Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

MARINE INVESTIGATION REPORT M17C0035

Flooding

Fishing vessel *L.K.C*
Sept-Îles, Quebec, 45 nm E
21 April 2017

Canada

Transportation Safety Board of Canada
Place du Centre
200 Promenade du Portage, 4th floor
Gatineau QC K1A 1K8
819-994-3741
1-800-387-3557
www.tsb.gc.ca
communications@tsb.gc.ca

Marine investigation report M17C0035

Cat. No. TU3-7/17-0035E-PDF
ISBN 978-0-660-27056-2

This report is available on the website of the
Transportation Safety Board of Canada at www.tsb.gc.ca

Le présent rapport est également disponible en français.

Marine Investigation Report M17C0035

Flooding
Fishing vessel *L.K.C*
Sept-Îles, Quebec, 45 nm E
21 April 2017

Summary

On 21 April 2017, at approximately 0330 Eastern Daylight Time, the engine room of the fishing vessel *L.K.C* flooded while the vessel was anchored 45 nautical miles east of Sept-Îles, Quebec. There were 4 crew members on board. The Canadian Coast Guard Ship *Cap Rozier* arrived on scene, helped to pump out the water, and towed the vessel to Sept-Îles. There were no injuries or pollution in this occurrence.

Le présent rapport est également disponible en français.

Table of contents

1.0 Factual information 1
- 1.1 Particulars of the vessel 1
- 1.2 Description of the vessel 1
  - 1.2.1 Engine room 2
- 1.3 History of the voyage 2
- 1.4 Environmental conditions 3
- 1.5 Damage to the vessel 4
- 1.6 Vessel certification 4
- 1.7 Crew certification and experience 4
  - 1.7.1 Familiarization, training, and emergency preparedness 4
- 1.8 Vessel repairs and modifications 5
  - 1.8.1 Oversight of repairs 6
- 1.9 Post-occurrence damage analysis 6
- 1.10 Watchkeeping 7
  - 1.10.1 Fatigue management 8
  - 1.10.2 Safe manning 8
- 1.11 Bilge high water alarms 8
- 1.12 Life rafts 9
  - 1.12.1 Inspections 9
  - 1.12.2 Certification and service 9
  - 1.12.3 Life raft approval 10
  - 1.12.4 Service stations 10
  - 1.12.5 Inflation of the life rafts 10
  - 1.12.6 Laboratory analysis 10
  - 1.12.7 Quality assurance for life raft service 11
  - 1.12.8 Life raft manufacturing and service oversight roles 12
- 1.13 Previous occurrences 14
- 1.14 TSB laboratory reports 14

2.0 Analysis 15
- 2.1 Factors leading to the flooding 15
- 2.2 Repairs to the intermediate bearing 15
- 2.3 Watchkeeping 15
- 2.4 Bilge high water alarm 16
- 2.5 Life raft service oversight 16

3.0 Findings 18
- 3.1 Findings as to causes and contributing factors 18
- 3.2 Findings as to risk 18
- 3.3 Other findings 18

4.0 Safety action 19
- 4.1 Safety action taken 19
  - 4.1.1 L.K.C owner 19

Appendices 20
Appendix A – Profile of crab fishing vessel L.K.C. 20

1.0 Factual information

1.1 Particulars of the vessel

Table 1. Particulars of the vessel

Name	*L.K.C*
Official number	820506
Port of registry	Québec, Quebec
Flag	Canada
Type	Fishing, trap
Materials	Steel
Gross tonnage	65.91
Length overall	14.36 m
Draft	2.6 m
Built	1998
Propulsion	1 diesel engine 283 kW, single screw
Cargo	Crab, 36 tons
Crew	4
Registered owner/manager	162115 Canada Inc., Quebec

1.2 Description of the vessel

The *L.K.C* is a steel, single-hull fishing vessel used for snow crab fishing.

Figure 1. Fishing vessel L.K.C

The wheelhouse and accommodations are located forward, and the engine room is situated beneath the wheelhouse (Figure 1). The wheelhouse is elevated and is accessed via a door on its aft starboard side.

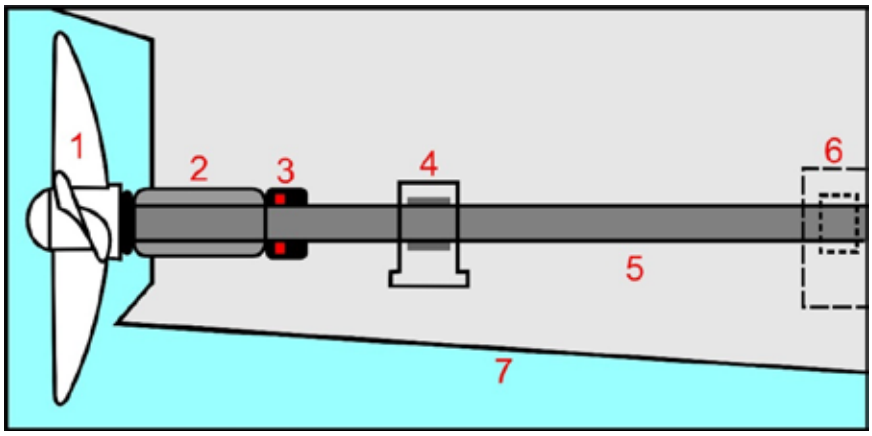
The wheelhouse is equipped with 1 radar, 1 very high frequency (VHF) radiotelephone, a chart plotter, a global positioning system, an auto-pilot, a closed-circuit television screen that displays the feed from 4 cameras in the engine room, and a Class II emergency position-indicating radio beacon.

The hull is subdivided by 5 transverse bulkheads into 6 compartments, from forward: accommodations (accessed by stairs descending from the wheelhouse), the engine room, the port and starboard live crab wells, the centre live crab well, the steering gear compartment, and the bait hold (Appendix A).

1.2.1 Engine room

The engine room is accessible from the work deck via a door on the port side, aft of the wheelhouse. A ladder leads to the forward area of the compartment. The propulsion plant consists of a high-speed diesel engine connected to a single shaft via a gearbox (Figure 2). The propulsion shaft drives a fixed-pitch propeller and is supported by an intermediate bearing and a water-cooled stern tube. A mechanical seal is fitted ahead of the stern tube to ensure the watertight integrity of the engine room.

Figure 2. Propulsion shaft arrangement, showing 1: propeller; 2: water-cooled stern tube; 3: mechanical seal; 4: intermediate bearing; 5: propulsion shaft; 6: engine and gearbox; and 7: keel



The engine room bilge water can be pumped by 2 means: a hydraulic bilge pump connected to the main engine, and an electric pump supplied by one of the auxiliary generators.

1.3 History of the voyage

The vessel left Sept-Îles, Quebec, on 09 April 2017. At the time of departure, the master, first mate, and 2 deckhands were on board. Between the 09 and 13 April, the vessel set traps in the vicinity of Banc-à-la-Boucane (45 nautical miles [nm] east of Sept-Îles), then completed its first fishing voyage and landed its catch at Rivière-au-Renard. During that first voyage, the intermediate bearing was damaged.

On 14 April, the master replaced the damaged bearing at Rivière-au-Renard. The vessel resumed operations and carried out a second fishing voyage from 15 April to 18 April. The catch was landed at Rivière-au-Renard.

On 19 April, the vessel proceeded to the fishing grounds about 82 nm northwest of Rivière-au-Renard. The crew worked for about 22 hours on 20 April, with intermittent breaks.

At approximately 2300,[1] the master anchored the vessel about 45 nm east of Sept-Îles, Quebec, and the crew went to sleep. The master slept in the wheelhouse and awoke twice to check the radar.

At approximately 0330, the master awoke and noticed that the live crab well's circulation pump had stopped. The master did not hear an alarm. He proceeded to the engine room and found that it had flooded to approximately 1.1 m above the engine room floor. The master noted the water level and went to the accommodations, checked the state of all the adjacent compartments and spaces and found them to be dry. He woke the crew and ordered them to go to the wheelhouse to don their immersion suits.

At 0408, the master sent a Mayday message on VHF radio channel 16, which was acknowledged by the Canadian Coast Guard. Assisted by crew members, the master launched the starboard life raft from the top of the wheelhouse.

The starboard life raft only partially inflated, with only the top chamber inflating. The master ordered the launch of the second life raft from the port side. That life raft also partially inflated, with only the bottom chamber inflating. The 2 deckhands boarded the starboard life raft.

As water flooded the engine room, the main engine and coupled hydraulic pump were disabled. The electrical pump motor was also submerged, rendering it inoperative. As the generators were located higher in the engine room, they continued to run and supply electricity.

The master went back to check the water level in the engine room and found that it was still rising. With the assistance of the first mate, he rigged a yacht-type 12-volt direct current submersible pump, which was powered by the VHF radiotelephone's battery and had hoses reaching into the engine room. The pumping started and the water level was stabilized.

In the meantime, the Canadian Coast Guard Ship (CCGS) *Cap Rozier* was tasked to assist the *L.K.C*, and other fishing vessels in the vicinity were alerted.

At 0730, CCGS *Cap Rozier* arrived on scene and supplied additional engine-driven pumps. As the level of the water in engine room went down, the source of water ingress was identified to be the mechanical seal ahead of the stern tube. CCGS *Cap Rozier* towed the vessel to Sept-Îles.

1.4 Environmental conditions

At the time of the occurrence, the sea was calm and the winds were light. Environment Canada had forecast light winds for the evening of 20 April, increasing to easterly winds at 15 to 25 knots by noon on 21 April. The temperature was 0 °C.

---

1 All times are Eastern Daylight Time (Coordinated Universal Time minus 4 hours).

1.5 Damage to the vessel

The engine room of the *L.K.C* was flooded to about 1.1 m above the engine room floor. The main engine was submerged and had to be overhauled after the incident. The electrical motors and equipment in the lower engine room were damaged and had to be replaced.

While the engine room was being pumped out, the vessel's stern tube was found to be damaged and no longer watertight.

1.6 Vessel certification

The *L.K.C* had a periodic inspection certificate issued by Transport Canada (TC) on 07 April 2017 for Near Coastal, Class 1, and Home Trade waters, Class II, voyages. The certificate was valid for 4 years.

1.7 Crew certification and experience

The master held a Fishing Master, Fourth Class, certificate issued on 14 January 2016, limited to vessels of less than 100 gross tonnage and valid for 5 years. He had worked at sea since 1978 and was certified as a master in 1989. He had been the master on the *L.K.C* since 1998.

The first mate held a valid certificate for "[Officer of the Watch] of a fishing vessel of < 24 metres in length overall." He had worked as a fisherman for 25 years.

One deckhand had a Marine Emergency Duties certificate and a restricted radio operator certificate. He had worked as a fisherman for 20 years, with a focus on shrimp fishing for the previous 3 years.

The other deckhand had sailed for 2 weeks as cook on a general cargo vessel and had no fishing experience.

1.7.1 Familiarization, training, and emergency preparedness

According to the *Marine Personnel Regulations*, "the master and the authorized representative of a vessel shall ensure that any person assigned a function on that vessel receives the on-board familiarization and safety training set out in TP 4957 before they start to perform any duty on board the vessel."[2]

Masters of fishing vessels are also required to "take adequate steps to ensure that the crew understands the use of the lifesaving […] appliances and knows where they are located."[3] This includes

---

2 Transport Canada, SOR/2007-115, *Marine Personnel Regulations* (last amended 03 February 2017), subsection 205(1).

3 Transport Canada, C.R.C., c. 1486, *Small Fishing Vessel Inspection Regulations* (SVFIR), section 51, archived regulations available at http://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1486/20060322/P1TT3xt3.html (last accessed 05 July

- their duty in case of emergency,
- the general safety practices on board, and
- the location and nature of any special hazards present on board.

A vessel post-inspection report dated 07 April 2017 noted a requirement to develop rules and emergency procedures for safe operation and to provide the crew with safety training and vessel familiarization. The same requirement had been documented on a previous inspection of the vessel. No records of corrective actions from the master or warnings from the regulator were found.

However, before the 2017 fishing season began, the master hired a marine emergencies consultant, who provided training to familiarize and refresh the crew about many aspects of emergency preparedness, including donning immersion suits; preparing, launching, and securing life rafts; following man-overboard procedures; and firefighting. This training provided an insight into safety management and risk detection, as well as the basics of organizational health and safety.

In the vessel's wheelhouse, a muster list displayed the roles assigned to each crew member in an emergency situation, and the crew was aware of the list. There were no planned emergency drills on board.

There were no records regarding drills, training, or familiarization of crew.

1.8 Vessel repairs and modifications

In 2014, an additional auxiliary generator was installed to provide more power to the deck equipment. The same year, new bilge pumps and new circulation pumps for the live crab wells were installed.

Before the opening of the 2017 fishing season, the master had installed a new automatic lubrication system on the intermediate bearing, as the existing system required frequent manual greasing. The new device was a widely used commercial unit that consisted of a grease capsule fitted with a chemical timer. This device was fitted on top of the nozzle that had previously required manual lubrication. The system was set to diffuse the grease content over a period of 4 months.

During the first fishing voyage, the bearing's automatic lubrication device failed, which caused significant friction and the disintegration of the intermediate bearing rollers.

On 14 April, before the second fishing voyage, a new intermediate bearing was installed at the wharf in Rivière-au-Renard, Quebec. This replacement was a journal bearing made with Babbitt alloy; it uses the properties of this soft alloy and the interaction with the lubricant to reduce friction.

2018). The SVFIR were repealed and replaced in July 2017 by the *Fishing Vessel Safety Regulations* (FVSR).

1.8.1 Oversight of repairs

In addition to the inspection that TC is required to carry out every 4 years,[4] TC inspects vessels after major modifications,[5] installations, or major repairs.[6]

Any other repair that may affect the vessel's stability can be reported on a dedicated form[7] and made available to TC at the time of the next inspection.

Apart from the general rule to follow manufacturers' specifications or recommendations, there is no oversight regarding regular maintenance activities on board.

On the *L.K.C,* the replacement of the intermediate bearing and the installation of the automatic lubrication device were carried out after TC's 29 March 2017 inspection and were not required to be reported to TC or to be inspected outside of the regular inspection interval.

1.9 Post-occurrence damage analysis

The TSB Engineering Laboratory conducted a technical analysis of the remains of the bearing that was damaged during the vessel's first voyage and of the stern tube.

The bearing parts were heavily corroded, and the bearing rollers and cages had disintegrated, likely when the bearing failed. While the exact cause of the bearing failure could not be determined, the bearing may have been damaged as a result of a lack of lubrication. The automatic lubrication device's cartridge was filled to 88% capacity, indicating a lower delivery rate than expected, despite the fact that the lubricant cartridge was within its 2-year expiry date.

It was concluded that the mechanical seal or its mounting was likely to have been damaged or altered when the bearing failed during the vessel's first voyage, but the type of damage that caused the stern tube seal to lose its watertightness during the occurrence voyage could not be determined.

---

4 Ibid., section 46.

5 In the SVFIR/FVSR, a major modification is defined as modification or repair, or a series of modifications or repairs, that substantially changes the capacity or size of a fishing vessel or the nature of a system on board a fishing vessel, and that thus affects its watertight integrity or stability. Such modifications may be recorded on form TP 85-0435 and presented on an inspector's request. This form explicitly excludes ordinary repairs and maintenance.

6 According to Transport Canada, SOR/90-264, *Marine Machinery Regulations*, subsection 2(1), major repairs are "repairs or alterations to machinery that substantially alter the capacity, size or type of the machinery."

7 Transport Canada Form 85-0435, "Fishing Vessel Modification History." See also Transport Canada, RDIMS 2424361, *Ship Safety Bulletin* (SSB) 01/2008: Fishing Vessel Safety — Record of Modifications. The keeping of a record of modifications that affect stability is now required in the new *Fishing Vessel Safety Regulations*, section 3.12.

1.10 Watchkeeping

The *Marine Personnel Regulations*[8] require that a deck watch be maintained in accordance with the *Standards of Training, Certification and Watchkeeping for Seafarers Code* (the STCW Code). The STCW Code describes in detail the training and aptitudes required for watchkeepers. Fundamental principles of watchkeeping are presented in the Code, including the following:

- All watchkeepers performing safety, security, or pollution-preventing tasks must have 10 hours of sleep for each period of 24 hours, including one continuous period of 6 hours.[9]
- Under the authority of the master, the officers of the watch are responsible for the safety of navigation during their watch and must be physically present at the command station.[10]

Furthermore, for vessels at anchor, the STCW Code recommends that

> [t]he master of every ship at an unsheltered anchorage, at an open roadstead or any other virtually "at sea" conditions, ensures that watchkeeping arrangements are adequate for maintaining a safe watch at all times. A deck officer shall at all times maintain responsibility for a safe anchor watch.
>
> In determining the watchkeeping arrangements, and commensurate with maintaining the ship's safety and security and the protection of the marine environment, the master shall take into account all pertinent circumstances and conditions such as:
>
> maintaining a continuous state of vigilance by sight and hearing as well as by all other available means;[11]
>
> […] situations which might affect the security of the ship;
>
> […] the designation of stand-by crew members.[12]

After more than 20 hours of fishing, while the vessel was at anchor and the crew was sleeping below, the master of the *L.K.C* had planned to sleep in the wheelhouse with intermittent wake-ups for radar checks. No relief watchkeeper was assigned.

---

8 Transport Canada, SOR/2007-115, *Marine Personnel Regulations* (last amended 03 February 2017).

9 International Maritime Organization, *Standards of Training, Certification and Watchkeeping for Seafarers Code*, Section A-VIII/1, paragraphs 2 and 3.

10 Ibid., Section A-VIII/II, Part 4-1, paragraphs 13 and 18.

11 Also based on the International Maritime Organization *Convention on International Regulations for Preventing Collisions at Sea, 1972* (COLREGS), Rule 5, at http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/COLREG.aspx (last accessed on 05 July 2018).

12 International Maritime Organization, *Standards of Training, Certification and Watchkeeping for Seafarers Code*, Section B-VIII/2, Part 4-1, paragraphs 4 and 5.

1.10.1 Fatigue management

Lack of sleep leads to fatigue, which, in turn, can impair human performance. Such impairments can contribute to accidents in the workplace. Fatigue risk factors include sleep disruption, continuous wakefulness, circadian rhythm effects,[13] medical sleep disorders, or the consumption of medications or drugs. Fatigue risk factors specific to the fishing industry can include working long hours at sea, maintaining a 24-hour presence on the bridge with a minimum crew, and poor quality of sleep on the vessel, due to engine noise, quality of sleeping quarters, vessel motion, etc. To minimize the risk of fatigue on a fishing vessel, mitigation measures can be put in place. For example, crew members can be reminded to get a good night's sleep before a voyage, and periods of rest for all crew while at sea can be planned. If a permanent watch is required, a relief watch schedule can be organized so that rested crew members can take over.

The investigation determined that fatigue was not a factor in this occurrence.

1.10.2 Safe manning

The safe manning document issued by TC in 2016 classified the vessel's watch arrangement as that of a "day vessel" as opposed to a 2- or 3-watch arrangement; the document also acknowledged 2 types of voyages: daily and prolonged, requiring a minimum crew of 3 (1 certified fishing master, 1 certified fishing watchkeeper, and 1 seaman) for prolonged voyages.

The vessel was not required to have watch engineers, and the safe manning document also confirmed that the vessel's machinery spaces were periodically unattended.

1.11 Bilge high water alarms

The *L.K.C* was equipped with a bilge high water sensor that sounds an alarm in the engine room when the bilge water rises above a certain level.

The *Small Fishing Vessel Regulations* (repealed 13 July 2017) and the new *Fishing Vessel Safety Regulations* provide detailed technical requirements for bilge piping and pumping, but not for bilge high water alarms.

On the standard TC inspection checklist[14] used by the inspector on 29 March 2017, the *L.K.C's* bilge high water alarm was checked, in accordance with regulatory requirements.[15]

---

13 Circadian rhythm is the human body's internal clock. Because of the circadian rhythm, a person's desire for sleep is strongest between 0300 and 0500 (circadian trough) and during a lesser circadian trough in the mid-afternoon.

14 Form RDIMS 7136304, last revised 08 March 2016.

15 Transport Canada, TP 4937, Notice to Inspectors (New) Restricted (2005) was first issued in 1985 to vessel inspectors. Although it addresses fire alarms, which are required to sound in the wheelhouse, it does not address bilge-water alarm systems. Transport Canada, *Ship Safety Bulletin* 04/2000: Flooding Detection on Fishing Vessels (17 April 2000), at

1.12 Life rafts

1.12.1 Inspections

In December 2014, the *L.K.C* received a written warning from TC for having operated with non-inspected life rafts during the 2014 fishing season.

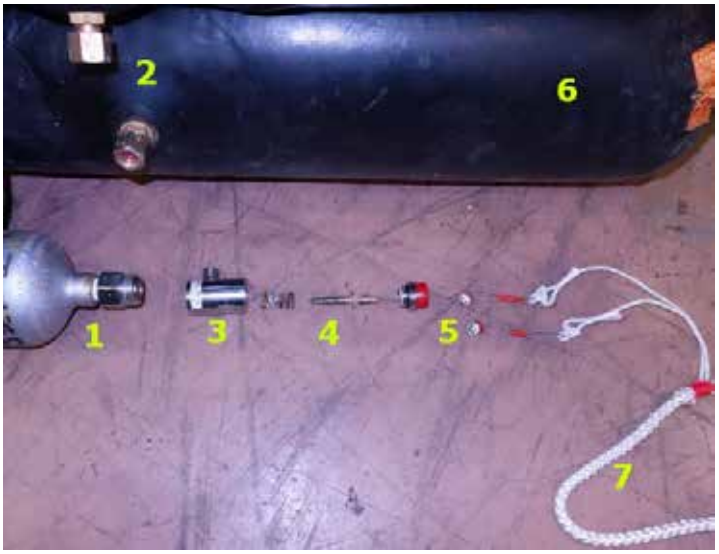
In April 2015, the vessel's life rafts were replaced by 2 new, 6-person life rafts compliant with SOLAS-A (*International Convention for the Safety of Life at Sea*). A certificate of inspection was issued in January 2017 by the life raft service station in Montréal, Quebec.

1.12.2 Certification and service

TC's quadrennial inspection, performed in the spring of 2017, verified the validity of the life rafts' certificates of inspection. The certificates of inspection confirmed that the life rafts' materials had been verified, wear or other defects had been identified, and that the life rafts had been repacked in a shell at the distributor's service station. The life rafts' certificates of inspection confirmed that the inflation systems were also verified.

On a life raft of the type employed on the *L.K.C*, the inflation system consists of 2 cylinders containing a carbon dioxide and nitrogen gas mixture, each connected to one of the 2 independent chambers of the raft. The cylinder heads are fitted with a membrane, a valve assembly, and a firing mechanism connected by a tug line to the life raft's painter (Figure 3).[16]

Figure 3. Life raft cylinder arrangement showing 1: cylinder head (contains membrane); 2: raft couplings for cylinders; 3: T-valve; 4: spring, firing pin; 5: arming nut, firing wire and fusible parts; 6: raft bottom chamber; 7: tug line (attached to painter)



New or used cylinders are filled and inspected at a subcontractor's cylinder- and gas-service facility in accordance with the distributor's requirements. A life raft's certificate of inspection confirms that the weight of the gas in the cylinders has been verified.

http://www.tc.gc.ca/eng/marinesafety/bulletins-2000-04-eng.htm (last accessed 05 July 2018). The bulletin responds to TSB Recommendation M94-06, which recommends that "TC regulate the mandatory fitting of high water level alarms in all compartments including fish holds, on large fishing vessels."

16 The painter is the rope extending from one end of the life raft's shell. It is designed to be pulled out and tugged to trigger the inflation of the life raft, after which it is used as a head line.

1.12.3 Life raft approval

The life rafts on the occurrence vessel were model type SMLR-A-6, manufactured on behalf of FitzWright Survival Inc. by Shanghai Star Rubber Products Co., Ltd., in China. This specific life raft model had a SOLAS-type approval certificate provided by DNV-GL.[17]

1.12.4 Service stations

The *Life Saving Equipment Regulations*[18] stipulate that the owner of a service station must ensure that the station meets the requirements of the regulations[19] and that the station is accredited by the manufacturers of the products serviced there. The regulations also specify that the manufacturer is responsible for ensuring that accredited and trained technicians provide adequate service and that TC's Marine Technical Review Board[20] is informed of the names of the service stations and accredited technicians.

1.12.5 Inflation of the life rafts

The type of life rafts on the *L.K.C* are 6-person inflatable shelters that use 2 independent chambers for flotation. Each of these chambers is connected to a 2 L gas cylinder that releases the gas into the chamber when the raft's painter is tugged. The bottom chamber acts like a mattress, and the top chamber erects the sides and a canopy. Each raft is folded and packed in a fibreglass shell.

The deployment of a throw-overboard type of life raft is straightforward. Essentially,

- each end of the shell is lifted by a crew member;
- the raft is thrown overboard;
- the painter (tied to the vessel) is pulled to trigger the inflation of the raft; and
- the raft is brought alongside and boarded.

The *L.K.C*'s life rafts were the approved mandatory lifesaving equipment for the vessel. At the time of the occurrence, they were 2 years old and were deployed using the above steps.

1.12.6 Laboratory analysis

Upon examination at the TSB Engineering Laboratory, the material and chambers of both rafts were found to be normal, with the exception of a minor leak in the upper chamber of the port-side life raft. The mechanisms designed to pierce the cylinders' membranes by

---

17 International Maritime Organization, *International Convention for the Safety of Life at Sea* (SOLAS), *1974*, as amended Reg. III/4, III/13, III/21, III/26, III/31 and III/34, X/3, LSA-Code and MSC.81(70), as amended.

18 Transport Canada, C.R.C., c. 1436, *Life Saving Equipment Regulations* (last amended 17 June 2015), section 118.

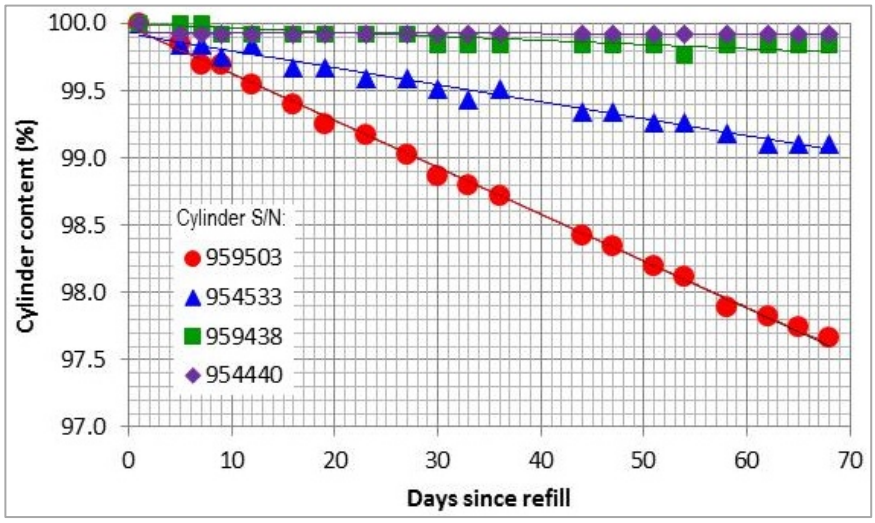
19 Ibid., Schedule IV.

20 Government of Canada, *Canada Shipping Act, 2001* (S.C. 2001, c. 26), subsection 26(1): "Marine Technical Review Board."

tugging on the rafts' painters also worked as expected. Additionally, no obstruction that may have prevented the gas from entering the rafts' chambers was found.

The TSB took the cylinders back to the same service facility and had them refilled under similar conditions. Leak tests on the 4 cylinders were later conducted at the TSB Engineering Laboratory, and it was found that 3 of the cylinders were leaking at various rates (Figure 4). Two of the cylinders had a leak rate that would have resulted, after a year, in exceeding the leakage tolerance stated in the manufacturer's service manual. When this leak rate is detected during an inspection, the cylinder must be refilled.[21]

Figure 4. Graph showing the leakage over time of the 4 cylinders, shown in percentage value. According to the manufacturer's service manual, 2% was the maximum acceptable level of leakage.



Short leak tests conducted after filling and based on weight measurement or cylinder immersion, such as those practised at the service station or the subcontractor's cylinder- and gas-service facility, were found to be ineffective, because the time for detection of a leak was too short.

The investigation therefore determined that the most likely cause of the life raft chambers' failure to inflate was insufficient gas content in the corresponding cylinders.

1.12.7 Quality assurance for life raft service

The life raft service station did not use a quality assurance model,[22] but it had started using data tracking in 2014 to record product returns from the field. It had no records of rafts returned with cylinders below the prescribed standard weight.

---

21 Because it is impossible to recreate the exact conditions of the occurrence, note that the cylinder could have been leaking at a different rate (or not leaking at all) before the event.

22 An example of a quality assurance (QA) model is ISO 9002, under which policies and procedures document registration and product traceability provide evidence that QA was applied.

The life raft service station used the manufacturer's technical service manual and checklists as its main guidelines. The service manual presents detailed procedures for the maintenance and inspection of all of the product's components, including completion of a service record for each raft inspection and the presence of a second person to double-check the critical points of the life raft before the inspection is completed.

There is no record that either the life raft service station or the subcontractor's cylinder- and gas-service facility responsible for the maintenance of the cylinders was audited internally or by external authorities. However, after the occurrence, the raft service technicians were issued a training certificate that was endorsed by the manufacturer.

1.12.8 Life raft manufacturing and service oversight roles

There are 4 entities (the manufacturer, the service station owner, TC, and a recognized organization [RO][23]) responsible for ensuring that life rafts meet construction and inspection standards[24] before being installed on board a vessel.

The manufacturer's responsibilities[25] include

- keeping the Marine Technical Review Board[26] informed of product malfunctions or failures;
- keeping the Marine Technical Review Board informed of the names of service stations and qualified technicians;
- accrediting service stations; and,
- ensuring that the technicians are qualified.[27]

The investigation found no evidence that, at the time of the occurrence, the manufacturer had informed the Marine Technical Review Board of any lifesaving equipment malfunctions or failures or the names of the service stations and qualified technicians. However, the

---

23 An RO is an organization authorized to perform specific functions on behalf of the Minister of Transport, as described in the authorization and agreement governing the delegation of statutory functions for vessels registered in Canada between the Minister of Transport and recognized organization.

24 Transport Canada, C.R.C., c. 1436, *Life Saving Equipment Regulations* (last amended 17 June 2015); International Maritime Organization, *International Convention for the Safety of Life at Sea* (SOLAS), *1974*, as amended SOLAS 74 as amended Reg. III/4, III/13, III/21, III/26, III/31 and III/34, X/3, LSA-Code I, IV, MSC.81(70), MSC/Circ.811, MSC.207(81), MSC.218(82), MSC.226(82), MSC.293(87), MSC.295(87), MSC.323(89); and additional standards: ISO 15738 for components of the gas-inflation system, Transport Canada, TP14612E, Procedures for Approval of Life-Saving Appliances and Fire Safety Systems, Equipment and Products (2011), and TP14475E, Canadian Life-Saving Appliance Standard.

25 Transport Canada, C.R.C., c. 1436, *Life Saving Equipment Regulations* (last amended 17 June 2015).

26 Government of Canada, *Canada Shipping Act, 2001* (S.C. 2001, c. 26), subsection 26(1): "Marine Technical Review Board."

27 Transport Canada, C.R.C., c. 1436, *Life Saving Equipment Regulations* (last amended 17 June 2015), Schedule IV, 14-d and 14-f.

manufacturer had accredited the service station and had ensured that the technicians at the service station were qualified.

The service station owner's responsibilities[28] include

- ensuring the equipment is serviced by accredited technicians;
- ensuring that the service station meets the requirements of schedule IV[29] of the *Life Saving Equipment Regulations*;
- ensuring that the service station is accredited by the life raft's manufacturer; and
- notifying the closest Marine Technical Review Board office each time any piece of inflatable lifesaving equipment is about to be serviced.

The service station owner ensured that the station met the requirements of Schedule IV of the *Life Saving Equipment Regulations*; the equipment was serviced by accredited technicians; and the station was accredited by the life raft's manufacturer. However, the investigation found no evidence that the service station owner had notified the closest Marine Technical Review Board office before servicing any piece of inflatable lifesaving equipment.

TC is responsible for ensuring that the manufacturer and service station owner comply with the standards and regulations related to life raft construction and inspection. TC delegates the compliance oversight of the life raft construction and inspection to an RO under the provisions of a delegation agreement.[30] The responsibilities of the RO are outlined in the *Procedures for Approval of Life-Saving Appliances and Fire Safety Systems, Equipment and Products*.[31]

Under the delegation agreement, the RO can designate a "service supplier," which is an organization or a person that provides services on behalf of the RO. The service supplier must be approved or recognized by the RO.[32] The RO is responsible for oversight of the service supplier.

In granting approvals for lifesaving appliances, the RO is required to ensure that

- [t]he lifesaving appliances meet the relevant standards […]
- [t]he tests and follow-up procedures are carried out to the relevant test standards […].[33]

---

28 Ibid., Part III, sections 118 and 119.

29 This schedule describes the servicing requirements for inflatable survival equipment.

30 Transport Canada, TP 13585, *Authorization and agreement governing the delegation of statutory functions for vessels registered in Canada between the Minister of Transport and [recognized organization]*.

31 Transport Canada, TP 14612 E, Procedures for Approval of Life-Saving Appliances and Fire Safety Systems, Equipment and Products (May 2011).

32 Transport Canada, TP 13585, Authorization and agreement governing the delegation of statutory functions for vessels registered in Canada between the Minister of Transport and [recognized organization].

33 Transport Canada, TP 14612 E, Procedures for Approval of Life-Saving Appliances and Fire Safety Systems, Equipment and Products (May 2011), part 2.2.1.

Additionally, the procedures for approval state that

> [i]t is the responsibility of the RO to ensure that service providers who test and maintain life-saving appliances approved according to these procedures are doing so in accordance with the relevant international standards and additional RO requirements as appropriate.[34]

In the case of the *L.K.C*, the RO (DNV-GL) approved the life raft type. The RO was not aware of the service station in Montréal, Quebec, and therefore was not auditing it. The RO had recognized a service station operated by the same company in Dartmouth, Nova Scotia.

1.13 Previous occurrences

M11L0050 (*Lady Jacqueline)* – On 21 May 2011, the fishing vessel *Lady Jacqueline* took on water, and the crew had to abandon the vessel. By the time they had become aware of the ingress, the water level was too high to be able to pump out the water. The vessel was not fitted with a high bilge water alarm system, which would have provided an early warning of water ingress, nor was such a system required by regulation.

M17C0075 (*Katrena I)* – On 26 May 2017, there was water ingress on the fishing vessel *Katrena I* that was not detected at an early stage, as the bilge-water alarm sounded in the engine room, where no crew were present. The vessel was disabled but was later towed in safely. Following the occurrence, the owner installed a bilge high water alarm with both visual and auditory components, which would alert crew present in the wheelhouse.

1.14 TSB laboratory reports

The following TSB laboratory reports were completed in support of this investigation:

- LP102/2017 – Life Raft Analysis

[34] Ibid, section 2.2.1.5.

2.0 Analysis

The investigation found that the engine room of the *L.K.C* flooded due to a leaking mechanical seal at the stern tube. Although the exact cause of the seal's failure could not be determined, it is likely that the seal was damaged or altered when the intermediate bearing failed during the vessel's first voyage. By the time the crew became aware of the water ingress in the engine room, the water level had risen to a level that rendered the hydraulic and electric pumps inoperable.

This analysis will focus on the repairs to the intermediate bearing, watchkeeping, high bilge water alarms, and oversight of life raft service.

2.1 Factors leading to the flooding

Before the 2017 fishing season, the master had installed an automatic lubrication device. During the first voyage of the season, the device failed and the rollers of the intermediate bearing disintegrated, producing heat and vibration in the propulsion shaft. The heat and vibration likely affected the stern tube seal at the other end of the propulsion shaft. A replacement bearing was installed after the first voyage, and the vessel resumed operations.

On 20 April, 6 days following the bearing replacement and after the completion of the workday, the vessel was at anchor. The master and crew went to sleep, with the master waking periodically to check the radar.

Water flooded the engine room in the early hours of 21 April because the mechanical seal of the vessel's stern tube had failed. The high bilge water alarm sounded only in the unmanned engine room. Consequently, the crew was unaware of the water ingress, and the water rose to a level that rendered both bilge pumps inoperable.

2.2 Repairs to the intermediate bearing

When the intermediate bearing failed on the *L.K.C,* the master took action to replace it. He located a replacement bearing in Rivière-au-Renard and installed it at the wharf with the assistance of the first mate.

The bearing's replacement and the installation of the automatic lubrication device were not required to be reported to Transport Canada (TC), as they did not constitute major modifications or repairs.

The investigation could not determine whether the installation of the new bearing was done correctly, nor could it determine the exact cause of the mechanical seal's failure.

2.3 Watchkeeping

The *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers* (the STCW Convention) and the *International Regulations for Preventing Collisions at Sea* cover the principles of watchkeeping while navigating, at anchor, and in port. Two clear ideas are

consistent within both conventions: masters must use all means available to maintain the safety of the vessel and ensure a continuous watch.

On the *L.K.C*, laying the vessel at anchor was a planned opportunity for the crew to rest after intensive work. The master stood at the wheelhouse but planned to sleep, with intermittent wake-ups to check the radar.

The investigation found that the master's plan did not allow for the maintenance of a continuous watch to adequately monitor situations that might affect the security of the vessel by, for example, making rounds, monitoring the wheelhouse closed-circuit television, or planning a watchkeeper rotation.[35]

If masters of fishing vessels do not ensure that a continuous watch is kept while the vessel is at anchor, there is a risk that the crew may not become aware of an unsafe situation.

2.4 Bilge high water alarm

On board the *L.K.C*, the bilge high water alarm system was designed to sound in the engine room only, which was an unmanned space. At the time of the occurrence, it was not heard due to its remoteness from the wheelhouse and the other crew, who were sleeping at the time. There was also interfering noise from the auxiliary machinery, 2 generators, and circulation pumps.

Fishing vessels such as the *L.K.C* are not required to have bilge high water alarms that sound in the wheelhouse or in a space on the vessel that is normally manned.

If bilge high water alarms are installed in such a way that they sound only in unmanned spaces on a vessel, there is an increased risk that crews may not have an early warning of unsafe conditions.

2.5 Life raft service oversight

The life raft manufacturer, the owner of a life raft service station, the regulator, and the recognized organization (RO) have roles to play in ensuring that a vessel's lifesaving appliances are compliant with the applicable standards and regulations.

The RO approved the life raft type but was not aware of the service station in Montréal, Quebec. Consequently, the RO was not auditing the testing and maintenance at the service station servicing the *L.K.C*'s life rafts.

Transport Canada (TC) delegated to the RO its responsibility to ensure that the construction and servicing of the life rafts were compliant, under the provisions of the delegation

---

35 International Maritime Organization, *Standards of Training, Certification and Watchkeeping for Seafarers* Code, Section B-VIII/2, Part 4-1, paragraph 5.

agreement. TC and the RO were not aware of the operations of the service station, resulting in the service station operating without regulatory oversight.

3.0 Findings

3.1 Findings as to causes and contributing factors

1. When the vessel was at anchor on the night of the occurrence, the stern tube's mechanical seal failed and water began to enter the engine room.

2. The bilge high water alarm sounded only in the unmanned engine room, and, consequently, the crew was unaware of the water ingress.

3. Because the ship had no consistent watchkeeping while at anchor, crew members did not detect the water ingress at an early stage.

4. The water rose to a level that rendered both bilge pumps inoperable.

3.2 Findings as to risk

1. If masters of fishing vessels do not ensure that a continuous watch is kept while the vessel is at anchor, there is a risk that the crew may not become aware of an unsafe situation.

2. If bilge high water alarms are installed in such a way that they sound only in unmanned spaces on a vessel, there is an increased risk that crews may not have an early warning of unsafe conditions.

3.3 Other findings

1. Neither life raft fully inflated; the most likely cause of the life raft chambers' failure to inflate was insufficient gas content in the corresponding cylinders.

2. Cylinder leak tests based on weight measurement or cylinder immersion for a limited time period, such as those practised at service stations or subcontractors' cylinder- and gas-service facilities, are ineffective in detecting slow leaks in gas cylinders.

3. The crew had taken safety training just before the fishing season, conducted by a marine emergencies consultant, after a recommendation by Transport Canada.

4. There was no record of training or familiarization as required under the *Marine Personnel Regulations*.

4.0 Safety action

4.1 Safety action taken

4.1.1 L.K.C *owner*

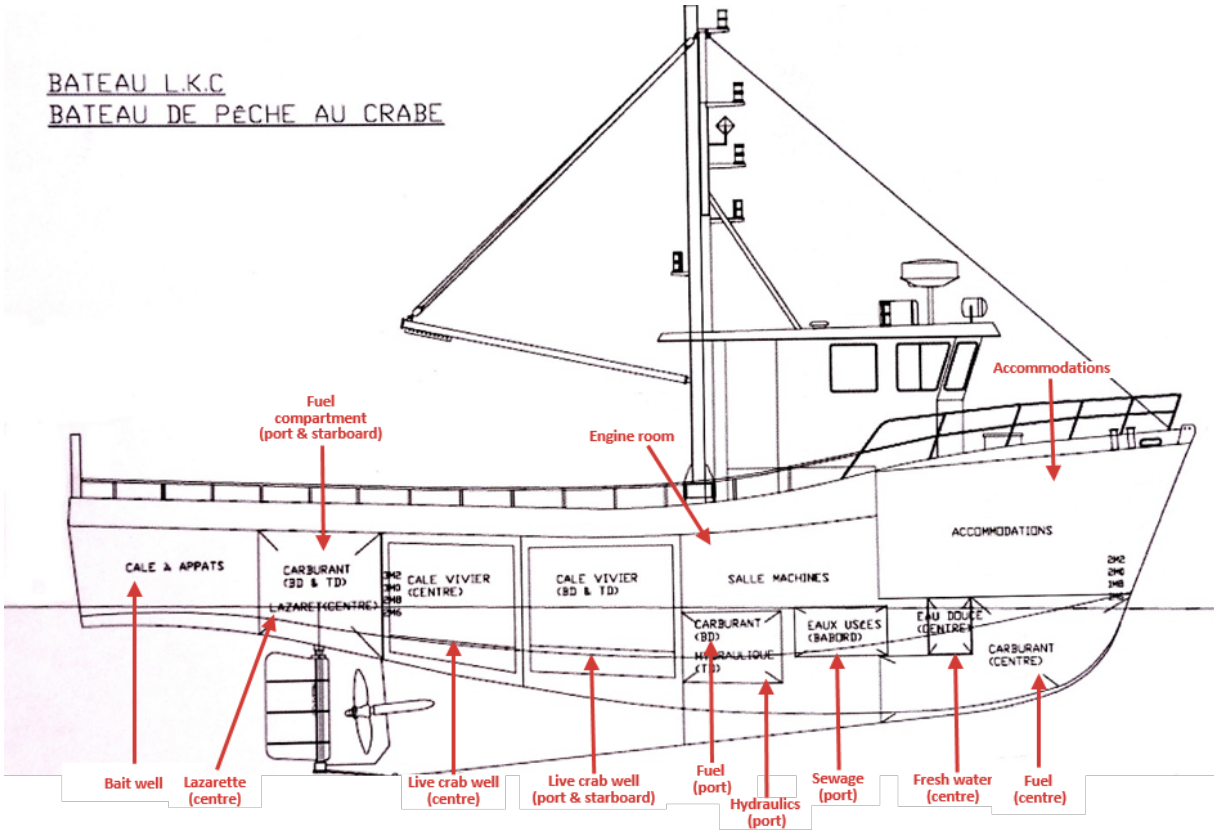
The owner of the *L.K.C* installed an additional sounding device that will sound in the wheelhouse when the bilge high water alarm is triggered.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 20 June 2018. It was officially released on 10 July 2018.

Visit the Transportation Safety Board of Canada's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the key safety issues that need to be addressed to make Canada's transportation system even safer. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.

Appendices

Appendix A – Profile of crab fishing vessel L.K.C



Source: Marinexpert Plus Inc., with TSB translations