Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

MARINE INVESTIGATION REPORT
M03M0077

FIRE AND SINKING

SMALL FISHING VESSEL *SILENT PROVIDER*
OFF PETIT-DE-GRAT, NOVA SCOTIA
25 JUNE 2003

Canada

Transportation Safety Board of Canada | Bureau de la sécurité des transports du Canada

Marine Investigation Report

Fire and Sinking

Small Fishing Vessel *Silent Provider* off Petit-de-Grat, Nova Scotia 25 June 2003

Report Number M03M0077

Synopsis

At about 1700 Atlantic daylight time, on 25 June 2003, the fishing vessel *Silent Provider* left Canso, Nova Scotia, in fair weather and visibility, and headed for Petit-de-Grat, Nova Scotia. Approximately one hour later, smoke was seen coming from the engine room doorway. The fixed halon fire smothering system in the engine room was discharged, but did not appear to bring the fire under control. The crew broadcast a Mayday, then deployed the rigid liferaft, an Ovatek 4, into the water.

After donning their immersion suits, the two-member crew entered the water and attempted to board the rigid liferaft. When the first crew member entered the liferaft, a significant amount of water was shipped inside, and the liferaft rolled onto its side. Concerned about his safety, the crew member exited the liferaft. After several unsuccessful attempts to board and stabilize the craft, the crew decided to remain in the water and use the rigid liferaft as a flotation device.

Approximately one hour after abandoning the *Silent Provider*, the two crew members, suffering from mild hypothermia, were rescued by the fishing vessel *Cape Ryan*. The *Silent Provider* later burned to the waterline and sank.

Ce rapport est également disponible en français.

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Figures

Photos

1.0 Factual Information

1.1 Particulars of the Vessel

	Silent Provider
Official Number	0808646
Port of Registry	Lunenburg, Nova Scotia
Flag	Canada
Type	Fishing vessel
Gross Tonnage[1]	72.68
Length	15.9 m
Draught[2]	Forward: 2.1 m Aft: 3.3 m
Crew	two (operator and one crew member)
Built	1987
Propulsion	Caterpillar diesel engine, 358 kW, driving a single fixed-pitch propeller
Owners	Private owner

1.1.1 Description of the Vessel

The *Silent Provider* was a mid-range stern trawler of closed, wooden construction. Built in 1987, it was used on the east coast of Canada to supply various fisheries. The vessel was powered by a marine diesel engine driving a single fixed-pitch propeller.

Photo 1. Fishing Vessel *Silent Provider*

1 Units of measurement in this report conform to International Maritime Organization (IMO) standards or, where there is no such standard, are expressed in the International System of units.

2 See Glossary at Appendix D for all abbreviations and acronyms.

1.2 *History of the Voyage*

On 25 June 2003, the fishing vessel *Silent Provider* left Canso, Nova Scotia,[3] at approximately 1700 Atlantic daylight time[4] and made way for Petit-de-Grat to undergo an underwater hull inspection by Transport Canada (TC).

Approximately one hour after leaving port, with the throttle at cruising speed (1400 rpm), the crew members heard an unusual noise from the engine room. They opened the engine room door to investigate, but dark black smoke was coming from below. They took the engine out of gear and worked the kill switch, but the engine speed did not slow. They then attempted to use a five-pound dry chemical fire extinguisher, but the now intense smoke precluded its use. They activated the vessel's halon fire suppression system and isolated the propane tanks (closed the valves to the appliances) from the galley. Shortly thereafter, one of the crew members opened the engine room door to check the effect of the halon only to find that the fire was well established. The fuel shut-off valves and the ventilation to the engine room were not closed.

During the next few minutes, the operator broadcast a Mayday on very high frequency (VHF) channel 16 while the other crew member collected and prepared the immersion suits. Smoke in the wheelhouse was now too thick to permit occupation, and both crew members retreated to the open after deck. They observed yellow smoke coming out of the engine exhaust and black smoke coming out of the engine room vents and access.

Both crew members climbed onto the wheelhouse top and launched the Ovatek 4 rigid liferaft into the water, which was approximately three metres below. When the rigid liferaft hit the water, the aft boarding hatch popped open, and the bailer fell out and was lost. The crew members then cut the painter, guided the liferaft aft, and made it fast to the fishing vessel. They donned their immersion suits, and the operator jumped into the water near the liferaft. He pulled the boarding ladder out and stood on it, grabbing the handle above the hatch to steady himself. As his weight transferred to the ladder, the aft portion of the liferaft tipped down and became partially submerged.[5] This caused the liferaft to take on a significant amount of water through the aft boarding hatch. The operator managed to dive inside, but as he did, the liferaft rolled on its side. Concerned for his safety, he exited the rigid liferaft by the forward hatch.

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[3] All locations are in Nova Scotia unless otherwise noted.

[4] All times are Atlantic daylight time (Coordinated Universal Time minus three hours).

[5] The operator and the crew member each weighed approximately 110 kg.

Meanwhile, the other crew member had also abandoned the burning fishing vessel. He entered the liferaft in a similar manner as the operator had, but the liferaft again rolled on its side and could not be stabilized. At one point, the operator tried to right the overturned liferaft by holding onto the water pockets,[6] but his leverage was reduced when the water pockets ripped. After several further unsuccessful attempts at boarding, the crew members mutually agreed to remain in the water and to hold onto the becketed grab lines on each side of the craft. They cut the painter to allow the rigid liferaft to drift away from the now dangerously burning vessel.

At 1927, approximately one hour after entering the water, the two crew members were rescued by the outbound fishing vessel *Cape Ryan*,[7] which returned to Canso where both crew members of the *Silent Provider* were transported to a hospital.

1.3 Weather

Seas were reported to be about 0.5 m with light winds. Water temperature taken from satellite telemetry was about 10°C. Visibility was reported to be approximately two nautical miles in a slight fog.

1.4 Injuries to Persons

Both crew members were treated for mild hypothermia.

1.5 Damage

1.5.1 Damage to the Vessel

The *Silent Provider* eventually burned to the waterline and sank. It was declared a total loss.

1.5.2 Damage to the Environment

There was no apparent damage to the environment.

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6 Water pockets are small bags attached to the bottom of a liferaft, which fill with seawater when the liferaft is deployed, providing stability to the liferaft during boarding or in a seaway.

7 The rescue took place at 45°27' north and 060°56' west. See Appendix A.

1.6 Certification

1.6.1 Vessel Certification

The *Silent Provider* was subject to quadrennial (every fourth year) TC inspections in accordance with the *Small Fishing Vessel Inspection Regulations*. A short-term inspection certificate was issued in April 1999, which expired in August 1999 pending an underwater inspection. The underwater inspection was carried out, and the inspection certificate (valid for voyages within the limits of home trade, Class II) was extended to expire in March 2003.

Before the inspection certificate was issued in 1999, work was carried out that included the examination, by a competent authority,[8] of the fixed halon fire-extinguishing system for the engine space. This system consisted of a 25-pound charge of halon 1301, a pull cord, a rate-of-rise heat detector, a pressure switch bell, piping, and related nozzles. The system pressure was gauged at 500 pounds per square inch (psi), and all was deemed satisfactory.[9] In addition, the existing diesel engine was replaced with a new Caterpillar diesel engine, model 3408.

In 1999, the vessel was equipped with both a four-person rigid liferaft (Ovatek 4, serial number 52), and a six-person inflatable liferaft. The vessel also carried four immersion suits. In April 2003, the inflatable liferaft was removed from the vessel as TC now allowed all small fishing vessels to carry one liferaft if immersion suits were also carried for all members of the crew.[10]

In February 2003, the fixed fire-extinguishing system was again inspected by the same competent authority in preparation for the upcoming TC quadrennial inspection. System pressure was 450 psi. It was noted by the competent authority that, if the pressure continued to drop, the system should be replaced because parts for this system are no longer available. In April, a short-term inspection certificate was issued again pending an underwater inspection. In May, all immersion suits were inspected by a competent authority. The rescue lights of all four suits were changed, and a minor repair to the left wrist seal of one suit was completed. In all other respects, the suits were declared satisfactory. The owner planned to have an underwater hull survey carried out in June in Petit-de-Grat to complete the inspection.

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8 A competent authority is a company engaged in the manufacture or testing of fire-extinguishing equipment as specified in the *Fire Detection and Extinguishing Equipment Regulations*.

9 Rated pressure of the system is 600 psi.

10 TC's Board of Steamship Inspection Decision 7424 dated August 2001, which is applicable to all fishing vessels exceeding 12.2 m in length, but not exceeding 24.4 m in length or a gross tonnage of 150.

1.6.2 *Crew Certification*

The operator held a fishing master, third-class certificate issued in April 2000. The other crew member held a fishing master, fourth-class certificate issued in June 1985. According to TC regulations, these certificates were appropriate for the vessel and voyages being undertaken.

1.7 *Personnel History*

1.7.1 *Marine Emergency Duties Training*

Both crew members had taken Marine Emergency Duties (MED) training: the operator in 2000 and the crew member in 1984. Neither crew member, however, had formal training in using a rigid liferaft because this subject is not included in the MED syllabus. Although certain training institutions have acquired Ovatek liferafts for their training as determined by client needs, this option was not available to the crew members of the *Silent Provider* at the time of their MED training.

1.7.2 *Ovatek Familiarization*

Each Ovatek liferaft is shipped with a user's manual and an instructional video that provide information on liferaft use and maintenance, including the proper boarding method and how to use included equipment. However, the appropriate procedure for righting a swamped and overturned Ovatek is not addressed in either the manual or the video.

The crews members' memories of viewing the training video varied from vague to no recollection. In the four years since purchasing the Ovatek, they had not put the liferaft in the water to practice boarding it.

1.8 *Liferaft Construction and Testing Standards*

Standards for constructing and testing liferafts are set out by the International Maritime Organization (IMO) in the International Convention for the Safety of Life at Sea, 1974 (SOLAS).[11] The Canadian standards, which closely follow the IMO standards, are defined in these references:

- TP 7321
- TP 11342
- TP 1324

[11] The SOLAS requirements are specified in the *International Life-Saving Appliances Code* and IMO Resolution A.689(17) as amended by resolutions MSC.54(66) and MSC.81(70), as well as circulars MSC/Circ.615 and MSC/Circ.809.

1.8.1 *Fabrics Used in Liferaft Construction*

Both the SOLAS and the Canadian standards prescribe minimum tear and tensile strength for the following textile components of a liferaft:

- buoyancy tubes, inflatable supports, and boarding ramps
- floors
- outer canopies
- inner canopies

All materials and components used in liferaft construction must resist deterioration due to the effects of weathering during stowage on board ship and due to exposure to seawater. In addition, textiles must be tested for tear and tensile strength, and records of these tests kept.[12] The strength requirements are summarized in the following chart.

Textile Component	Canadian Standards		SOLAS Standards	
	Tensile (newtons/50 mm)	Tear (newtons)	Tensile (newtons/50 mm)	Tear (newtons)
Buoyancy Tubes Inflatable Supports Boarding Ramps Floors	2400 (warp)[13] 2000 (weft)	1000 (warp) 900 (weft)	2255	1030
Outer Canopies	950	400	930	490
Inner Canopies	500	140	100	n/a

The standards do not include specific tensile or tear strength requirements for water pocket textiles.

A survey of some major inflatable liferaft manufacturers shows a variety of practices in use today for water pocket construction.[14] One manufacturer fabricates water pockets from the same material that is used in other parts of the liferaft. This material has a tensile strength of

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[12] One sample in every 10 rolls or 1000 m of textile is tested as per TP 1324, *Material Specification for Coated Fabrics Used in the Manufacture of Inflatable Liferafts*.

[13] Warp direction is lengthwise along the fabric roll; weft direction is perpendicular to warp.

[14] Three responses were received from a total of eight manufacturers surveyed.

1663 newtons (N)/50 mm. Two other major manufacturers use a textile that is specific to the water pockets, with maximum tensile strengths of 950 N/50 mm and 540 N/50 mm, respectively. All respondents confirmed that they use a quality control system to ensure that the material meets their in-house strength and tear specifications.

1.8.2 Water Pocket Specifications

The Canadian standards include specifications for size, shape, deployment, and distribution of water pockets for inflatable liferafts. Specifically, water pockets must have a capacity of at least 225 litres on liferafts for 10 or fewer people. There are no similar requirements for water pockets on rigid liferafts, nor were the Ovatek 4 water pockets assessed against the standard for inflatable liferafts.

1.8.3 Liferaft Testing

The Canadian standards require that a liferaft pass a number of operational tests before a certificate of type approval is granted. In TP 7321, there are three basic categories of tests:

- tests for all liferafts
- tests for inflatable liferafts
- tests for rigid liferafts

Because the Ovatek 4 holds fewer than six people, it was tested against the Canadian Coastal Liferaft Standard, TP 11342.[15] This standard has no provisions specifically for testing rigid liferafts, so certain tests for rigid liferafts taken from TP 7321 were also used when deemed necessary.

During the type approval process for the Ovatek 4 and the Ovatek 7, certain tests were either modified or waived if TC viewed them as inapplicable. The changes included

- the mooring out test;
- the swamp test (no waves were used to evaluate the seaworthiness of the liferafts when swamped);
- the jump test; and
- the floor strength test.

For details of these test requirements, see Appendix C.

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15 TP 7321 and SOLAS address only lifesaving appliances that carry six or more people.

1.9 Rigid Liferafts

1.9.1 Ovatek Liferafts

The Ovatek rigid liferaft is currently the only rigid liferaft of its kind known to be manufactured in the world. The factory is located in New Brunswick. Two models are currently in production: the Ovatek 4 and the Ovatek 7 (the number following the name indicates the carrying capacity of the liferaft). A six-person liferaft (called the Esperanto 6) was initially developed as the prototype, but is no longer in production. As of June 2003, approximately 230 Ovatek 4s and 275 Ovatek 7s had been sold primarily to fishers on the east coast of Canada. Approximately 60 units were sold outside Canada, mostly in the United States. Additionally, approximately 43 Esperanto 6s were sold.

The Ovatek liferafts are constructed with a double-layered fibreglass shell filled with approximately 38 mm of polyurethane foam, which provides inherent flotation and insulation. They are fitted with two hatches, one aft with an integrated ladder for boarding and one forward. The upper shell is fitted with air vents that can be screwed closed, and a becketed line is attached around the outside diameter. The Ovatek 4 is 2.06 m in length, weighing 115 kg and the Ovatek 7 is 2.83 m in length, weighing 182 kg. The centre of gravity is such that the Ovatek, even with the ballast retention devices empty, will self-right if the hatches are closed and there is no water within.

The Ovatek 7, because of its overall dimensions and capacity, is considered to be more suitable as a lifesaving appliance on board vessels of approximately 15 m or more in length. The Ovatek 4 is more appropriate on vessels as small as 12 m in length.

Both Ovateks are provided with the emergency equipment specified in the *Small Fishing Vessel Inspection Regulations*. In 2000, a de-watering hand pump was added to the emergency equipment package. Consequently, all Ovatek 4 units with serial numbers 79 and lower (the occurrence Ovatek 4 was serial number 52) and all Ovatek 7 units with serial numbers 84 and lower are not equipped with this pump.

The Ovatek 4 water pockets fill with seawater when the liferaft is launched. These bags are intended to stabilize the craft during boarding and when in a seaway (in open seas). When stowed, the bags sit under the liferaft in a shallow cavity within the stowage cradle. Although protected from sunlight, salt water can seep into the cavity and saturate the textile. The stowage cradle has drain holes, but salt crystals

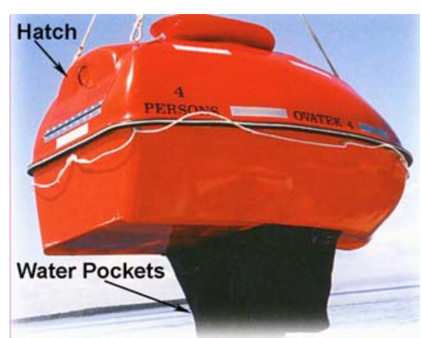

Photo 2. Ovatek 4

left from the evaporating water remain imbedded in the fabric. In contrast, the Ovatek 7 does not have water pockets. It has an internal ballast arrangement whereby seawater enters openings in the hollow fibreglass keel.

To launch an Ovatek 7, the liferaft is pivoted on the stowage cradle and pushed over the side bow first. The stowage cradle has an athwartships notch that accommodates the liferaft's keel and facilitates the launch procedure. To launch the flat-bottomed Ovatek 4, it must be lifted from its storage cradle and thrown overboard by two people to avoid damaging the underhanging water pockets.

Photo 3. Ovatek 7

Both Ovatek models were approved by TC in June 1998 for use on vessels that are subject to the *Small Fishing Vessel Inspection Regulations*, the *Large Fishing Vessel Inspection Regulations*, as well as the *Life Saving Equipment Regulations*.

1.9.2 Ovatek 4 Water Pocket Material

The manufacturer of the Ovatek liferafts has strict quality control measures for the in-house production of the fibreglass shell, and for the joining and assembly processes. The Ovatek 4 uses fabric in the external water pocket assembly. The water pockets are constructed off-site under a subcontract and are installed by the Ovatek manufacturer. The subcontractor uses a black nylon material that is procured through a wholesale textile dealer who sources the material from overseas markets.

Ovatek Inc. has not provided material strength specifications to the subcontractor, nor have batches of the material been tested at intervals for tear and tensile strength. At one point, the water pocket subcontractor changed the wholesale supplier of the nylon, but did not inform Ovatek Inc. The nylon from the second supplier was used for water pockets in units numbered 57 and higher. The Ovatek 4 used on board the *Silent Provider* was unit number 52; its water pockets were made of nylon provided by the first supplier.

Testing and analysis was conducted on the occurrence water pocket material, as well as on three other samples.[16] One of the three samples was supplied by Ovatek and is the material currently used in production. The other two samples were taken from Ovatek 4 liferafts that had been fitted on working fishing vessels. One sample was from a liferaft fitted two years ago and the other from a liferaft fitted four years ago. The occurrence sample from the *Silent Provider* liferaft was also fitted four years before the occurrence. All four samples were a plain weave, single-coated nylon.

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16 TSB Engineering Laboratory report LP 093/2003

The tests indicate that the nylon currently used in production, when new, has a tensile strength (warp direction) of 1094 N/50 mm. Because of its greater total fibre cross-sectional area, this nylon is significantly stronger than the nylon used in producing models 56 and earlier. The tests further indicate that all three samples of used material had experienced strength degradation in both the warp and weft directions. For example, the two-year-old sample showed an 11 per cent loss in tear strength (weft direction). Of the two four-year-old samples, the occurrence sample had a tear strength loss (weft direction) of approximately 25 per cent from the estimated original tear strength, and the other sample had a loss of 29 per cent.[17]

1.9.3 Occurrence Liferaft

Type approval tests included a satisfactory hose test, which ascertains the weathertight capability of the hatch. A post-occurrence examination of the Ovatek 4 used by the crew of the *Silent Provider* revealed that the rear hatch door would not latch firmly in place because one of the two latches did not catch at all, and the other one barely caught the lip of the hatch opening. Furthermore, the hatch door edge did not meet evenly with the lip of the hatch opening and did not compress the gasket to seal the opening. As a result, the hatch was not weathertight. Quality control documents for the liferaft do not indicate any problem at the time of manufacture.

The nylon water pockets had been severely damaged with multiple tears in the material. Although the crew of the *Silent Provider* reported that some damage to these bags occurred during efforts to stabilize and right the liferaft when trying to board, some additional damage may have been incurred during the salvage and recovery of the liferaft. It was not possible to quantify the extent of the damage incurred solely during the boarding attempts.

1.10 Post-Occurrence Testing

1.10.1 Transportation Safety Board of Canada Performance Tests

To evaluate the influence of various factors on the boarding and stability parameters of the Ovatek 4 and Ovatek 7, the TSB conducted several calm water pool tests in fall 2003. A person of similar mass as the two crew members (approximately 110 kg) and wearing an immersion suit attempted entries into the liferaft. Tests were carried out to compare the performance of the liferafts with and without water pockets, and when swamped versus when dry inside. Entry was attempted both head first and feet first. Righting tests were also performed on both models.

Entry tests showed that the feet-first method did not result in successful entry. Therefore, all other tests were conducted with the boarder entering the liferaft according to the manufacturer’s instructions, that is, by entering head first.

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17 No unused samples of nylon from the first supplier were available; calculations based on total fibre cross-sectional area were used to estimate the original strength.

The first boarder attempting entry into the Ovatek 4 experienced similar difficulties as those encountered by the crew of the *Silent Provider*. The liferaft trimmed by the stern and took on a significant amount of water. Once water had been shipped inside, entry was greatly hindered as the liferaft heeled over significantly during each attempt. Entry by a person of 75 kg produced a significant trim but not enough to result in water being taken on. Once the first boarder had entered the Ovatek 4, the second boarder was able to enter the liferaft without difficulty.

The Ovatek 7 trimmed less by the stern during boarding than did the Ovatek 4 and did not take on any water during the process. When the liferaft was swamped (intentionally, for the sake of the tests), the craft's rolling motion increased, but the boarding attempt was successful.

There was no discernable difference in the degree of trim during boarding for an Ovatek 4 without water pockets as compared to one with water pockets. On the other hand, the rolling motion of a fully loaded Ovatek 4 with water pockets appeared to be dampened significantly as compared to one without water pockets.

A dry Ovatek 4 with the hatches closed is self-righting, and righting an overturned Ovatek 4 with the hatches open (in the swamped condition) was easily accomplished. However, given that the liferaft is not equipped with a righting line, the user had a tendency to grab the external water pockets for leverage to right the liferaft. A dry Ovatek 7 with the hatches closed is also self-righting. However, when swamped, with the hatches either open or closed, it could not be righted by people in the water. A summary of all test results can be found in Appendix B.

1.10.2 Transport Canada Performance Tests

In March 2004, TC conducted pool tests with both the Ovatek 4 and Ovatek 7 models. Tests similar to the initial type approval tests were carried out, and the liferafts performed according to the standard. In addition to the type approval tests, Ovatek personnel demonstrated during tests to right a swamped liferaft that a swamped and listing liferaft could be de-watered and, thereby, righted by entering the unit, closing the hatches, and using the hand pump to evacuate the water through the air vent located on the top of the liferaft. Ovatek personnel also demonstrated that a swamped Ovatek 4 that was equipped with a righting strap could be righted without using the water pockets for leverage. The occurrence liferaft had neither a hand pump nor a righting strap.

Other boarding tests compared the performance of an Ovatek 4 and a six-person inflatable liferaft in waves of 0.5 m in amplitude.[18] The heaviest boarder weighed approximately 92 kg. When the liferafts were dry inside, both models performed well, with no water being taken

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18 Tests were undertaken at the Offshore Engineering Basin of the Institute for Ocean Technology, in St. John's, Newfoundland and Labrador.

aboard during boarding. With free surface present,[19] the inflatable liferaft was stable during boarding in calm waters, while the Ovatek 4 was not.

[19] "Free surface" refers to water that is moving freely within a liferaft. This may affect the liferaft's stability.

2.0 Analysis

In Canada, the fishing industry has a higher rate of accidents resulting in fatalities and vessel loss or abandonment than any other sector of the marine industry. A number of previous investigations have focussed on fires aboard ship and the inadequate tactics used by fishers to fight those fires.[20]

Given the reality that seafarers may have to abandon their vessels, it is crucial that on-board lifesaving equipment perform its designed function effectively. The Board continues to be concerned about fishing vessel safety including the carriage requirements for and performance of lifesaving equipment, and emergency preparedness. The analysis of this occurrence is presented within the framework of firefighting and survival-related issues.

2.1 Firefighting

Although not required by the *Small Fishing Vessel Inspection Regulations*, many fishing vessels such as the *Silent Provider* are equipped with a fixed fire-extinguishing system (such as the halon system). When properly used, such systems are highly effective in extinguishing a fire.

Engine room fires are extremely volatile, with high heat and combustible materials such as hydraulic fluid and fuel in abundance. Procedures for fighting such a fire call for all openings to the space to be closed before discharging the extinguishing agent and then keeping the space battened down. Any breach in this procedure will allow the extinguishing agent to escape and oxygen to enter the space, resulting in insufficient time to extinguish the fire. In addition, the main engine must be shut down, and the fuel supply cut off. Experience has shown that, if this is not done, some of the extinguishing agent will be "consumed" by the internal combustion engine and expelled up the exhaust pipe.[21] This appears to have been the case in this incident.

The sinking of the *Silent Provider* precluded examining the vessel to determine the cause of the fire. However, it is known that, although the engine kill switch was activated, the main engine did not shut down. Furthermore, because the engine room openings were not all closed and the fuel supply was not shut off, the efficiency of the halon system to extinguish the fire was compromised, and some of the carbon monoxide generated by the fire escaped. With the ventilation open and the main engine still running, the fire spread quickly.

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[20] TSB reports M93M0005, M94M0050, and M01N0061

[21] A mixture of halon and internal combustion gases could account for the yellow smoke seen exiting the engine exhaust.

Fires on fishing vessels have long been identified as high risk incidents. After the fires on the *Judith Suzanne* (1993) and the *Rali II* (1994), the Board expressed concern about the extent to which engine room fires continue to cause significant losses in the Canadian fishing fleet.[22] Ship Safety Bulletin (SSB) number 13/96 issued by TC stressed the need to improve fishers' knowledge about and skill in firefighting on fishing vessels. An earlier SSB (6/95) drew attention to the importance of MED training. Notwithstanding the extent to which basic MED training addresses the principles of firefighting, past occurrence investigations have revealed that the actions taken by fishers during an emergency may not bring engine room fires under control.

Fishers lack knowledge and understanding of the proper use of fixed fire-extinguishing systems. Consequently, the benefits of such systems in fighting engine room fires may not be fully realized. Until such time as these shortcomings are fully addressed, whether by training or education, inadequate firefighting tactics on fishing vessels may continue to put crews and vessels at risk.

2.2 Rigid Liferafts

2.2.1 Use and Training

Although both crew members of the *Silent Provider* had undergone MED training, because the syllabus did not include procedures for using rigid liferafts, they were not formally trained in their use. Although the manufacturer supplies written instructions with each unit sold, the instructions do not stress the importance of the first boarder entering head first with weight kept low and close to the stern of the liferaft, nor is this information displayed at the liferaft hatch. However, a very informative instructional video is supplied with each unit and it shows the proper head-first boarding technique.

Although the Ovatek 4 had been fitted on the vessel some four years before the occurrence, the crew members had never put it in the water nor attempted waterborne entry. If they had deployed the liferaft during exercises, they would have had a better understanding of the special considerations needed during entry.

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22 TSB reports M93M0005 and M94M0020

During pool tests, it was discovered that, once swamped, the Ovatek 7 assumed a near 90-degree list. Even if the hatches were closed, the liferaft could not be righted by two people in the water. The manufacturer explained that, under these conditions, the liferaft must be entered, the hatches closed, and the liferaft de-watered using the hand pump to discharge water through the air vent. Once de-watered, it will return to the upright position. However, information and guidance about what to do when the liferaft is swamped are not contained in the training video or in the user's manual for either Ovatek model.

Photo 4. Swamped Ovatek 7 on its side during TSB pool tests

The two crew members were unaware of the procedure to de-water and right their liferaft. Unfamiliarity with essential lifesaving equipment can render the equipment less effective, as was shown in this occurrence.

2.2.2 *Inflatable and Rigid Liferafts: Strengths and Weaknesses*

Following abandonment of a vessel, inflatable liferafts have been found empty and overturned. "To enhance stability and to limit drift, the SOLAS liferaft is fitted with stabilizing pockets [water pockets] which deploy below the buoyancy tubes, and a sea anchor. The sea anchor is the primary means of stabilization after the liferaft has been launched, but research conducted . . . indicates that the stability of liferafts in breaking waves is a problem."[23]

The final report on the loss of the passenger/car ferry *Estonia*, which resulted in over 850 fatalities, calls the inflatable liferafts useful, but notes that they exhibit some serious deficiencies in heavy seas such as those experienced the night of the *Estonia* occurrence.[24] The deficiencies noted included the following:[25]

- Many liferafts did not fully inflate.
- Many liferafts capsized because of the wind pressure and drifted upside down.

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23 R.B. Paterson and C.A. Sullivan, Fleet Technology Limited, *The Development of an Easily Recovered Liferaft*, TP 13041, 1997.

24 Significant wave height was approximately four metres.

25 Joint Accident Investigation Commission of Estonia, Finland, and Sweden, *Final Report on the Capsizing on 28 September 1994 in the Baltic Sea of the Ro-Ro Passenger Vessel MV Estonia*, Government of the Republic of Estonia, December 1997.

- Some of the upside down, drifting liferafts were later righted by the waves. When this happened, however, those who were on the liferafts were again thrown into the sea and had great difficulties climbing back in.

- The canopies of the liferafts did not raise automatically, and the openings could not be closed properly.

- Much water accumulated on the bottom of the liferafts. In the worst case reported, there was 20 cm of water on the bottom of a liferaft. The bail scoops were so small that they were ineffective, and many survivors used their shoes to bale.

- The rope ladder went underneath the liferafts, swinging the feet of those who were trying to climb on, thus affording practically no help.

- The operating head was not properly tightened to the CO_2 pressure cylinder in many liferafts found after the accident. This may be why many liferafts were not fully inflated.

Notwithstanding the safety benefits of an inflatable liferaft, there are weaknesses evident with this type of lifesaving appliance.

- They are vulnerable to heat and flame. During a fire on board the fishing vessel *Jakejewe*, the crew attempted to abandon into an inflatable liferaft, but once deployed into the sea, it caught fire as well. When they were rescued, one crew member was clinging to a fishing buoy and the other two crew members were clinging to the deflated remains of the liferaft. One of these two subsequently died as a result of hypothermia.[26]

- There is an uncertainty factor associated with this type of liferaft. Although they are inspected and repacked every year (or in some cases, every two years) by accredited service depots, the crew cannot ascertain for themselves that the liferaft is operational until it is time to use it—which is too late if the liferaft does not function as designed.

- It is impractical for crews to practice deploying an inflatable liferaft. There are barriers to self-directed training with this type of equipment: having been deployed for training, they may then be unavailable if they must be repacked by an accredited facility, making training expensive and troublesome.

[26] TSB report No. M03M0072

- They can be damaged during transport. "The process of removing the liferaft and its container from a vessel and transporting it to the service station and back often accounts for most of the damage to the container and the liferaft itself. Mishandling the container may cause it to crack internally, and the splinters from these cracks could cause damage to the liferaft."[27]

By comparison, a rigid liferaft has strengths in most of these areas. The Ovateks' fire-retardant laminate is resistant to heat and flames. Owners can readily self-inspect the entire liferaft internally and externally. No inflation is required, so problems associated with this process are avoided. The boarding ladder is rigid and easily accessible, giving boarders more stability.

In addition, a rigid liferaft may be used as a "safe haven" during an emergency.[28] This is a unique option that may reduce the riskiest aspect of abandoning a small vessel—entering the water, then boarding the liferaft. Not only must personnel become waterborne, they must attempt to marshal and control the liferaft, often under less-than-ideal conditions. Furthermore, waterborne personnel are exposed to additional risks associated with a hostile environment including hypothermic conditions. The "safe haven" approach keeps personnel from exposure to these risks.

2.2.3 Rigid Liferaft Design Considerations

2.2.3.1 Trim While Boarding and Free Surface Effect: Ovatek 4

The boarding tests conducted by the TSB revealed no discernable difference in trim while boarding either with or without water pockets fitted to the Ovatek 4. The water pockets will only exert a significant restoring moment if lifted out of the water. The fact that the water pockets on the Ovatek 4 are located near midships and close to the longitudinal pivot point decreases their ability to reduce the trim of the liferaft while boarding (see Photo 5). When the first boarder is heavy, trimming

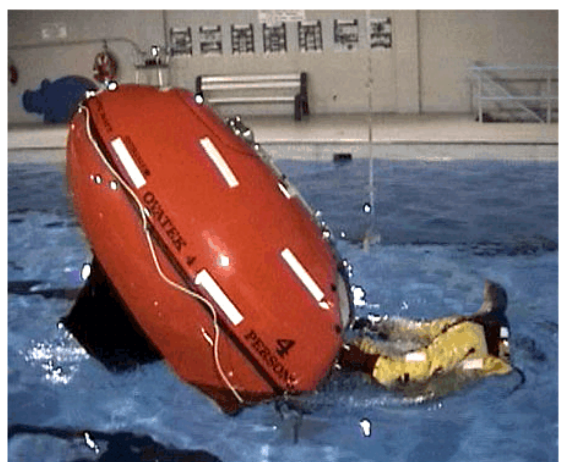

Photo 5. Ovatek 4: trim while boarding during TSB pool tests

27 B. Gebreab, J.A. Gin, and M. Stewart, MGI International Marine Safety Solutions Inc., *Development of a SOLAS Liferaft*, Transport Canada Report No. TP 11672E, 1993.

28 This was successfully done in spring 2003 by the crew of the fishing vessel *Caboteur* in the Gulf of St. Lawrence . All six crew members boarded the Ovatek 7 on the deck and were later rescued when their vessel sank beneath the liferaft.

is sufficient to allow water to enter the craft. The resulting free surface effect reduces stability. While the seven-person model could be boarded even when free surface was present, the Ovatek 4 was unstable with free surface present.

When boarding an Ovatek, it is crucial that the first person keep low and enter head first. If at all possible, other waterborne personnel must help stabilize the liferaft as the first person boards. Although this is emphasized in the manufacturer's training video that is shipped with each new Ovatek, a second person may not always be available to help stabilize the liferaft during boarding. Additionally, there is no assurance that the liferaft will remain dry before the first boarder enters. Waves striking the open hatch or the weight of a large person on the boarding ladder may allow sufficient water to be shipped inside to dramatically reduce stability while boarding.

Since an Ovatek has sufficient inherent buoyancy to remain afloat when completely flooded, any water that is shipped inside during boarding cannot sink the liferaft. However, the events of this occurrence and the results of the TSB pool tests demonstrated that the liferaft's instability under these conditions prompted personnel to abandon their attempts to board the liferaft and instead remain outside in the water. As the Ovatek 4 could not be boarded safely, it exposed the crew to undue risk.

2.2.3.2 Water Pocket Fabric

The liferaft standards do not address the minimum strength of water pocket fabric. Furthermore, the Ovatek manufacturer neither conducts in-house fabric tests nor requires test results and strength specifications from the nylon supplier. Experiments conducted by the TSB indicate that the nylon currently in use is, in fact, stronger than the nylon previously used. However, the tensile strength of the current nylon when new (1094 N/50 mm) is less than half of the tensile strength required by the liferaft standards for the floor and buoyancy tube fabric of inflatable liferafts. It should be noted that the tensile strength of the water pocket fabric used by some inflatable liferaft manufacturers is even less than that of the fabric used in the Ovatek 4. However, because the stowage shell protects the water pockets when the liferaft is not inflated, they are not subject to the same environmental exposure as the water pockets on the Ovatek. Tensile and tear strength degradation over time are likely to be significantly less for inflatable liferafts than for the exposed Ovatek.

Examination of fabric samples taken from Ovateks that had been in service showed no indication of pre-existing mechanical damage or wear, degradation due to sunlight exposure, or chemical attack.[29] However, all used specimens showed degradation in strength over time (refer to Figure 1). By virtue of their external stowage position, the water pockets are vulnerable to the effects of environmental weathering and to the risk of mechanical damage during deployment

29 TSB Engineering Laboratory report LP 093/2003

or use. With no minimum strength standard for construction, and no replacement policy or inspection guidelines to ensure their continued integrity, the probability of damage will significantly increase over time.

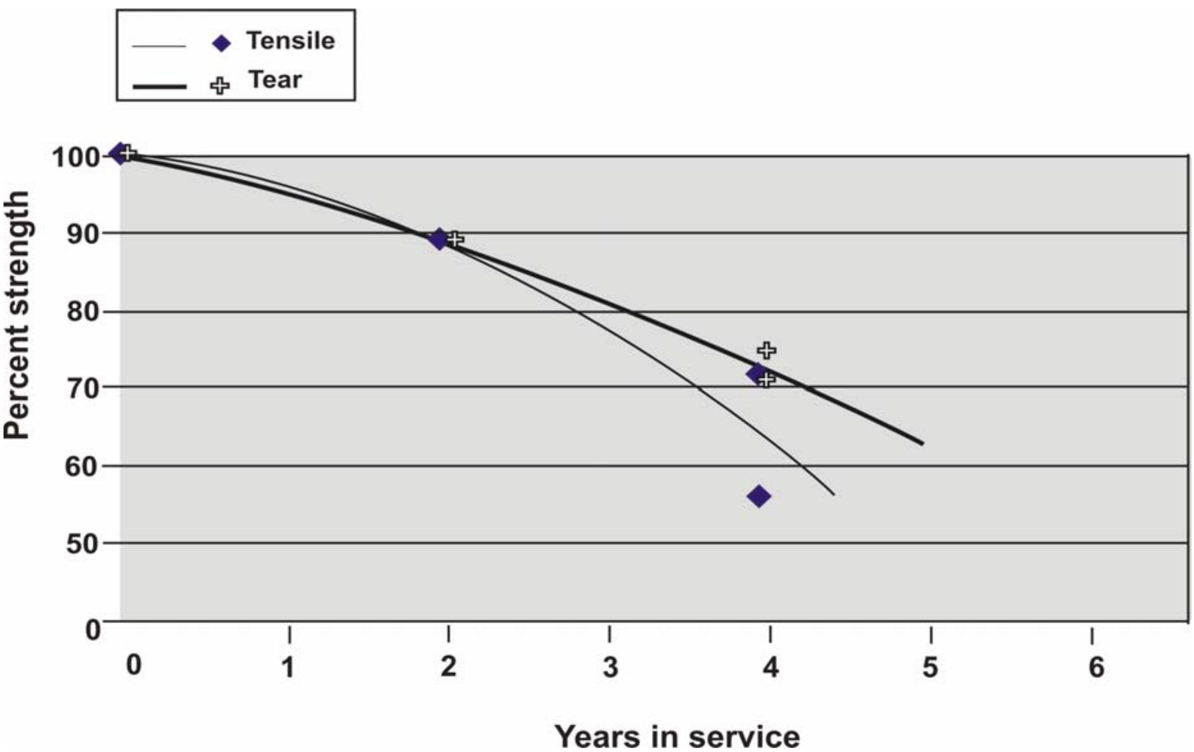

Figure 1. Graph showing nylon strength degradation (weft direction) over time

2.3 *Liferaft Testing Standard*

The mass of each crew member of the *Silent Provider* was approximately 110 kg. When the crew members tried to board the Ovatek 4, the stern of the liferaft submerged, allowing a substantial amount of water to enter through the aft hatch. Consequently, the liferaft lost transverse stability, which precluded normal boarding. In tests conducted after the occurrence, the Ovatek 7 also exhibited performance shortcomings; it could not be righted from the exterior when overturned and swamped. Notwithstanding these performance shortcomings, both the Ovatek 4 and Ovatek 7 had been successfully type approval-tested against the standard for new liferafts.

Standards exist as a matter of pragmatic commercial and social necessity.[30] Often, the driving force behind changing a standard dramatically is a major accident or a disaster. For example, SOLAS was established after the *Titanic* sank. However, standards can also change incrementally through influences such as trend analysis, social changes, and changes in risk acceptance or perception, among others. In 1997, the IMO recognized the desirability of a reasoned approach to standard/regulation development when it adopted the Formal Safety Assessment (FSA) methodology. "The FSA is described as a rational and systematic process for assessing the risks associated with any sphere of activity, and for evaluating the costs and benefits of different options for reducing those risks. It, therefore, enables an objective assessment to be made of the need for, and content of, safety regulations."[31] Without such a risk assessment process, standards will be more prone to dramatic change following a disaster than to incremental change by way of analysis. It is also conceivable that new devices may pass the required tests, yet remain less than adequate because of new, unevaluated risks.

Stability, boarding, righting, and being swamped are all elements that are considered in the liferaft standards, be they Canadian (TP 7321, TP 11342) or international. Although the Ovateks passed all the tests required by TC, these tests were not an adequate measure of the liferafts' performance in real-world conditions. Some of the shortcomings of the present standard, as demonstrated by the events of this occurrence, are discussed in the following sections.

2.3.1 *Stability and Boarding*

A liferaft, whether inflatable or rigid, is most vulnerable and least stable during entry by the first or lone boarder. Once the first boarder has entered, that mass can be used to counteract the trim and/or heeling moment induced by subsequent boarders. Before or during boarding, there is a high probability that a liferaft will take on water. Therefore, it is reasonable to expect that the liferaft standard should evaluate performance with a free surface present. The likelihood that waves will be present during boarding is also high; however, the standard does not require testing in waves to assess stability.

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30 T. Schoechle, *Toward a Theory of Standards*, SIIT 1999 Proceedings: 1st IEEE (Institute of Electrical and Electronics Engineers) Conference on Standardization and Innovation in Information Technology, Aachen, Germany, September 1999.

31 International Maritime Organization, *Maritime Safety Committee 68th Session*, 28 May to 06 June 1997, Formal Safety Assessment guidelines adopted, www.imo.org/newsroom/mainframe.asp?topic_id=110&doc_id=345 (accessed 14 June 2005).

2.3.2 *Mass of Occupants*

Statistics indicate that the average mass of Canadian males 20 years of age and over is 81.5 kg.[32] Statistics from the United States are similar. However, the performance and capacity tests required by the liferaft standard are based on a mass of 75 kg per person. Considering the likelihood that the majority of Canadian fishers weigh at least the average for Canadian adult males, there is a strong probability that the margin of safety provided by the liferaft standard may not be adequate.

2.3.3 *Righting Test*

Although the righting test for inflatable liferafts requires that the canopy be filled with water before the righting attempt (essentially the swamped condition), the righting test for rigid liferafts is done with the hatches closed and without water inside. Given that the opportunity exists for a rigid liferaft to be swamped as soon as the hatch is opened for entry, it is reasonable to expect that the liferaft standard should evaluate performance with a free surface present.

2.3.4 *Water Pocket Material Specifications*

Standards have been set for all elements of liferaft construction except water pockets, for which there are no minimum strength and sample testing requirements. Consequently, the performance of water pockets cannot be reasonably assured. Furthermore, as a result of their exposure in the stowed position, the Ovatek water pockets are vulnerable to strength degradation due to weathering. Testing by the TSB has indicated that the conditions of the mooring out test are not a sufficient evaluation of strength degradation and resistance to weathering over several years.[33]

For a liferaft to meet its desired objective, it must demonstrate an acceptable level of performance based on a reasonable expectation of use, size, and mass of users, as well as wave and weather conditions. The present liferaft standard does not reflect these expectations.

2.4 *Cold Water Survival*

Unable to stabilize or easily board the liferaft, both crew members decided to hang on to the outside, thereby remaining in the water for approximately one hour before rescue. Their immersion suits were their sole protection against the 10°C water temperature.

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32 Statistics Canada, *Canadian Community Health Survey 2000/2001.*

33 TSB Engineering Laboratory report LP 093/2003 reported that testing found that, after a 40-day exposure to seawater, the tear and tensile strength of the nylon did not diminish.

Since their introduction to the marine industry, immersion suits have proven to be an efficient and reliable way to increase survival time in the water. The TSB has recorded a number of instances where immersion suits, which provide a measure of protection against hypothermia, have saved lives.

- In December 1990, a crew member of a fishing vessel was rescued after seven hours in cold water.
- In January 1993, a crew member of a fishing vessel was recovered after approximately five hours in the frigid sea.
- In February 1995, a crew member of a fishing vessel was rescued after over two hours in cold water.
- In December 2001, a four-person crew had only two immersion suits. Both crew members wearing the immersion suits survived, while only one of the other two crew members survived.

Lacking immersion suits, or using them incorrectly, increases the risk of perishing from hypothermia. In this occurrence, both crew members had immersion suits and used them. The immersion suits provided a measure of protection from hypothermia.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. The sinking of the *Silent Provider* precluded examining the vessel to determine the cause of the fire.

2. The engine could not be stopped by the kill switch, nor was the ventilation to the engine room closed off before activating the halon fire-extinguishing system. The running engine consumed and expelled some halon, and oxygen was allowed to freely enter the engine room space, causing the fire to intensify.

3.2 Findings as to Risk

1. Notwithstanding the extent to which basic Marine Emergency Duties (MED) training addresses firefighting principles, inadequate firefighting tactics employed by fishers during an emergency places crews and vessels at risk.

2. The nylon water pockets of the Ovatek 4 are vulnerable to mechanical damage during launch, to environmental weathering, and to strength degradation over time; however, no replacement policy or inspection guidance is in place to ensure their integrity.

3. Information and guidance about the appropriate actions to take to right an Ovatek once it becomes swamped are not contained in the training video or the user's manual.

4. The shortcomings of the Canadian and international liferaft testing standards jeopardize the survivability of seafarers following abandonment of their vessels. Of specific concern are
   - the stability and boarding requirements;
   - the average body mass of 75 kg for occupants;
   - the righting test; and
   - the lack of specifications for the tensile and tear strength of water pocket fabric.

5. Water shipped through the liferaft's aft hatch and retained on its floor adversely affected the stability of the Ovatek, thus hindering the crew's attempts to stabilize or otherwise use the liferaft as it was intended to be used.

6. Rigid liferaft training is not included in the MED syllabus, nor did the crew take steps to familiarize themselves with the characteristics of the rigid liferaft. Unfamiliarity with essential lifesaving equipment can render such equipment less effective.

7. Many early units of the Ovatek 4 and Ovatek 7 are not equipped with a de-watering hand pump. Without a de-watering hand pump, personnel are unable to follow the manufacturer's recommended de-watering procedure, thus exposing them to undue risk.

3.3 Other Findings

1. The closing mechanism of the aft hatch was defective, compromising the weathertight integrity of the liferaft.

2. The use of immersion suits provided a measure of protection from hypothermia.

4.0 Safety Action

4.1 Action Taken

4.1.1 Transportation Safety Board of Canada

On 22 September 2003, the Transportation Safety Board of Canada (TSB) issued Marine Safety Advisory (MSA) 04/03 to Transport Canada (TC), advising of safety deficiencies related to the performance of the Ovatek 4 liferaft, in particular:

- the spring-loaded latches on the rear hatch did not fully engage;
- the rear hatch could not be sealed weathertight because the shape of the hatch did not follow closely the shape of the hull;
- the external water pockets are vulnerable to
  - damage during use, and
  - weathering of the material that affects strength and resistance to tearing; and
- stability appears to be compromised once water has been shipped and retained on the floor of the liferaft.

Also, on 22 September 2003, the TSB sent MSA 06/03 to TC, advising of deficiencies in the training for use of rigid liferafts. In particular, although there are similarities between the waterborne entry procedures for inflatable liferafts and rigid liferafts (Ovateks), there are some noteworthy differences. Although TC accepted the Ovatek rigid liferaft as an alternative to inflatable models, training for this type of liferaft is not included in the Marine Emergency Duties (MED) syllabus.

In addition, Marine Safety Information (MSI) letter 09/03 was also sent to TC on 22 September 2003. The letter informed TC of the Board's continued concern about the inadequate firefighting tactics being used on fishing vessels. In general, fishers do not appear to have incorporated the proper use of fixed fire-extinguishing systems into their occupational routines. As a result, vessel losses and fatalities continue to occur because of engine room fires, even on vessels equipped with fixed fire-extinguishing systems.

On 13 November 2003, TSB representatives met with TC Construction and Equipment Standards personnel to brief them about observations made during the pool tests conducted on 23 September and 15 October. The Board expressed concerns about perceived shortcomings in the Canadian and international liferaft testing standards, as well as about the Ovatek testing program. At this time, the Board delivered MSA 07/03, which formalizes the safety communication described in the briefing. All safety communications concerning Ovatek liferafts were also copied to Ovatek Inc.

4.1.2 Transport Canada

On 29 July 2003, TC informed the United States Coast Guard of the possible problems with the Ovatek 4 and of its intention to add a condition to the certificate of approval. This condition states that the liferaft is to be inspected at the same interval as the vessel on which it is installed.

On 29 October 2003, TC responded to MSA 04/03 with information that TC inspectors had visited the Ovatek production facilities and were satisfied that remedial measures had been put in place to address the issue of apparent weathering and the risk of damage to the exterior water pockets of the Ovatek 4 model. Further to this, TC advised that the manufacturer has developed a new ballast system for the Ovatek 4 that is similar to the Ovatek 7 system, which does not have a ballast bag. The new system will undergo type tests before approval.

Also on 29 October 2003, in response to MSA 06/03, TC advised the TSB that both TP 4957, *Marine Emergency Duties Training Program*, and the MED A3/A4 syllabus would be amended to include special training for boarding a rigid liferaft. In a later communication, TC indicated that it will amend the appropriate MED syllabuses for training fishers to address the findings as to risk outlined in this report.

On 24 November 2003, TC met with Ovatek representatives to discuss the issues raised by the TSB in its safety communications and to arrange for further pool tests.

On 29 and 30 March 2004, TC conducted tests of both the Ovatek 4 and Ovatek 7 to verify type approval status and to evaluate minor changes that were made in both liferaft models to address issues described in TSB safety communications (refer to section 4.1.3). Testing confirmed that the liferaft performed according to the present standard. Testing was also done in a wave environment to assess the liferaft performance during boarding. This test is above and beyond the requirements of the present standard. Personnel from the TSB attended the testing as observers.

TC is currently participating in two separate studies, whose preliminary data suggest that:

- a standard mass of 75 kg is insufficient for type testing, and
- more detailed anthropometric data are required to define type test subjects.

Results of both studies were presented for consideration to the 48th session of the Design and Equipment Subcommittee (IMO) held in February 2005. TC will seek amendments to the SOLAS testing protocol that will more accurately define test subjects.

4.1.3 Ovatek Inc.

Ovatek Inc. is attempting to inform owners of the Ovatek units of the possible aft hatch weathertightness issue. Ovatek personnel also visited approximately 50 existing installations, verifying the overall condition of the liferafts.

In addition, Ovatek has undertaken various research and development activities during the winter of 2003-2004. A number of changes have been made or are under consideration.

- The bailer is now secured in place when an Ovatek liferaft is shipped.
- Several steps were taken to address the aft hatch weathertightness issue, including increasing the latch penetration and imposing tighter quality control during fabrication.
- A warning is now posted at the sill of the boarding hatch to remind users to enter head first.
- Pending approval by TC, boarding will be further aided by the addition of a strap handle attached to the inside bottom of the Ovatek 4 and Ovatek 7.
- Pending approval by TC, righting an Ovatek 4 will be further aided by the addition of a righting strap.
- A new video and written instructions will be produced to be shipped with each new unit sold. The new video and written instructions will include information about de-watering a swamped Ovatek, righting, and head-first entry.
- Prototype assessment is ongoing to replace the textile water pocket arrangement on the Ovatek 4 with an integrated fibreglass system similar to that of the Ovatek 7.

4.2 Action Required

4.2.1 Ovatek Rigid Liferafts

As mentioned in this report, the Ovatek rigid liferaft has strengths in most of the areas in which inflatable liferafts are weak. The Ovatek liferafts

- are resistant to heat and flames by virtue of their fire-retardant laminate;
- are virtually unsinkable and serve as a buoyant device;
- can readily be self-inspected by owners;
- can readily be used in practice exercises at no cost and little effort;
- require no inflation, thus avoiding inflation-related problems; and
- may be used as a “safe haven” during an emergency (other than fire).

A rigid liferaft made of fibreglass, such as the Ovatek, is inherently more robust than an inflatable rubber-coated textile liferaft. However, several shortcomings with this make of rigid liferaft have been identified during the investigation and remain unresolved.

- The nylon water pockets of an Ovatek 4 are vulnerable to mechanical damage during launch and to environmental weathering, which affects the tear strength of the material.

- The nylon water pockets are subject to degradation over time, and there is no replacement policy or inspection guidance in place to ensure that the integrity of the water pockets is maintained.

- Water shipped through the liferaft's aft hatch and retained on its floor adversely affects the stability of the Ovatek 4, thus hindering attempts to use the liferaft as intended. Although it is virtually unsinkable, the limited information supplied with the product and the lack of training with this equipment when free surface effect is present can place crews at risk.

- Early units of the Ovatek 4 and Ovatek 7 are not equipped with de-watering hand pumps. Personnel using these units are unable to follow the manufacturer's new recommended de-watering procedure for a swamped unit. Furthermore, owners of these units are unaware of the procedure for de-watering their liferaft since the original videos and instruction manuals do not contain this information.

Subsequent to the investigation and in response to some of the safety deficiencies highlighted, Ovatek Inc. has taken positive action about the bailer and the aft hatch weathertightness issue. Ovatek Inc. is awaiting TC approval to include an interior boarding handle that will greatly assist crew in entering the liferaft. The manufacturer is also considering replacing the nylon water pocket arrangement with a permanent fibreglass ballast arrangement similar to that of the Ovatek 7.

Notwithstanding the improvements already made by the manufacturer or those pending, certain issues related to safety remain unaddressed. The Board is concerned that, without the safety information about de-watering and righting a swamped Ovatek, without the proper equipment such as the de-watering hand pump (for owners who purchased Ovateks before this pump became standard issue), and without adequate experience using these liferafts in the swamped condition, owners of Ovatek liferafts will be at greater risk than they need to be if confronted with the necessity to use this equipment. Therefore, the Board recommends that:

> The Department of Transport, in conjunction with the manufacturer, ensure that all present and future owners of Ovatek liferafts receive information that will allow users to properly de-water and right a swamped liferaft and encourage all users to practice these procedures.

M05-02

4.2.2 *Standards for Testing Rigid and Inflatable Liferafts*

Liferafts are often used under environmental conditions that are substantially more challenging than calm water pool testing. The investigation revealed that, although the rigid liferaft passed individual tests related to stability, swamped condition, boarding, and righting, when used under realistic conditions, the liferaft did not function as expected. When the liferaft swamped, boarding became very difficult (unless the new technique was used), rendering it ineffective for its intended purpose.

Less-than-adequate performance of inflatable liferafts has been noted in several investigations into Canadian and international occurrences including those noted below.

- On 10 April 1995, the fishing vessel *Hili-Kum* took on water and capsized in Hecate Strait, British Columbia. The crew launched an inflatable liferaft and abandoned ship; however, the liferaft repeatedly capsized. Of the crew of three, only one survived.

- On 28 September 1994, the Ro-Ro passenger ferry *Estonia* capsized and sank in the Baltic Sea. In this incident, 852 passengers and crew lost their lives. Passengers and crew encountered problems with boarding, and with liferafts that repeatedly capsized and whose canopies did not inflate.

- On 26 November 1999, the high-speed craft *Sleipner* ran aground and sank on a voyage between Stavanger and Bergen, Norway. Sixteen passengers lost their lives. Two liferafts were released; however, one failed to inflate and the second capsized from wave and wind action.

Survival in emergency situations at sea depends to a large extent on survival equipment performing as intended. When a liferaft is deployed in such situations, survivors must contend with conditions that may make it difficult to use the liferaft effectively. For example, there may be rough seas, the liferaft may take on water before or during boarding, it may become inverted, or there may be injured people involved. Consequently, it is essential that the standards for testing liferafts–rigid or inflatable–measure performance in relation to anticipated use and, ideally, under actual service conditions. Presently, this is not the case. Canadian standards, which are derived from IMO standards, for testing liferafts call for critical tests such as swamping, righting, stability, and boarding to be done in isolation one from the other and under calm conditions. The stability of liferafts with water pockets also depends on the integrity of those water pockets. Despite this, the standards do not address material testing of water pockets, nor is there an appropriate minimum strength requirement commensurate with their use. In 2004, the Canadian Coast Guard began a study entitled "Liferaft Performance During Evacuation, Rescue/Recovery." However, the study concentrates on the physical, cognitive, and competency requirements of personnel in liferafts, and does not investigate the deficiencies identified as a result of this occurrence.

In response to observed deficiencies in liferaft performance during the *Estonia* capsizing in 1994, the Joint Accident Investigation Commission recommended, among other things "urgent action to develop new lifesaving concepts and equipment, especially for passenger vessels where large numbers of untrained people are to be rescued."

However, the development of such "new lifesaving concepts" is hampered by the paucity of performance-based marine standards for lifesaving equipment. Such standards should take into account the operational and environmental parameters that can be reasonably expected during use, and set performance criteria accordingly. These standards would allow the industry to be innovative in researching and developing new safety equipment. As a result, continuous design improvement and technical progress may increase the level of safety and protection afforded to seafarers and passengers.

The Board is aware that the *Canadian Aviation Regulations* (CARs)[34] require that sea trials be conducted on liferafts designed for carrying on aircraft. The CARs require that:

> the liferaft must be demonstrated by tests or analysis or a combination of both to be seaworthy in an open sea condition of 17 to 27 knot winds and waves of 6 to 10 feet, and
>
> the liferaft must be deployed to simulate deployment from an aircraft under the most adverse wind direction and wave condition.

Notwithstanding TC's recognition that performance-based testing be applied to liferafts in the aviation industry, such a practical demonstration of liferaft capability in actual service conditions is not required for liferafts carried on Canadian vessels. The Board is concerned that liferafts are

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34 *Canadian Aviation Regulations*, Part V, Subchapter B, Technical Standard Orders, Part 537.103, TSO-C70a Liferafts (Reversible and Nonreversible), www.tc.gc.ca/civilaviation/regserv/affairs/cars/part5/standards/537/sub-b.htm (accessed 14 June 2005).

being certified without full consideration of realistic service conditions such as boarding or stability with water inside the liferaft or boarding while in waves, and that Canadian and international standards for testing and certification of rigid and inflatable liferafts are not sufficiently performance-based, thus placing passengers and crews at undue risk. Therefore, the Board recommends that:

> The Department of Transport develop and implement performance-based standards to ensure that all liferafts deployed on Canadian vessels are capable of operating in severe marine conditions and, further, encourage the International Maritime Organization to adopt a parallel approach internationally.

M05-03

4.3 Safety Concern

4.3.1 Firefighting Tactics on Fishing Vessels

The efficiency of the halon system on the *Silent Provider* was compromised by a number of events, most of them crew-related, notably:

- The engine was not stopped.
- Engine room openings were not all closed.
- The fuel supply was not shut off.
- The engine room door was opened at a critical moment to check if halon had deployed.

The Board has expressed concerns about significant losses in the Canadian fishing fleet due to engine room fires.[35] Although firefighting training is now being given to fishers through the new mandatory MED A3 and MED A4, this training attempts to cover the entire spectrum of emergency duties–including lifesaving, abandonment, survival, firefighting, emergency response, regulatory and environmental issues, seamanship, vessel operations, weather, and rescue–all in eight hours. It is uncertain at this time whether these essential firefighting techniques are being properly emphasized during this training.

Ineffective tactics used to fight engine room fires on fishing vessels have been documented in past occurrences. Fishing vessel losses and fatalities continue to occur due to engine room fires on vessels equipped with fixed fire-smothering systems. Although it is the responsibility of the

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[35] Safety Concern in TSB report M94M0020, fire on board the fishing vessel *Rali II* east of Cape Breton Island on 07 June 1994

master to ensure, through drills and practices, that the crew is familiar with the specific fire-extinguishing system on board ship, many fishers, including masters, are not aware of the proper use of fixed smothering systems to combat engine room fires.

The Board is concerned that the level of firefighting proficiency among fishers is less than adequate, and that the inherent risk of this inadequacy is detrimental to safety.

4.3.2 Standard Mass Determination

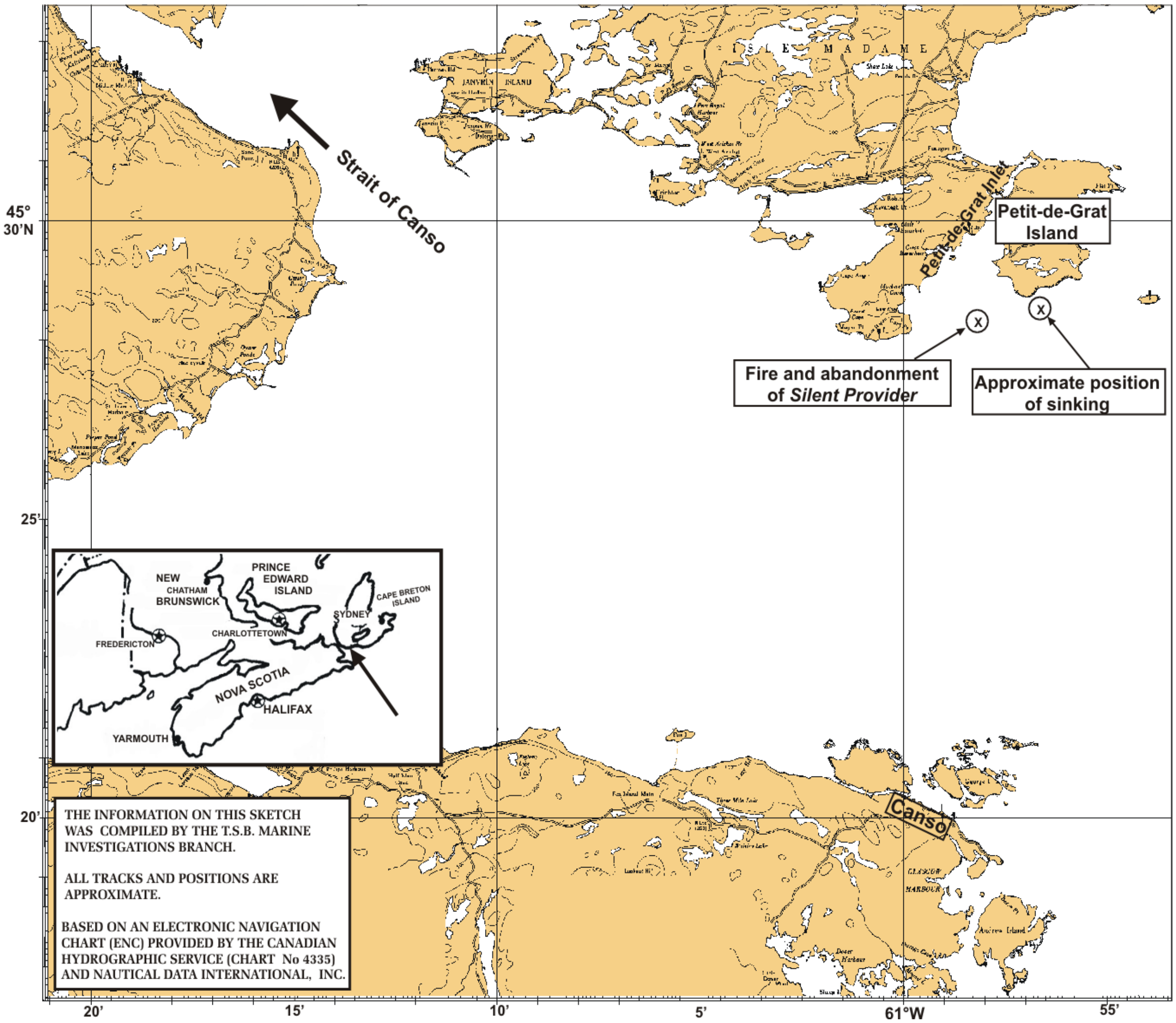
Statistics show that more than half of all males over 20 years of age in Canada and the United States have a mass of at least 80 kg. A key criterion to evaluate the performance of a lifesaving device is based, as in the case under review, on a less-than-average value.

Although TC has addressed this issue in conjunction with the United States and Sweden at the IMO, it is undetermined at this time if a new standard mass will be agreed upon, or if it will be adequate. It would be logical that a lifesaving device be tested at a higher-than-average mass to create a margin of safety for the majority of users. Decisions such as these should be based on statistics and on the application of rigorous anthropometrical methodology. As the average weight of individuals increases, “standard mass” is becoming a concern for the air transportation industry as well. Subsequent to the fatal crash of Georgian Express Flight 126 in January 2004, the TSB recommended that TC re-evaluate the standard weights for passengers and carry-on baggage, and adjust them for all aircraft to reflect current realities.

Notwithstanding progress being made on this issue, the Board remains concerned that the standard mass currently used in liferaft testing is inadequate, and that a new standard mass may still not be adequate to ensure acceptable performance of lifesaving devices built for target groups such as fishers. The Board will continue to follow developments related to this issue.

This report concludes the Transportation Safety Board’s investigation into this occurrence. Consequently, the Board authorized the release of this report on 16 June 2005.

Appendix A – Occurrence Area



Appendix B – Summary of Transportation Safety Board of Canada Pool Tests

Boarding Tests (110 kg person boarding head first)			
Ovatek 4	with water pockets	dry	Liferaft trimmed and took on a substantial amount of water through the boarding hatch.
		water inside	Liferaft trimmed, took on additional water through the boarding hatch, and subsequently heeled on its side when first boarder attempted entry. Entry not accomplished.
	without water pockets	dry	Liferaft trimmed and took on a substantial amount of water through the boarding hatch. The liferaft behaved in a similar fashion to the liferaft with water pockets.
		water inside	—test not performed—
Ovatek 7	ballasted	dry	Liferaft trimmed slightly as boarder entered. No water was taken on through the boarding hatch.
		water inside	Liferaft trimmed noticeably and heeled slightly as boarder entered. No water was taken on through the boarding hatch.

Righting Tests		
Ovatek 4	hatches closed (dry)	Overturned liferaft returned to upright position without assistance.
	hatches open (wet)	Overturned liferaft remained overturned, but could be righted with assistance from one person. Without the benefit of a line or strap to aid in righting, people in the water tended to grab and pull on the external water pockets to turn liferaft over.
Ovatek 7	hatches closed (dry)	Overturned liferaft returned to upright position without assistance.
	hatches open (wet)	Overturned liferaft assumed a near 90-degree orientation on its side. Attempts to right it by two people in the water were not successful.

Appendix C – Description of Type Approval Tests Relevant to this Investigation

The liferaft type approval tests that are of specific interest to this investigation are described in the following paragraphs.[36]

Mooring Out Test – A liferaft is loaded with a mass equal to the total number of persons that it is to accommodate (each having an average mass of 75 kg) and its equipment, and is moored in a location at sea or in a seawater harbour. The loaded liferaft must then remain afloat for a period of not less than 15 days (30 days for TP 7321 and the SOLAS standard). In the case of an inflatable liferaft, the pressure may be topped up once a day using the manual pump or bellows; however, during any 24-hour period, the liferaft must retain its shape. Upon completion of the mooring out period, the liferaft must not have sustained any damage that would impair its performance.

Loading and Seating Test – The freeboard of the liferaft in the light condition, including full equipment but not personnel, must be recorded prior to this test. The freeboard of the liferaft is again recorded once the full complement, having an average mass of 75 kg and each wearing an immersion suit, have boarded and are seated. In this condition, occupants must have sufficient space and headroom and the freeboard must be at least 300 mm.

Boarding Test – The boarding test is to be carried out in a swimming pool by a team of not more than four people who should be of mature age, of differing physiques, and preferably not strong swimmers. At least one subject shall weigh less than 75 kg. For this test, individuals are to be clothed in shirt and trousers, or a coverall, and be wearing an approved immersion suit. Prior to boarding the liferaft, each individual is to swim about 100 m and, on reaching the liferaft, are to attempt to board it immediately. Each individual must attempt to board the liferaft individually with no assistance from the other swimmers or anyone already on board, and the water must be of sufficient depth to prevent any external assistance when boarding. Liferaft boarding arrangements are considered satisfactory if three of the four individuals board the liferaft unaided, and the fourth boards with the assistance of the others.

Stability Test – To test the stability of a liferaft, two people, each wearing an immersion suit, must first board the empty liferaft and then demonstrate that they can readily assist from the water a third person, also wearing an immersion suit, who is required to feign unconsciousness. The third person must have his or her back towards the liferaft so that he or she cannot assist

[36] The text is a condensed version of the Canadian liferaft standards (TP 7321 and TP 11342) and includes only information pertinent to this investigation.

the rescuers. In this test, it must be ascertained that the water pockets of the liferaft adequately counteract the upsetting movement on the liferaft, and that there is no danger of the liferaft capsizing.

Swamp Test – It must be demonstrated that the liferaft, when in a fully swamped condition, is capable of supporting the number of people it is designed to accommodate, remains seaworthy, and will not seriously deform. It must be tested in at least 10 waves of at least 0.3 m height (SOLAS requires waves of 0.9 m height). The waves may be produced by the wake of a boat or by other suitable means.

Righting Test (Inflatable Liferafts) – Before attempting this test, an inflated liferaft is loaded with its heaviest equipment pack and inverted in the water. All entrances, ports, and other openings in the liferaft canopy must be opened to allow the infiltration of water into the canopy when capsized. The canopy is to be allowed to fill completely with water, if necessary by partially collapsing the canopy support. Righting arrangements are considered satisfactory if each person rights the liferaft unaided.

Righting Test (Rigid Liferafts) – The liferaft is placed in the water and is inverted if it is not of a design that can be used either side uppermost. Righting arrangements are considered satisfactory if each person rights the liferaft unaided. In this test, it is not required to have water enter the liferaft prior to righting.

Appendix D – Glossary

cm	centimetre(s)
CO_2	carbon dioxide
FSA	Formal Safety Assessment
IEEE	Institute of Electrical and Electronics Engineers
kg	kilogram(s)
kW	kilowatt(s)
IMO	International Maritime Organization
m	metre(s)
MED	Marine Emergency Duties
mm	millimetre(s)
MSA	Marine Safety Advisory
MSI	Marine Safety Information letter
N	newton(s)
psi	pound(s) per square inch
rpm	revolution(s) per minute
SIIT	Standardization and Innovation in Information Technology
SOLAS	International Convention for the Safety of Life at Sea, 1974
SSB	Ship Safety Bulletin
TC	Transport Canada
TP	Transport Publication
TP 1324	*Material Specification for Coated Fabrics Used in the Manufacture of Inflatable Liferafts*
TP 7321	*Standards for Life Rafts and Inflatable Rescue Platforms*
TP 11342	*Coastal Life Raft*
TSB	Transportation Safety Board of Canada
VHF	very high frequency
ʹ	minute(s)
°	degree(s)
°C	degree(s) Celsius