crew on board at the time of the grounding. A large-scale SAR operation commenced and the body of a crew member was recovered from the water 3nm from where *Harvester* had foundered. He was wearing neither a lifejacket nor other buoyancy aid. The second crew member was not found despite an extensive search.

The MAIB report[17] concluded that neither crew member was wearing a PFD, significantly lowering their chances of survival.

[14] MAIB Report No 21/2016.

[15] Recommendation 2016/146.

[16] MAIB Report No 23/2016.

[17] MAIB Report No 22/2016.

The report also noted that a personal locator beacon is a very useful additional means of raising the alarm particularly, as in this case, if no one is left on board and the only other means of raising the alarm remains on the vessel.

Harvester's automatic identification system (AIS) unit was switched off at the time of the accident. An historical track of the vessel's movements would have been particularly valuable to those involved in the initial search and rescue operation.

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 OVERVIEW

Louisa sank by the bow and foundered while at anchor in Mingulay Bay. Following recovery and investigation of the wreck, it is concluded that the cause of the foundering was flooding of the hold. The skipper and crew had all gone to bed in the accommodation, and the hold bilge alarm failed to wake them because the alarm sounder in the crew cabin had previously been disabled. The events leading up to the flooding and the circumstances in which it occurred could not be conclusively determined, but water probably entered the hold from the deck wash hose.

When abandoning the vessel, the crew attempted to launch the liferaft. However, the liferaft failed to inflate because its CO_2 cylinder was empty, which resulted in the skipper and crew having to enter the water. Although they had all donned lifejackets, the skipper and two crew became unresponsive through cold water immersion and were later found face down in the water by the rescue services.

Before abandoning *Louisa*, the crew activated the vessel's EPIRB. Although UKMCC had received an initial alert by 0239, the first request for a SAR asset was not made by HMCG until 0322. Had the rescue services arrived on scene earlier, it is possible that there would have been more survivors.

2.3 VESSEL STATUS

At the time of the accident, *Louisa* was at anchor approximately 200m from the shore in Mingulay Bay with the skipper and crew asleep in the accommodation. Post-accident examination of the vessel indicates at the time of the accident that:

- The main engine was running at apparently slow speed with the propeller engaged astern, and the vivier system hydraulic pump was being driven from the main engine power take off.

- All machinery space and accommodation doors were left open, and the hold hatch cover was secured in the open position.

- The deck wash pump had probably been left running (see section 2.5).

While the skipper had been known, on occasion, to leave the engine running astern for short periods while moored alongside, such as when loading bait, it would be highly unusual to leave the engine driving the vessel astern when the vessel was at anchor, especially when the wheelhouse was unmanned. More normal would have been for the main engine to be shut down and the hydraulic vivier pump driven from the auxiliary engine. However, it is possible that although the main engine was left running to power the vivier pump, the propeller was only engaged astern by the skipper in an attempt to overcome the rapidly increasing bow trim. Also, while not always the case, it would have been a routine task to shut down the general service (deck wash) pump before the crew took their rest.

2.4 FATIGUE

Louisa's crew had been fishing continually for 4 days, working approximately 20 hours per day. During that period they had not had any dedicated rest or meal breaks, they had mainly sustained themselves by eating snacks, and had slept when possible during the relatively short transits between each string of creels. Besides being short of sleep, the crew were physically exhausted by the work required to shoot and recover the strings of creels and to process the catch. Ultimately, the skipper had anchored the vessel because he considered both he and the crew were too tired to continue fishing safely.

While the skipper's decision to halt operations to enable the crew and himself to rest was wise, by then the crew were fatigued. The evidence indicates that they interrupted their work to eat a meal, and afterwards went straight to bed. The consequence of this was that the vessel's machinery was not shut down / reconfigured appropriately, which created the conditions for the accident to occur. Further, because the bilge alarm sounder in the crew cabin had been disabled, the skipper and crew did not receive any early warning that the hold was flooding.

Instead of managing work routines to prevent fatigue and so ensure adequate levels of safety were maintained, the skipper worked the crew and himself to a state of tiredness such that the safety of the vessel and its crew was compromised. The work ethic that resulted in this behaviour can be linked to the share remuneration scheme, which encouraged the skipper and crew to maximise the catch whenever suitable conditions provided.

2.5 VESSEL FOUNDERING

There was no evidence that *Louisa* had suffered external damage, all hull and tank boundaries were intact, and seawater piping systems retained their integrity throughout post-accident system testing.

Modelling of foundering scenarios showed that 35t of water in the hold would have heavily trimmed the vessel by the bow, with negligible stability remaining. Flooding the engine room would have caused the vessel to sit deeper in the water with a stern trim but would not have resulted in foundering. Therefore, flooding of the hold was considered to have been the probable cause of the foundering.

The drainage hole between the hold and the fore peak effectively rendered these spaces as one compartment, exacerbating the effects of floodwater in the hold which, in turn, would have accelerated the foundering **(Figure 14)**.

Following extensive trials and testing, and in the absence of any other plausible explanation, it is concluded that water probably entered the hold from the deck wash hose. When the crew went for their meal, the general service (deck wash) pump was probably running, the hold hatch cover was open and a number of bait boxes were stacked aft of the hatch coaming. It is probable that the hose, which could flail around the deck if not firmly secured, became wedged between the bait boxes, and

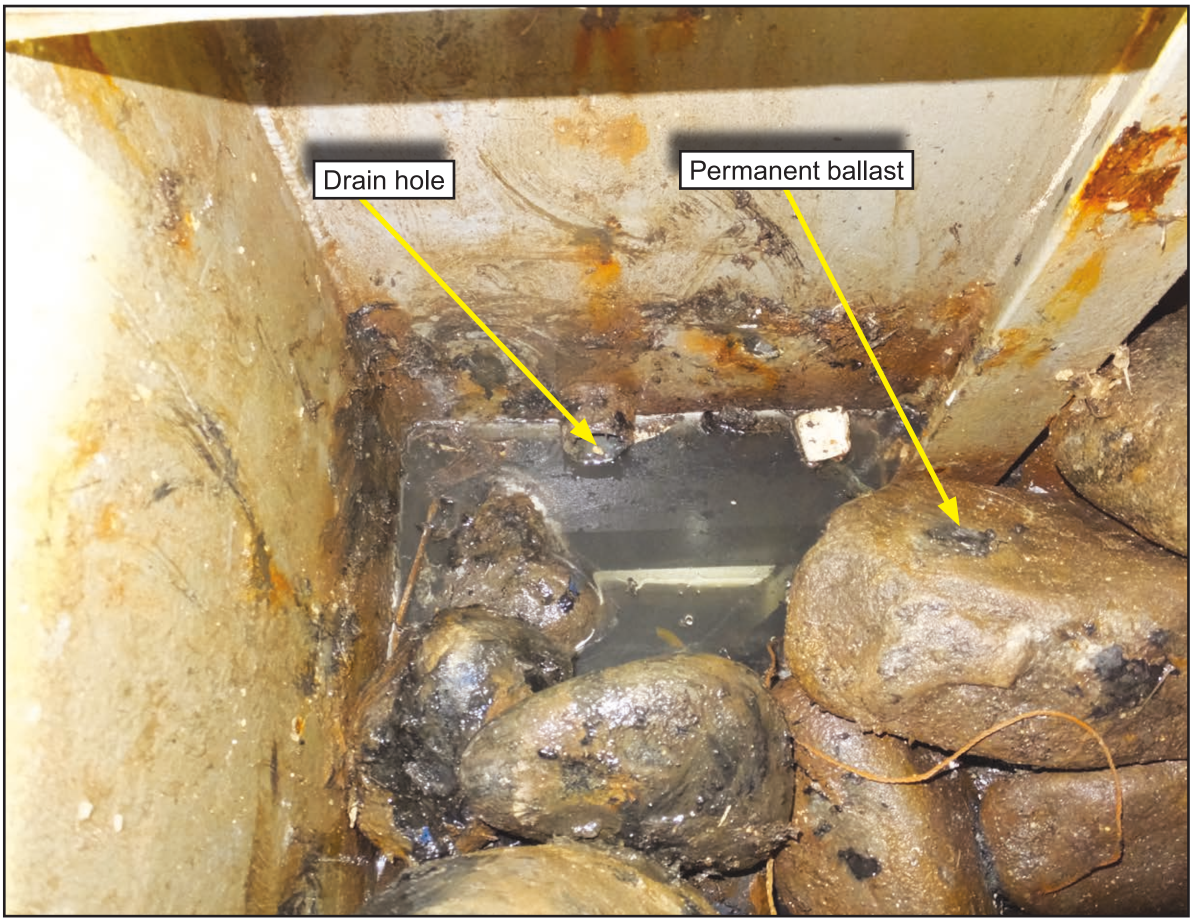

Figure 14: Hold/fore peak drain

this allowed water to spray against the open hatch cover and fall into the hold. As the general service (deck wash) pump had a rated capacity of 35t/hr, the water in the hold could have accumulated to a critical point, in the worst case, within an hour.

2.6 ABANDONING THE VESSEL

The skipper and crew woke as the vessel acquired a significant bow down trim. Once roused, they all exited the accommodation through the wheelhouse, but on reaching the aft deck they were forced to stand on the aft bulkhead of the wheelhouse due to the attitude of the vessel.

There was no evidence to suggest that abandon ship drills had been routinely practised on *Louisa* but the skipper's decision to return to the wheelhouse to collect lifejackets and then instruct the crew to operate the EPIRB and prepare the liferaft, was prudent and appropriate. Although cutting the liferaft canister straps and removing the liferaft from the canister was not in accordance with the manufacturer's operating instructions, it was an appropriate action in the circumstances and should not have prevented the liferaft from being inflated had the CO_2 cylinder been charged.

The necessary speed of the abandonment gave no opportunity for the skipper and crew to don warm clothes. Their survival in water of 10ºC therefore relied heavily on them being able to board the liferaft and / or a rapid rescue.

2.7 COLD WATER SURVIVAL

Without an inflated liferaft, the effect of cold water immersion was a significant hazard to the crew as they abandoned *Louisa*.

That the skipper and his crew were able to discuss survival options once they were in the water indicates that they had overcome the immediate effects of cold water shock. That they were wearing lifejackets when they entered the water is likely to have been a major contributory factor to their surviving the initial shock by assisting them in keeping their airways clear of the water as they got their breathing under control.

Thereafter, the crew would have suffered from cold incapacitation as their hands and legs cooled and they progressively lost dexterity and co-ordination. This would have reduced their ability to conduct survival tasks, and increased their reliance on the ability of the lifejackets they were wearing to maintain their airways clear of the water. As they became increasingly hypothermic, they would eventually have lost consciousness, but could have survived had their airways remained clear of the water until they were rescued.

Postmortem examination results in respect of Christopher Morrison and Martin Johnstone indicate drowning as the cause of death. It is therefore uncertain to what extent they had succumbed to the effects of hypothermia at the time of death.

By the time the ALB found the first unresponsive casualties, they had been in the water for approximately 1 hour and 52 minutes. The 50% survival rate for normally clothed individuals in water of 10ºC is predicted to be 2 hours. It is possible, therefore, that more of the crew would have survived had their lifejackets been more effective in keeping their mouths clear of the water and had rescue services arrived sooner.

2.8 LIFESAVING APPLIANCES

2.8.1 The liferaft - onboard management

Louisa's liferaft was on hire to the owners from Premium Liferaft Services. The hire agreement included annual replacement to comply with the requirement under MGN 499 (M+F) for annual servicing. However, the liferaft had not been changed for 2 years and was out of date for service. It was secured to the vessel with an HRU, which was also found to be out of date. When the crew attempted to operate the liferaft, it failed to inflate owing to the CO_2 cylinder being empty.

Although past its expiry date, the HRU was found to have operated and to have cut the liferaft canister securing strap.

The shortcomings identified above indicate that insufficient attention was being paid on board *Louisa* to the fitting and servicing of the vessel's liferaft. Had the liferaft been serviced/changed annually, as required, it is very likely that its replacement would have functioned correctly when it was needed on 9 April 2016.

2.8.2 The liferaft - servicing

Refurbishment of the CO_2 cylinder fitted to *Louisa*'s liferaft had been sub-contracted by Premium Liferaft Services to Thameside Fire Protection Company Limited in November 2011. Post-accident examination of the cylinder found that it had not been filled post-refurbishment, which had not been identified when its filled weight was written on the cylinder; there were surface cracks in the valve attachment thread at the neck of the cylinder; and, the valve assembly had not been tightened into the neck to the manufacturer's recommended torque setting.

The investigation found that Thameside Fire Protection Company Limited did not have access to any manufacturer's information relating to maintenance of the cylinder or valve assembly, and relied on general requirements for cylinder testing under the transportation of pressurised gas cylinders BS EN 1968:2002. They were subject to third party audit in respect of their fire protection business but not in respect of liferaft cylinder testing. Premium Liferaft Services had not carried out any audit of Thameside Fire Protection Company Limited before sub-contracting work to the company.

The sub-contractor's omission to refill *Louisa*'s liferaft CO_2 cylinder was almost certainly an isolated incident. However, it was allowed to occur owing to deficiencies in the work process. If there had been a formal work specification detailing each step of the process, including a requirement to record the cylinder weight before and after servicing, this deficiency ought to have been detected.

The work processes and recording of cylinder maintenance were not well defined, with no detailed work specification issued by Premium Liferaft Services on despatch of the cylinders. The guidance in MGN 499 (M+F) relating to liferaft servicing also lacked definition in this regard.

2.8.3 Lifejackets

The circumstances of this accident and the subsequent trials and testing of the Cosalt Premier (32kg or more) solid-filled lifejackets have raised concerns about the effectiveness of the lifejackets worn by *Louisa*'s skipper and crew.

The second set of tests carried out by the Department of Transport in May 1992 on the Cosalt Premier (32kg or more) solid-filled lifejackets met the requirements specified by the IMO (see section 1.9.7). If these tests had been conducted with the test subjects wearing normal clothing, and similar results had been achieved, it would have also met the corresponding requirements for novel individual buoyancy equipment. However, the conditions applied to the water performance tests both in 1992 and under current requirements are restricted (test subjects wearing only swimming costumes and in still, fresh water).

Against the testing requirements for the Cosalt Premier (32kg or more) solid-filled lifejacket (A.689(17) and MSC.81(70)), an Administration has, in particular circumstances, discretion to disregard a very slight deviation from the specified criteria. Against the current testing requirement (MSC.200(80)), there is a possibility of a lifejacket meeting the test requirements having recorded a number of 'no-turns'. Therefore, the IMO testing requirements acknowledge that an approved lifejacket may, under some circumstances, be incapable of satisfactorily turning a face down, unresponsive casualty, and keeping their airway clear of the water. This highlights the absence of any factor of safety to take account of the lifejacket being used in operational conditions i.e. with an unspecified range of subjects wearing clothing other than swimming costumes in other than calm conditions.

Prototype lifejackets that initially fail approval tests could be retested using the same or different test subjects (within the defined criteria) and subsequently pass the required tests without modification, as was the case with the Cosalt Premier (32kg or more) solid-filled lifejacket in 1992. Conversely, lifejackets that pass the required tests could subsequently fail the tests without modification, as demonstrated by the tests commissioned by the MCA following this accident (see section 1.9.8). The variability of outcome evidenced by testing of the Cosalt Premier (32kg or more) solid-filled lifejackets raises doubts about the robustness of the testing regime.

Further amendments to the recommended lifejacket water performance tests, introduced on 22 May 2014 (MSC.378(93)), notably relax the turning time and freeboard requirements against amended design and construction requirements for an RTD, reducing pre-existing safety factors.

Paul Alliston, Christopher Morrison and Martin Johnstone had all undertaken sea survival training during which they were taught how to don lifejackets correctly. That all three were found unresponsive and face down in the water indicates that their lifejackets were incapable of turning them onto their backs and keeping their airways clear. Assuming that they had donned and secured their lifejackets in accordance with their training and the manufacturer's instructions, this finding supports that of the MAIB lifejacket trials and the MCA commissioned testing, and questions the suitability of both historical and extant lifejacket water performance test protocols.

2.8.4 Inflatable PFDs

The MAIB lifejacket trials found that the inflatable PFD, of the same make and design as those available but unused on *Louisa*, righted a face down test subject within 2s on each occasion. The PFDs issued to *Louisa* were intended for use during normal fishing operations rather than vessel abandonment. However, they had remained in their original packaging, showed no signs of use and were out of date for servicing. This was not unexpected as, despite campaigns to encourage their use and as highlighted in the *Annie T* and *Harvester* MAIB reports, many UK fishermen have not yet accepted the rationale for routinely wearing these valuable safety devices.

2.8.5 LSA maintenance

The LSA on *Louisa* was commensurate with carriage requirements but significant items were out of date for test or replacement.

The liferaft should have been serviced annually but was overdue for service by a year, the HRU was found to have functioned satisfactorily but was overdue for replacement, and the EPIRB's battery was also overdue for replacement. While not part of the formal LSA outfit, the PFDs were also out of date for service.

Even where items of safety equipment have been hired, the responsibility to maintain and service them to ensure they remain in date and fit for purpose rests with the vessel's owners. Notwithstanding this, Premium Liferaft Services operated a system for prompting hirers when payment was due based on invoice dates.

However, the invoice dates did not align with service dates. With minor adjustments and a focus on servicing requirements, the system could have provided a potentially useful prompt to *Louisa*’s owners that the liferaft was due for replacement under their existing contract.

2.9 SEARCH AND RESCUE

2.9.1 Summary of key times and events

Time (UTC)	Event
0232	Satellite detects EPIRB alert.
0239	New incident input to Vision 4. UKMCC advises CGOC of EPIRB alert.
0241	Second satellite detects EPIRB alert.
0244	UKMCC enters **coarse** EPIRB position into Vision 4.
0250	UKMCC passes co-ordination to CGOC Falmouth.
0251	CGOC Falmouth requests CGOC Stornoway to contact vessel.
0251	UKMCC receives **refined** EPIRB position.
0306	NMOC notes on Vision 4 that it is aware of the EPIRB alert and that it is monitoring narrative.
0312	UKMCC enters **refined** EPIRB position into Vision 4.
0316	CGOC Falmouth confirms with UKMCC that **refined** position is accurate to 120m and passes co-ordination to CGOC Stornoway.
0322	CGOC Stornoway pages Barra ALB DLA.
0327	CGOC Stornoway contacts ARCC and requests SAR helicopter.
0333	CGOC Stornoway pages Barra ALB crew.
0340	Barra ALB launches.
0344	CGOC Stornoway pages R948 aircraft crew.
0356	CGOC Humber advises CGOC Stornoway that IMdatE system placed *Louisa* in Mingulay Bay at 0140.
0413	Barra ALB arrives on scene in Mingulay Bay.
0424	Barra ALB locates two unresponsive casualties.
0539	R948 SAR helicopter reports having recovered survivor.

Table 2: Summary of key times and events

2.9.2 UKMCC/HMCG interface

At the outset of the emergency response, there was confusion between UKMCC and CGOC Falmouth with respect to the application of the descriptors used to define the alert. On this occasion **resolved**, **unresolved**, **refined** and **unrefined**, appeared in the coastguard log, which differed from the standard terminology used by Cospas-Sarsat and UKMCC (see 1.10.3). There was also a lack of understanding of the operation of the Cospas-Sarsat system relating to encoded and alert only beacons.

The coastguard operator recognised an **unresolved** alert but was unsure of the term **unrefined** which was used by the UKMCC operator to describe the location in place of the standard term **coarse** position. In turn, the UKMCC operator was unsure how the embedded global positioning satellite (GNSS) function of the EPIRB worked and, although aware that the **coarse** position had accuracy of 15nm associated with it, was unable to satisfactorily explain this to Falmouth. The reliance on a LEOSAR with a pass time of 0410 was unreasonable given the environmental conditions and predicted survival times. Even when the second, **refined** position was received the UKMCC operator was still concerned about a lack of data points, which had no relevance in relation to a position generated by a GNSS embedded EPIRB.

The inconsistent terminology for EPIRB positions used by UKMCC and coastguard, coupled with insufficient knowledge of the EPIRB and satellite system, caused confusion and resulted in a delay in prosecuting SAR action.

2.9.3 Speed of response

On receipt of *Louisa*'s EPIRB alert, UKMCC checked that it was a new alert, and then informed CGOC Falmouth and initiated a new incident on Vision 4. UKMCC and CGOC Falmouth then checked the EPIRB's registration details, and UKMCC categorised the alert as an **unresolved** 406 alert with a location of 56 45.00N 007 30.00E. UKMCC passed co-ordination to CGOC Falmouth, who then requested CGOC Stornoway to initiate local information gathering.

CGOC Falmouth implemented HMCG's standard operating procedure for satellite distress beacon alerts based on receipt of a **detect only** or **unresolved** alert, meaning that the EPIRB's position will only be confirmed following local information gathering and/or through the **unresolved** location becoming **resolved** following a second satellite pass. In either event, co-ordination remained with CGOC Falmouth until the EPIRB's position was confirmed.

Although included as an option in the procedure, in view of the uncertain timescale required to confirm an EPIRB's position following a **detect only** or **unresolved** alert, and the potential inaccuracy of an **unresolved** location, no consideration is normally given to tasking SAR assets until such time as the position is confirmed.

The procedure states: '*An EPIRB activation is always a DISTRESS ALERT*', implying that SAR tasking should be initiated as soon as the EPIRB's position is confirmed.

The introduction of GNSS enabled EPIRBs provides an opportunity to significantly improve SAR speed of response. A **coarse** position is subject to an assumed maximum error of 15nm, which is sufficiently accurate to identify the relevant CGOC and to start tasking SAR assets in readiness to deploy once the **refined** position, accurate to within 120m, is received. Local information gathering is still important to attempt to confirm whether or not an alert is **false**, prior to receipt of the **refined** position and a decision to deploy SAR assets. However, it is no longer a priority for the purpose of confirming the EPIRB's position. The benefit of GNSS enabled EPIRBs with respect to SAR response time was highlighted in the *Ocean Way* MAIB report.

HMCG's standard operating procedure for satellite distress beacons currently makes no specific reference to the handling of GNSS enabled EPIRB alerts.

2.9.4 Response to *Louisa*'s EPIRB alert

Louisa's EPIRB alert provided a **coarse** position that was 5.54nm from its actual position and within CGOC Stornoway's area of operations. CGOC Falmouth was advised of the EPIRB's **coarse** position at 0239. A **refined** EPIRB position was received by UKMCC at 0251, but it was not until 0316 that CGOC Falmouth passed co-ordination to CGOC Stornoway, and not until 0322 that CGOC Stornoway started SAR asset tasking. Contributing to this delay might have been that CGOC Falmouth was not made aware of the **refined** position until UKMCC entered the information into Vision 4 at 0312.

Although contrary to HMCG's standard operating procedure for satellite distress beacon alerts, if CGOC Falmouth had passed co-ordination to CGOC Stornoway at 0239, CGOC Stornoway could have started to task SAR assets in readiness to deploy once the **refined** position had been received. In the event, Barra ALB launched at 0340, incurring an unnecessary delay to the SAR response of 49 minutes. If SAR asset tasking had started once the **refined** position had been received by UKMCC at 0251, a delay of 31 minutes could have been avoided. However, in the event, this position was not apparent to CGOC Falmouth until it was entered into Vision 4 at 0312.

2.9.5 Incident location

The EPIRB's **coarse** position was categorised as **unresolved**, prompting CGOC Falmouth to request CGOC Stornoway to initiate local information gathering in accordance with HMCG's standard operating procedure. Although not a confirmed position, the EPIRB's **coarse** position was actually 5.54nm south-east of Mingulay Bay and in an area that a Stornoway registered fishing vessel could reasonably be expected to be operating.

In the absence of an AIS transmission from *Louisa*, no personal locator beacons being worn by the skipper and crew, and no success in calling the EPIRB's registered emergency contacts, CGOC Stornoway was reliant on establishing a confirmed position by other means. The benefits of an historical track of a vessel's movements, and of wearing personal locator beacons, to those involved in SAR, were highlighted in the *Harvester* MAIB report.

Vessel monitoring system (VMS) positional data for *Louisa* was available to HMCG and could have been used to assist in establishing the vessel's location. *Louisa*'s last positon had been transmitted at 0140 and put the vessel in Mingulay Bay. VMS positional data was accessed by neither CGOC Falmouth, CGOC Stornoway nor the NMOC, and it was not until 0356 that CGOC Humber highlighted this information.

The *Ocean Way* MAIB report highlighted the benefits of CGOCs having computer systems capable of gaining access to essential information from all available databases. In response, the MCA gave assurance that the computer equipment in all CGOCs would be capable of accessing vessel positional data in a timely manner.

HMCG's omission to use all available tools suggests insufficient training and manpower resource for its CGOCs to act autonomously.

2.9.6 Network activity

Although each CGOC can act autonomously, the current coastguard model is of a network of individual nodes which combine to provide support as required. This is overseen by a network controller who manages routine workload to match network resources and provides supervisory cover in the event of an operational incident.

The network duty controller was on a break from 0300 to 0430, not returning to his post until after the SAR assets were on scene and the casualties had been located. During this period, the network was being monitored by a trainee who had been employed by HMCG for only 3 months. CGOC Stornoway's duty SMOO and MOO, who was still undergoing training, attempted to deal with a wide range of tasks. Additional workload was caused by a number of system-related deficiencies and communication problems. A lack of network interaction and supervision meant that the network was ineffective in supporting the SAR operation to the extent of eliminating confusion and ensuring a timely response to the EPIRB alert.

The *Aquila* and *Ocean Way* MAIB reports highlighted the need for effective network communications and co-ordination between CGOCs and the need to follow effective procedures to ensure important information is not overlooked in demanding situations.

SECTION 3 - CONCLUSIONS

3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. While all on board went to bed in the accommodation, the configuration of *Louisa*'s machinery was inconsistent with best practice and demonstrated an underestimation of the risks associated with flooding and foundering. [2.3]

2. The bilge alarm sounder in the crew cabin had previously been disabled and prevented early notification of hold flooding to the skipper and crew. [2.4]

3. Instead of managing work routines to prevent fatigue and so ensure adequate levels of safety were maintained, the skipper drove the crew and himself to a state of tiredness such that the safety of the vessel and its crew was compromised. [2.4]

4. Modelling of possible foundering scenarios identified flooding of the hold as the probable cause of *Louisa*'s foundering. The probable means by which the water entered the hold was from the deck wash hose. [2.5]

5. The deck wash pump had probably been left running, and it is likely that the hose became wedged between bait boxes stacked aft of the hold hatch coaming, allowing water to spray against the open hold hatch cover. [2.5]

6. The necessary speed of vessel abandonment gave no opportunity for the skipper and crew to don warm clothes. Their survival in water of 10ºC therefore relied more heavily on entry to the vessel's liferaft and/or a rapid rescue. [2.6]

7. It is possible that there would have been more survivors had the skipper and crew's lifejackets been more effective in prolonging their survival and/or had the rescue services arrived sooner. [2.7]

8. The liferaft servicing company's sub-contractor omitted to refill *Louisa*'s liferaft CO_2 cylinder owing to deficiencies in the work process. The work processes and recording of cylinder maintenance were not well defined and no detailed work specification was issued by the liferaft servicing company on despatch of the cylinders. [2.8.2]

9. The guidance in MGN 499 (M+F) relating to liferaft servicing lacked definition with regard to a liferaft servicing company sub-contracting work in respect of maintaining and refilling liferaft CO_2 cylinders. [2.8.2]

10. IMO testing requirements acknowledge that an approved lifejacket may, under some circumstances, be incapable of satisfactorily turning a face down, unresponsive casualty and keeping their airway clear of the water. This highlights an absence of any factor of safety to take account of the lifejacket being used in operational conditions i.e. with an unspecified range of subjects wearing clothing other than swimming costumes in other than calm conditions. [2.8.3]

11. Assuming that they had donned and secured their lifejackets in accordance with the manufacturer's instructions, the fact that the skipper and two crew were found face down in the water supports the findings of MAIB trials and the MCA commissioned testing following the accident and questions the suitability of lifejacket water performance test requirements. [2.8.3]

12. Significant items of safety equipment on board *Louisa* were out of date for test or replacement. [2.8.5]

13. The liferaft servicing company operated a system for prompting hirers when payment was due based on invoice dates. With minor adjustments and a focus on servicing requirements, the system could have provided a potentially useful prompt to *Louisa*'s owners that the liferaft was due for replacement under their existing contract. [2.8.5]

14. Inconsistent terminology for EPIRB positions used by UKMCC and CGOC Falmouth, coupled with insufficient knowledge of the Cospas-Sarsat system, caused confusion and resulted in an unnecessary delay in prosecuting SAR action. [2.9.2]

15. HMCG's standard operating procedure for satellite distress beacons currently makes no specific reference to the handling of GNSS enabled EPIRB alerts. [2.9.3]

16. HMCG's omission to use all available tools suggests insufficient training and manpower resource for its CGOCs to act autonomously. [2.9.5]

17. A lack of network interaction and supervision meant that the network was ineffective in supporting the SAR operation to the extent of eliminating confusion and ensuring a timely response to the EPIRB alert. [2.9.6]

3.2 OTHER SAFETY ISSUES[18]

1. The work ethic that resulted in the skipper driving himself and the crew to a level of tiredness that compromised their safety, can be linked to the share remuneration scheme, which encouraged them to grasp every opportunity to continue fishing and maximise the catch whenever suitable conditions prevailed. [2.4]

2. The PFDs issued to *Louisa*, which were intended for use during normal fishing operations rather than vessel abandonment, had remained in their original packaging. Despite campaigns to encourage their use, many UK fishermen have not yet accepted the rationale for routinely wearing these valuable safety devices. [2.8.4]

[18] These safety issues identify lessons to be learned. They do not merit a safety recommendation based on this investigation alone. However, they may be used for analysing trends in marine accidents or in support of a future safety recommendation

SECTION 4 - ACTION TAKEN

4.1 MAIB ACTIONS

The **MAIB** has:

Issued a Flyer to the Fishing Industry **(Annex H)**.

4.2 ACTIONS TAKEN BY OTHER ORGANISATIONS

The **Maritime and Coastguard Agency** has:

1. Issued MGN 553 (M+F) – Life-Saving Appliances – Inflatable Non-SOLAS Liferafts, Lifejackets, Marine Evacuation Systems, Danbuoys and Lifebuoys – Technical Standards and Servicing Requirements, which includes guidance for liferaft servicing companies on sub-contracting work in respect of servicing liferaft CO_2 cylinders.

2. Conducted testing of the Cosalt Premier (32kg or more) solid-filled lifejacket used in the MAIB trials, an additional Cosalt Premier (32kg or more) solid-filled lifejacket and a similar, widely available solid-filled approved lifejacket. All three lifejackets failed to meet required test standards (see section 1.9.8).

SECTION 5 - RECOMMENDATIONS

The **Maritime and Coastguard Agency** is recommended to:

2017/130 Urgently conduct research to confirm or otherwise the effectiveness of SOLAS lifejacket water performance test requirements to ensure approved lifejackets will satisfactorily turn a face down, unconscious person onto their back with sufficient orientation and buoyancy to maintain their airway clear of the water. Any shortcomings in the water performance test requirements that may be identified should be brought to the attention of the International Maritime Organization for action.

2017/131 Update and enhance its response to satellite distress beacon alerts, particularly with regard to GNSS enabled EPIRBs, in respect of:

- HMCG's standard operating procedure.
- Staff training, in terms of both Cospas-Sarsat system knowledge and HMCG's operational requirements including the definition of standard terminology in relation to beacon alerts.
- Network functionality, reliability, supporting interactivity and resource, in terms of both manpower and equipment.

Premium Liferaft Services is recommended to:

2017/132 Update its liferaft servicing procedures to ensure:

- Any anomalies in the recorded CO_2 cylinder weight can be readily identified.
- Definitive work specifications are issued to sub-contractors.
- Selected sub-contractors are suitably qualified to undertake the specified work.
- Introduce a formal process to advise hirers when their liferafts are due for service.
- Compliance with the content of MGN 533 (M+F).

Thameside Fire Protection Company Limited is recommended to:

2017/133 Introduce liferaft CO_2 cylinder servicing procedures to ensure:

- Any anomalies in the recorded CO_2 cylinder weight can be readily identified.
- Sufficient documentation is held to facilitate servicing a CO_2 cylinder in accordance with the liferaft servicing company's work specification and the particular liferaft manufacturer's instructions.

***Louisa*'s owners** are recommended to:

2017/134 With respect to any fishing vessel they may own in the future, ensure that the vessel remains compliant with the relevant mandatory Code of Practice by:

- Developing a planned maintenance system to ensure the vessel is maintained and its safety equipment serviced in accordance with statutory requirements and manufacturers' instructions.

- Conducting formal risk assessments appropriate to the vessel's anticipated range of activities.

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

Marine Accident Report