Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

MARINE INVESTIGATION REPORT
M09L0068

CAPSIZING

RESCUE BOAT *1815*
OFF SAINTE-THÉRÈSE ISLAND
MONTRÉAL, QUEBEC
01 MAY 2009

Canada

Marine Investigation Report

Capsizing

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Off Sainte-Thérèse Island
Montréal, Quebec
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Report Number M09L0068

Summary

On 01 May 2009, at approximately 1345 eastern daylight time, the rescue boat *1815* capsized off Sainte-Thérèse Island, within the Port of Montréal, while participating in a training exercise. The four persons aboard were recovered from the water by another rescue boat. There were no injuries.

Ce rapport est également disponible en français.

Other Factual Information

Particulars of the Vessel

Vessel	*1815*
Official Number	C15398QC
Port of Registry	Montréal, Quebec
Flag	Canada
Type	Workboat / rescue
Gross Tonnage	4.6
Length [1]	6.4 m
Maximum Total Load [2]	1007 kg (including 6 persons)
Built	2008, Rosborough Boats, Halifax, N.S.
Propulsion	One Steyr diesel engine (230 HP) driving a Hamilton jet drive propulsion system
Crew	4
Registered Owner	City of Montréal - Service de sécurité incendie de Montréal

Description of the Vessel

Rescue boat *1815* was the first in a series of eight identical craft (model RFV-22 HammerHead) being acquired by the Montréal fire department, officially known as the Service de sécurité incendie de Montréal (SIM), for use in its nautical rescue program.

Rescue boat *1815* is made of vinyl ester resin with fibreglass and a foam core. The hull is a constant deep-V with a transom. Positive level flotation is provided via foam within the space below deck; the hull's sides are 670 mm astern, increasing to 740 mm above the deck in the forward part of the vessel, thereby forming a large well. A hinged door is fitted on the hull's port side aft above the deck, in way of the engine casing, to facilitate the recovery of persons in the water. A self-draining scupper is fitted on each side of the transom at deck level. An aluminum platform is attached on the exterior of the transom, above the propulsion drive.

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

2 The manufacturer's maximum recommended load, including all liquids (e.g. fuel, oils, fresh water, water in ballast or bait tanks and live wells) to the maximum capacity of fixed or portable tanks.

The steering console, which is protected by a fibreglass hard top supported by an aluminum frame, is equipped with radar, GPS (global positioning system) with chart display, VHF radiotelephones, a depth sounder, a magnetic compass and an engine kill switch with lanyard.

An engine casing protects the inboard engine; the propulsion is jet drive. Aft of the engine casing, the vessel is equipped with a roller for a towing line and a towing bitt.

Photo 1. RFV-22 HammerHead with side door closed (sister vessel)

History of the Voyage

On 01 May 2009, SIM began a six-day training session for firefighters selected to serve as coxswains on the RFV-22 HammerHead. After trainees had received basic theory and familiarization training on the vessel's operation that morning, four boats were launched at 1300 [3] from a ramp in Pointe-aux-Trembles, Quebec. [4] Rescue boat *1815* was crewed by an instructor and three trainees. All participants wore immersion suits and protective helmets.

After the trainees had performed some basic manoeuvres, the instructor decided to demonstrate the self-draining scuppers' ability to drain water from the deck. This involved opening the door on the port side with the intention of allowing some water to enter the cockpit. During these manoeuvres, trainees did not attach the kill switch lanyard, as there was a frequent rotation of operators at the helm.

After setting the propulsion to neutral, the instructor stood near the door. One firefighter was located at the steering console, another aft of the steering console on the centreline near the engine casing, and the third just forward of the steering console, slightly to the port side. When the door was opened, a larger than expected volume of water quickly flooded the afterdeck of the stationary vessel, which had become beam on to the sea. The vessel immediately settled lower into the water and capsized on the port side within approximately 10 seconds.

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3 All times are Eastern Daylight Time (Coordinated Universal Time minus four hours).

4 For a chart detailing the area of the occurrence, see Appendix A.

Rescue boat *1865*, an identical RFV-22 HammerHead operating nearby and crewed by one person, recovered the four persons from the water. Three of them entered via the side door and one climbed over the side. Rescue boat *1815* was towed ashore and hoisted from the water later that day.

Injuries to Persons

No injuries were reported as a result of the occurrence.

Damage to Vessel

The vessel sustained minor damage to its structure. Electronic components had to be replaced.

Personnel Certification and Experience

None of the crew aboard rescue boat *1815* held any marine certificate of competency, nor were any required.

As of 15 September 2009, the *Marine Personnel Regulations* require coxswains to hold a Pleasure Craft Operator Card.

The instructor on rescue boat *1815* has been a firefighter with SIM for seven years, the past three of which he was also a participant of its Nautical Rescue program. In April 2009, just prior to the occurrence, he received the SIM eight day familiarization training to serve as an instructor for the RFV-22 HammerHead course.

Vessel Certification

On 06 October 2008, Transport Canada (TC) issued a temporary Notice of Inspection for a vessel not more than 15 in gross tonnage and carrying not more than 12 passengers, for a voyage in sheltered waters and with a maximum complement of three. This notice was valid until 31 December 2008, pending the issuance of a certificate of registry.

The notice also specified that the vessel was to be operated in the conditions described by design category C [5] of the International Organization for Standardization (ISO) 12217-1. [6] An accompanying cover letter stated that, during rescue operations, the vessel was permitted to exceed the normal crew complement by three additional persons, for a maximum capacity of six. No mass limit was specified.

A certificate of registry (Small Vessel Register) was issued on 03 April 2009 by the chief registrar in Ottawa, Ontario.

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5 A category defines the limitations or the environmental conditions in which the vessel can safely operate. In this case, design category C refers to a significant wave height of 2 m, winds of up to Beaufort force 6 (21 – 26 knots) and gusts up to 17 m/s (33 knots).

6 ISO 12217-1: *Small craft – Stability and buoyancy assessment and categorization.*

Weather

Weather at the time of the occurrence was clear, with southwest winds at 20 to 30 knots and waves of 0.6 m in height.

Montréal Fire Department Marine Mandate and Training

SIM provides year-round search and rescue on the waterways surrounding Montréal. The department has various small craft available, which have been adapted to the area's environment and conditions. Firefighters in the Nautical Rescue program receive training on aspects such as the configuration of small vessels in their fleet, chart work, electronic navigation equipment, weather, small vessel handling and rescuing.

SIM received its first RFV-22 HammerHead in October 2008 and immediately began familiarizing its staff from the Training and Special Teams Division with the vessel. Due to the large number of firefighters who required training, [7] the Division initially trained a small group of instructors in April 2009, who would then train the remaining firefighters. Instructors were given an eight-day course, whereas the coxswains received a six-day course.

The course was designed to familiarize the firefighters with the new vessels. Due to the fact that these boats are fitted with a jet drive, their manoeuvring characteristics differ from those of other vessels in SIM's fleet. The course syllabus included a half day practice session for water recovery via the side door; it did not include a demonstration of the scuppers' ability to drain water from the cockpit. The instructor aboard rescue boat *1815* had, however, witnessed this during the period in which he was trained to be an instructor, following a recovery exercise where water entered the boat via the door. During the initial instructor training, the recovery exercise was conducted by heading the vessel into the current, maintaining helm control and then opening the door to recover persons from the water.

Training material developed by SIM indicated that the side door was to remain closed while the vessel is planing and when the sea conditions do not permit for it to be opened. No specific written instructions were provided on the use of the door during a recovery operation. SIM was aware, however, that TC considered it acceptable to open the door while the vessel was stationary for such an operation.

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7 Approximately 100 firefighters were to receive training as coxswains. These were selected from the eight fire halls where the vessels were to be based.

ISO Standards for Small Craft

There are over 50 ISO standards concerning small craft. These were originally developed to ensure a uniform level of safety in the design and construction of recreational craft throughout member states of the European Economic Area.[8] The standards came into effect under the auspices of the Recreational Craft Directive in 1998.[9] Although member states are not obliged to adhere to the standards, they must at least ensure equivalency. The Recreational Craft Directive is applicable solely to recreational craft with a hull length of 2.5 m to 24 m.

For a manufacturer to post a "CE marking"[10] on a boat, it must be built compliant to the Recreational Craft Directive. This is achieved by applying either specific product safety standards or the Directive's essential requirements during the design and manufacturing of a product. Once a product is brought into service, the manufacturer or its representative must be able to demonstrate that the correct standards and/or directives have been applied.

In addition, notified bodies,[11] appointed by the government of each member state, exist to assist with the interpretation and application of the regulations and standards. Other firms, called competent bodies, have approval to assist manufacturers in achieving certification under some European Union directives.

Small Vessel Regulations – Canada

In Canada, the requirements for a power-driven vessel that does not exceed a gross tonnage of 15, such as rescue boat *1815*, are found in the *Small Vessel Regulations*. The regulations incorporate by reference the *Construction Standards for Small Vessels* (TP 1332), which in turn give effect to three additional ISO standards, as of 01 April 2005:

- ISO Standard 11812: *Small craft – Watertight cockpits and quick-draining cockpits;*
- ISO Standard 12216: *Small craft – Windows, portlights, hatches, deadlights and doors – Strength and watertightness requirements; and*
- ISO Standard 12217-1: *Small craft – Stability and buoyancy assessment and categorization.*

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8 The European Economic Area was established on 01 January 1994, following an agreement between member states of the European Free Trade Association, the European Community, and all member states of the European Union. It allows the European Free Trade Association countries to participate in the European single market without joining the European Union.

9 The directive describes the requirements for products sold in the European Union.

10 A "CE" marking indicates that a product complies with the relevant European safety directives.

11 These are basically consulting firms that have been certified and approved by the governing bodies to administer the assessments, quite similar to the ISO 9000 program. These firms are certified for specific European Union directives and possess the required expertise.

TP 1332 also makes reference to other standards that must be taken into consideration, including elements of the American Boat and Yacht Council's (ABYC) *Standards for Small Craft.*

These ISO standards are interrelated, [12] serving not only to assess a vessel's stability, but also to establish certain construction requirements for watertightness, drainage and openings such as doors. ISO standards in Canada apply to non-pleasure craft, more specifically, all power-driven non-pleasure craft exceeding 6 m in length and less than 15 gross tonnage, must meet the stability requirements of ISO 12217-1. [13]

Vessel Construction

The RFV-22 HammerHead included the option of a side door, the design of which was based on comparison with models from other manufacturers and the construction of a demo model. During the side door design process, the potential risks associated with water ingress were not considered. The series manufactured for SIM were the first to be fitted and delivered with this option (see Photo 2 and Photo 3).

The door was cut into the hull side, is generally rectangular in shape and has the following approximate dimensions: 630 mm wide (at top), 605 mm wide (at bottom) and 580 mm high. [14] The door is hinged aft, opens inward and, when closed, locks in place via a single deadbolt locking mechanism on the forward side of the door.

Photo 2. Side door opened inward

Photo 3. Door sill (four persons aboard)

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12 The three ISO standards referenced in TP 1332, *Construction Standards for Small Vessels*, each contain provisions requiring that other ISO standards be applied, such as ISO 8666 (*Small craft – Principal data*), ISO 10240 (*Small craft –Owner's manual*) and ISO 14946 (*Small craft –* Max*imum load capacity*).

13 Transport Canada, *Construction Standards for Small Vessels,* 2004, TP 1332, Section 5.2.1.

14 Note that all doors are fitted identically aboard vessels owned by SIM.

Opening Appliances

ISO 12216 sets out the requirements for "opening appliances." These are defined as devices "made of a plate and possibly a framing system used to cover an opening in the hull or superstructure of a boat." Examples can include windows, port lights, hatches, deadlights, doors, sliding appliances and escape hatches.

According to ISO 12216, the lower edge of any opening appliance must be placed "at least 200 mm above the waterline, the boat being in the fully loaded, ready-for-use condition and upright." Moreover, in order to ensure structural integrity, "the small unsupported side" (in this case, the bottom of the door) for an opening located in the hull area "shall not exceed 300 mm." [15]

In a lightly loaded condition, the door sill on rescue boat *1855* (sister vessel of rescue boat *1815*) was 135 mm above the waterline. With four firefighters aboard (total mass = 385 kg), simulating as closely as possible the conditions at the time of the occurrence, the door sill was approximately 75 mm above the waterline.

Of the door's three supportable sides, those forward and aft are supported by the deadbolt and hinges, respectively. The unsupported bottom side is 605 mm.

Stability Requirements

TP 1332 requires [16] the RFV-22 HammerHead to undergo a stability assessment, as per ISO 12217-1. The purpose of the assessment is to confirm that a vessel is suitable to operate in its intended design category. [17] The scope of ISO 12217-1, however, "does not include or evaluate the effects on stability of towing, fishing, dredging, or lifting operations, which should be considered separately if appropriate."

There are six options available for assessing the stability of a small craft, in accordance with the standard. [18] Once a target design category has been selected, vessel stability is then assessed against a combination of up to eight different tests and requirements.

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15 ISO 12216, Section 6.3.1.1 – Height Above Waterline and Maximum Short Side Dimension.

16 The requirement for a stability assessment "applies to every non-pleasure craft (excluding multihulls, inflatable craft, vessels carrying cargo over 1000 kg, and vessels built or converted for towing, dredging or lifting) exceeding 6 m in length."

17 Generally, the design category will be determined in advance by the manufacturer, based on the boat's intended use and area of operation.

18 Each option depends on features such as the amount of decking or covering, and flotation. See Appendix B.

In June 2008, the manufacturer hired a naval architecture consultant to perform a stability assessment on an RFV-22 HammerHead. After consulting TC and with an inspector present, this assessment was conducted using option 6 for design category C. Accordingly, the vessel had to be tested in the four following areas:

- downflooding openings;
- downflooding height;
- offset-load test; and
- heel due to wind action.

Downflooding Openings

The purpose of this test is to determine all potential downflooding openings aboard a vessel through a visual inspection. ISO standards define downflooding openings as "any opening that may admit water into the interior or bilge of a boat, or a recess" [19] with a recess being "any volume open to the sky that may retain water," [20] such as a cockpit. Doors installed topside are generally considered to be downflooding openings, particularly one fitted, as in this case, in the hull.

However, the door on rescue boat *1815* was not considered by the consultant and TC to be a downflooding opening. In order for a downflooding opening to be considered exempt from consideration, the following four conditions must be met:

1. Opening appliances located topside must comply with ISO 12216 to watertightness degree 2. [21]

   In this occurrence, the side door was tested for watertightness by the manufacturer and considered compliant with the requirements of ISO 12216 watertightness degree 2. TC accepted the manufacturer's test as valid, although its results were not reviewed.

   The TSB conducted a post-occurrence watertightness test, [22] pursuant to ISO 12216, on the door of one of the RFV-22 HammerHeads owned by the fire department. The door failed to meet the requirement for watertightness degree 2 by a significant margin.

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19 ISO 12217-1, Section 3.2.1.

20 ISO 12217-1, Section 3.1.3.

21 After three minutes of continuous spraying with a dense thin water jet, ingress of water shall not exceed 50 ml.

22 TSB laboratory report LP129/2009, available on request.

2. The opening must be referenced in an owner's manual.

   In this occurrence, although there is no Canadian requirement for manufacturers to supply an owner's manual with a new vessel, the manufacturer had provided SIM with a general information book, written partly in English and in French. This book, however, included no reference to the door as a possible downflooding opening.

3. The opening must be clearly marked "watertight closure—keep shut when under way."

   In this occurrence, when the vessel was delivered, the manufacturer had not posted a marking on the door itself. However, the fire equipment retailer that served as "intermediary" between the manufacturer and SIM posted the following marking, in French, prior to final delivery, "*DANGER – LORSQUE VOUS ÊTES DÉJAUGÉS - PORTE FERMÉE*," which can be translated as, "DANGER – WHEN THE VESSEL IS PLANING, KEEP DOOR CLOSED."

4. For vessels built to design category C or D, the vessel must not sink when, at loaded displacement mass, the affected compartment is flooded as a result of the open door.

   In this occurrence, a flotation test was performed, [23] in accordance with the method set out in ISO 12217-1. Although it was not required under option 6, nor to exempt the door from consideration as a downflooding opening, the results nonetheless showed that the vessel would not sink.

Regardless of whether an opening is exempt from consideration as a downflooding point, it remains that downflooding openings must be located at least 200 mm above the waterline.

Downflooding Height

The purpose of this test is to demonstrate sufficient margins of freeboard for the vessel in the loaded condition. When the stability assessment was carried out, the door was considered exempt as a downflooding opening. As such, for the purposes of the downflooding height test, the lowest point of downflooding was not considered to be the door sill, but rather the top of the gunwale aft (i.e., 630 mm above the waterline in a fully loaded condition). The test required a minimum height of 500 mm and the vessel passed because the gunwale aft was used.

Offset Load Test

The purpose of this test is to demonstrate sufficient stability for the boat at loaded displacement mass against offset loading by the crew. This is achieved by determining the heel angle attained when the maximum recommended number of people on board (crew limit) are crowded to one side. In this occurrence, the test results were within the requirement for angle of heel, and also —with the door exempt from consideration as a downflooding opening —for minimum height to waterline.

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[23] This test was carried out by the consultant hired by the manufacturer.

Heel due to Wind Action

The vessel was exempt from meeting the test's requirements due to an insignificant windage area. [24]

Stability Assessment Results

After the consultant, who had been hired by the manufacturer, carried out the stability assessment, the vessel was considered to meet the conditions specified by design category C. During this stability assessment, the side door was not considered as a downflooding opening.

The consultant then issued a preliminary stability assessment report, which was subsequently verified by TC. The following statement was included, at TC's request, in a revised version, which was supplied to the manufacturer by the consultant:

> This stability assessment assumes that the port side access door will be tested to watertightness degree 2 in accordance with the ISO 12216 standard and that [the door] shall remain closed while the vessel is underway as per ISO 12217-1.

The vessel was not tested for stability with the door open, nor was any consideration given to the vessel operating with the door open, whether underway or stationary.

Maximum Total Load

The stability assessment determined that the vessel could carry a maximum total load of 1007 kg. Given a maximum fuel load of 169 kg, the vessel's actual maximum carrying capacity was 838 kg. This included a crew limit of six, stores, equipment and cargo.

These calculations were based on an average mass of 75 kg per crew member. On the day of the occurrence, rescue boat *1815* had a crew of four, with a combined mass of 408.2 kg and an average mass of 102 kg.

The maximum total load was not indicated on a label aboard the vessel, nor is there a requirement to do so for a non-pleasure craft in Canada. However, according to ISO 12217-1, this information is required to be referenced in the owner's manual.

Vessel Evaluation

Later in June 2008, following the stability assessment, a second naval architect consultant was hired —this time by SIM—to evaluate the RFV-22 HammerHead. Although this evaluation was limited to a physical inspection and sea trials of the vessel, this second consultant also verified all of the vessel's documentation, including the completed stability assessment. In the report to SIM, this second consultant expressed concern that the side door should not have been exempt

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[24] Projected profile area of hull, superstructures, deckhouses and spars above the waterline at the appropriate loading condition, the boat being upright.

from consideration in the initial stability assessment, as doing so effectively precluded its use in rescuing persons while underway. Accordingly, the report stated that the door, if opened while underway, should be considered a possible downflooding opening and, thus, have its sill used as the downflooding height in the stability assessment.

After being apprised of these concerns, TC communicated with a third consultant, a certified inspector with a European notified body who had previously provided training to the TC inspectors on ISO standards. Although the ISO inspector was not aware of the exact location of the door aboard the vessel, the two parties agreed that, so long as the side door was watertight to degree 2, it could be exempt from consideration as a downflooding opening and that it was therefore acceptable for the stability assessment to have used the top of the gunwale as the downflooding height. Additionally, TC and the certified ISO inspector agreed that while the vessel is stationary for a rescue operation and the door is open, it is acceptable to do so but that it had to remain shut while the vessel was underway in order to maintain watertightness to degree 2. No explanation of "underway" was offered, however, nor is the term defined within the ISO standards. According to the *International Regulations for Preventing Collisions at Sea (*Collision Regulations*)*, the word "underway" means that "a vessel is not at anchor, or made fast to the shore, or aground."

Vessel Compliance and Inspection

TC is not required to approve the vessel's plans prior to construction, nor perform an inspection during construction. Rather, it is the responsibility of the designer, manufacturer, constructor or owner to "carefully consider the intended operation of the vessel when determining its construction, watertight integrity, and stability" during the building process. [25]

The first RFV-22 HammerHead, rescue boat *1815,* was delivered to SIM in the fall of 2008. It came with a TC-issued conformity label, [26] affixed by the manufacturer to the steering console, thereby certifying the craft's compliance with TP 1332's requirements for pleasure craft. However, for non-pleasure craft, such as rescue boat *1815,* no such label is required. [27]

TC was not required to perform a new-build inspection of rescue boat *1815*. However, after a request from the manufacturer, TC inspected the vessel during the construction process. A representative was also present when the vessel's stability was assessed before being delivered to the owner. TC confirmed that the vessel was inspected and found to be compliant with TP 1332. This information was forwarded to the TC district service centre in Montréal, where the vessel was to operate.

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25 Transport Canada, *Construction Standards for Small Vessels*, TP 1332, Section 1.1.4.

26 Conformity labels are issued by Transport Canada upon request from a manufacturer after completing the necessary documentation for a vessel or model line. Labels are issued if the documentation is completed appropriately and the prescribed fees are paid.

27 Proposed changes in the *Small Vessel Regulations* will require all new vessels subject to its provisions to be certified by their manufacturer with a compliance notice.

According to the *Canada Shipping Act*, 2001 (CSA), owners of small non-pleasure craft must inform TC when entering vessels into service. A vessel may receive a first inspection from TC before entering service to ensure compliance with the Small Vessel Monitoring and Inspection Program. Whether or not a vessel has received a first inspection, it is the owner's responsibility to ensure compliance. However, TC may still perform spot checks or first inspections in order to ensure that vessels remain compliant with safety requirements.

After taking delivery of rescue boat *1815*, SIM contacted the TC district service centre in Montréal, requesting that a first inspection be carried out before the vessel entered service. This was carried out in accordance with the Small Vessel Monitoring and Inspection Program, which confirmed that the vessel met the safety requirements for the construction of hull and machinery, lifesaving appliances, navigation and communication equipment, and that the crew met the training and certification requirements. As TC had previously found the vessel compliant with TP 1332's construction requirements, its district centre in Montréal limited the inspection to safety equipment and crewing requirements. A temporary Notice of Inspection was subsequently issued, with the only outstanding item being the requirement for SIM to submit proof of registry, in accordance with the Small Vessel Register.

Analysis

Capsizing

Rescue boat *1815* was fitted with a side door to assist with the recovery of persons from the water. Although no instructions were provided by the manufacturer as to when, or in what conditions the door could be safely used, SIM's training program provided some guidance. In addition, further instructions had been posted indicating that the door was not to be opened while the vessel was planing. The vessel had been deemed by the manufacturer and TC to be compliant with the relevant standards and had also been inspected by TC prior to entering into service. Moreover, the vessel had undergone a stability assessment, in accordance with ISO 12217-1, and had been tested to demonstrate that it would not sink when flooded.

Although demonstrating the scuppers' capacity for self-draining was not part of the training program, the instructor had previously witnessed their use following a recovery exercise during which water had entered the vessel. It was therefore reasonable for the instructor, on the day of the occurrence, to believe that opening the door while the vessel was stationary would not be problematic.

However, when the instructor opened the door, the weather conditions, although being within the defined limitations of the design category assigned to the vessel, were not as favourable as when he had previously seen the door opened. At the time, the vessel was stopped, compromising the scuppers' ability to shed water, and the vessel came to lie broadside to the seas. The additional weight of the instructor and a firefighter on the port side reduced freeboard and allowed for a large quantity of water to flood the open cockpit when the door was opened. Given the uneven distribution of weight, the free-surface effect of water in the cockpit and possibly the wind acting on the hard top as the vessel listed to port, the vessel capsized within approximately 10 seconds.

Vessel Construction – Side Door

Rescue boat *1815* came with the option of a side door. This feature, referred to as an opening appliance within ISO 12216, was required to be a minimum height above the waterline; the unsupported side was also required not to exceed a maximum length. In addition, in order to be exempt from consideration as a downflooding opening, the door was required to meet four additional requirements from ISO 12217-1.

The investigation revealed, however, that the door did not meet ISO 12216's aforementioned requirements for an opening appliance. With the vessel fully loaded, its minimum height above the waterline would have been less than 75 mm, not the 200 mm required. Furthermore, its maximum unsupported side length was 605 mm, not the maximum allowed of 300 mm.

Moreover, for the purposes of the vessel's stability assessment, the door did not meet three of the four requirements specified in ISO 12217-1:

- it was not watertight to degree 2;
- it was not referenced in an owner's manual; and
- it was not clearly marked "watertight enclosure—keep shut when under way."

The door, therefore, was not eligible for exemption as a downflooding opening, meaning that the door sill was the lowest point of downflooding. Furthermore, even if the four exemption requirements had been met, the door sill was required to be at least 200 mm above the waterline for the stability assessment. As such, the vessel did not meet the requirements to be assigned design category C.

During the side door design process, the potential risks associated with water ingress during a recovery operation as well as the mitigating factors (such as limiting operating conditions, optimal weight distribution or water shedding capability while stationary) were not considered.

Despite these factors, the vessel was deemed by TC, the manufacturer,and the manufacturer's consultant to be compliant with all relevant standards and suitable for its intended use as a rescue boat in conditions described by design category C.

Compliance and Inspection

Regardless of who inspects a vessel, the relevant regulations and associated standards must be clearly understood and properly applied. In this occurrence, the manufacturer hired the first consultant and communicated with TC, which was involved in the construction process. Subsequently, SIM (as owner) hired a second consultant, whose concerns prompted the manufacturer to again contact TC. TC then communicated with a third consultant before the vessel was deemed suitable, which included the ability to utilize the recovery door when stationary.

However, despite the involvement of the manufacturer, the owner, three consultants and TC, the vessel, as built, did not comply with the following ISO standards:

- the side door did not meet two of the requirements for an opening appliance (ISO 12216); and
- the vessel's stability assessment inaccurately assigned it to design category C (ISO 12217-1).

Given that they address a wide range of vessel types and designs, ISO standards are inherently complex, offering numerous options for the assessment of a vessel's stability, depending on the features of the vessel under consideration.

In this occurrence, those who had experience and access to resources, deemed the vessel compliant, when it was not. It is, therefore, reasonable to assume that those with less awareness and experience or those who possess fewer resources, such as small builders or single owner/operators, may have even greater difficulty understanding and applying the requirements, as they take on a greater role in ensuring compliance.

It is worth noting that in Europe, for example, various notified and certified bodies—essentially, government-certified consulting firms—help manufacturers comply with numerous European Union directives.

This issue has previously been addressed by the TSB. In its 2001 investigation into the near sinking of the catamaran passenger vessel *Wasca II* (TSB report M01W0116), the Board found that "The self-enforcement of safety measures to ensure regulatory compliance is ineffective in some sectors … because of the lack of awareness, the complexity of regulations, and the lack of experience of some owners in interpreting them." In its 2002 investigation into the sinking of the amphibious passenger vehicle *Lady Duck* (TSB report M02C0030), the Board also found that "current marine requirements contained within the CSA, its regulations, standards and guidelines are complex" and "that it is difficult for owners, operators, and TC inspectors to determine which requirements apply to a particular class of vessel." The report noted that TC acknowledged this fact, which has been "reflected in the training given to inspectors with respect to small commercial vessel inspections."

This occurrence demonstrates that manufacturers, owners, consultants and some TC personnel may not fully understand the regulations and associated standards for the construction of small non-pleasure craft. Until such time that industry gains the requisite knowledge and experience with respect to the ISO standards, as now applicable in Canada, small non-pleasure craft may continue to be built and operated, despite being non-compliant and possibly unsafe.

Definition of "Underway"

Technical documents often make use of terms that require explanation. The general practice is to provide a definition to ensure common understanding and prevent misinterpretations. This is particularly true of regulations and standards, which are frequently complex or use terms that have multiple meanings.

In this occurrence, the side door was an opening appliance. As a potential point for water ingress, it was therefore expected to be kept closed under certain conditions. In fact, it was only exempt from consideration as a downflooding opening if kept closed while "underway."

Although this term is defined elsewhere, such as within the Collision Regulations and the American Boat and Yacht Council (ABYC) Standards, it remains undefined in the ISO standards. As a result, the intent of the conditions attached to the exemption was unclear to all those involved—the manufacturer, owner, TC, and several consultants. For example,when the door was opened on the day of the occurrence, the vessel, although stationary, was "underway" according to the Collision Regulations, but not according to the interpretation of TC and one of the consultants.

The lack of definition for key terms within a standard may result in an interpretation other than that intended and possibly to unsafe conditions aboard the vessel.

Scope of ISO Stability Standard

In this occurrence, rescue boat *1815* had its stability assessed against ISO standard 12217-1 (*Stability and buoyancy assessment and categorization*). In Canada, TP 1332 requires this standard to be used for non-pleasure craft exceeding 6 m in length and less than 15 in gross tonnage, excluding multihulls, inflatable crafts, vessels carrying cargo over 1000 kg and vessels built or converted for towing, dredging or lifting. The ISO standard 12217-1 also expressly states on its first page that it does not include or evaluate "the effects on stability of towing, fishing, dredging, or lifting operations, which should be considered separately if appropriate."

Rescue boat *1815* was designed and built to be used by a fire department for search and rescue. As such, its features included a towing post and a side door. This implied that, although it was not a tug, towing was not outside the vessel's realm of intended use. Other vessels also fall outside the scope of the standards (for example, small craft fitted with lifting gear), yet there is no established methodology or criteria for assessing their stability under all intended operations. Therefore, vessels may be inadequately assessed and subsequently exceed their operational limits, thereby placing those on board at risk.

Operating Instructions

It is important that operators be fully familiar with all equipment prior to beginning operation and that all relevant information be available to users. This is typically done via a user manual, which can include details such as performance, maintenance, limitations and key safety features. Rescue boat *1815* was no exception. The vessel's General Information book contained photos of the vessel, as well as the descriptions of and operating instructions for equipment such as compass, bilge pumps and hydraulic helm pump.

However, the general information book provided no guidance as to when the door could be opened or closed and, in fact, made no mention of the door at all. The vessel was delivered with instructions posted on the side door indicating that it was to remain closed while the vessel is planing. SIM was aware that TC considered it acceptable to open the door while the vessel was stationary for a recovery operation. In the SIM training program, the information provided to the trainees was that the side door was to remain closed while the vessel is planing and when the sea conditions do not permit it to be opened.

On the day of the occurrence, the instructor, who had previously seen the door opened while underway, was therefore unaware that there might have been anything wrong with this. Nonetheless, given the door's significance, ISO 12217-1 exempted it from consideration as a downflooding opening *only* under certain specific conditions; one of these was that its conditions of use be set out in an owner's manual. Some guidance should reasonably have been expected.

In Europe, the Recreational Craft Directive requires that all new vessels be supplied with a manual containing key safety information. To assist with this, there exists a standard (ISO 10240) outlining what information is to be presented and how. In this occurrence, however, TC did not require information on the door's use to be included in a user's manual, nor did the manufacturer provide it. Although not a requirement under the *Small Vessel Regulations*, providing a user's manual is nonetheless a recognized good practice. This is especially true when, as in this case, there may be multiple operators, some of whom may have limited marine experience.

Therefore, in the absence of key safety information regarding a vessel's features, performance and limitations, operators of small non-pleasure craft may unknowingly operate in an unsafe manner.

Maximum Load and Capacity

It is important that a vessel's operator be aware of information regarding its maximum load. This is particularly vital for rescue boats, which must operate safely while recovering people in an emergency and, as in this case, where there are 100 operators who require the information.

In this occurrence, rescue boat *1815* was certified to carry a crew of three, with a maximum of six persons, at an average mass of 75 kg each. In addition, the vessel's maximum load was 1007 kg, which also included fuel, stores, equipment and/or cargo.

Currently, information on maximum load is required to be displayed, in the form of a capacity label, on pleasure craft of less than 6 m in length. This enables the crew to determine the maximum amount of cargo and passengers the vessel can safely carry. Rescue Boat *1815*, as a non-pleasure craft of 6.4 m in length, required no such label.

Even if this information had been available, however, the vessel's capacity is based on an ISO standard average mass of 75 kg per person. However, statistics show that the average mass of Canadian males 20 years of age and older is 81.5 kg. [28] These figures are similar in the United States. In this occurrence, the average mass of the four persons on board the vessel was 102 kg.

The TSB has addressed this issue previously in the marine and air modes. Following the 2003 fire and sinking of the small fishing vessel *Silent Provider*, the Board cited a "strong probability" that the margin of safety provided by the 75 kg standard could be inadequate. [29] Subsequent to the fatal crash of Georgian Express Flight 126 [30] in January 2004, the Board recommended a re-evaluation of the standard mass for passengers and carry-on baggage, adding that these be "adjusted for all aircraft to reflect current realities." [31] More recently, subsequent to the

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28 Statistics Canada, Canadian Community Health Survey, 2000/2001.

29 TSB Report M03M0077.

30 TSB Report A04H0001.

31 Interim TSB Aviation Safety Recommendation A04-02 (TSB Report A04H0001).

capsizing of a fireboat in the harbour of Halifax, Nova Scotia, the Board noted that the figure of 75 kg "continues to be based on a less-than-average value" and that, as a result, vessels "continue to be assessed against unrealistic operating conditions." [32]

Therefore, without some method to provide operators with information regarding maximum load (for example, a capacity label), vessels may be operated beyond their limits. Moreover, standards that do not reflect a realistic average mass per person allow vessels to be assessed against unrealistic operating conditions.

Engine Kill Switch

The engine kill switch was not attached via a lanyard to the operator at the time of the occurrence. This was deemed unnecessary due to the constant rotation of trainees at the steering console. Although in this occurrence, the vessel was stopped with the jet drive in neutral, a previous TSB report [33] noted that not using this safety device could lead to a situation where the engine continues to run with no one at the controls.

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32 TSB Report M08M0062 (*Fireboat 08-448B*).

33 TSB Report M08M0062 (*Fireboat* 08-448B).

Findings as to Causes and Contributing Factors

1. While the vessel was stopped with the propulsion in neutral, it became beam to the prevailing seas.

2. When the side door was opened to allow water into the cockpit for a demonstration of the self-draining capabilities, a large volume of water flooded the cockpit.

3. The height of the door sill above the waterline was insufficient to prevent significant water ingress when the door was opened.

4. The distribution of the weight of the firefighters on board, the free-surface effect of water in the cockpit and possibly the wind acting on the hard top as the vessel listed to port caused the vessel to capsize rapidly.

5. No analysis of the risks associated with the use of the door was conducted by the manufacturer, nor were any instructions for the safe use of the door provided by the manufacturer to the Service de sécurité incendie de Montréal (SIM).

6. Training and instructions provided by the SIM to the instructor on the safe use of the door did not adequately address the risks of operations involving the opening of the door.

7. The inspection and stability assessment of the vessel failed to identify that the side door did not comply with the International Organization for Standardization (ISO) standards. As such, the vessel was delivered and put into service with an insufficient sill and downflooding height.

Findings as to Risk

1. Until such time as there is adequate knowledge of and experience with the new standards for the construction of small non-pleasure craft, vessels may continue to be built (and operated) despite being non-compliant and possibly unsafe.

2. The lack of definition for key terms within a standard may result in an interpretation other than that intended and possibly to unsafe conditions aboard the vessel.

3. For vessels whose operation falls outside the scope of the ISO standards, there is no established methodology or criteria for assessing their stability. These vessels may, therefore, be inadequately assessed and subsequently exceed their operational limits.

4. In the absence of key safety information regarding a vessel's features, performance and limitations, operators of small non-pleasure craft may unknowingly operate in an unsafe manner.

5. Standards that do not reflect a realistic average mass per person allow vessels to be assessed against unrealistic operating conditions.

6. Engine kill switches that are not used in conjunction with a lanyard may allow engines to run with no one at the controls.

Safety Action

Related Safety Action

Transport Canada (TC) has updated both the *Small Vessel Regulations* and the *Construction Standards for Small Vessels* (TP 1332). These took effect on 29 April 2010 and included the following changes: manufacturers must now provide end users with a document setting out a vessel's design limitations as well as a declaration of conformity. Manufacturers must also affix a compliance notice to the vessel stating the design limitations of the vessel and that the vessel met the construction requirements on the date of construction. For all vessels less than 6 m, [34] the compliance notice will also include certain specifications; maximum gross load capacity, maximum number of persons that can be carried and maximum engine power (if designed to be fitted with an outboard engine).

For small non-pleasure craft greater than 6 m, TP 1332 now contains alternative methods to assess stability, in addition to ISO 12217-1: *Small craft – Stability and buoyancy assessment and categorization*. Furthermore, TP 1332 also states that ''when the selected recommended practices or standards do not include or evaluate the effects on the stability of particular operations such as towing, fishing, dredging, lifting or any other special operation, the impact of these operations shall be separately considered, by using first principles, suitable additional criteria or appropriate testing.'' [35]

An amendment was made to ISO 12217-1 at the end of 2009. This amendment increased the weight of persons used during the offset load test to a minimum of 85 kg and, in some cases, to 98 kg to take into account the possibility of exceeding the weight of 75 kg (average mass per person).

Action Taken

On 08 July 2009, the TSB issued Marine Safety Information Letter 04/09 to TC highlighting the importance of taking into consideration all downflooding openings, such as side doors, and their intended use, when evaluating the stability and buoyancy of a vessel. In a response dated 23 October 2009, TC concurred that downflooding openings and their intended use be considered when evaluating the stability of a vessel.

The Service de sécurité incendie de Montréal (SIM) has prohibited [36] the use of the door on all of its RFV-22 HammerHeads.

The manufacturer of the RFV HammerHead notified operators not to use the door in their vessels until the TSB investigation is complete and the causes of the capsize are known.

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34 This includes pleasure craft and non-pleasure craft.

35 Transport Canada, *Construction Standards for Small Vessels,* 2010, TP 1332, Section 5.1

36 Following SIM's own internal investigation completed in July 2009, the doors have been bolted shut permanently so as to prevent their use.

Safety Concern

Compliance with Regulations and Standards

TC estimates that there are at least 50 000 small non-pleasure craft in operation in Canada and that this figure may be as much as 100 000. [37] As TC is no longer required to inspect small non-pleasure craft, a greater onus is being placed on manufacturers and operators to ensure compliance. As such, manufacturers and operators will need to be thoroughly conversant with the applicable regulations, standards and guidelines. However, as demonstrated in this occurrence, the manufacturer, consultants and even some TC personnel did not fully understand the regulations and associated standards for the construction of the vessel. The Board has also noted in previous occurrences [38] that enforcing self-compliance is not always effective, and that the regulations and standards can be complex.

The Board is concerned that, until such time as builders and operators become more knowledgeable and an audit or inspection program is implemented, there will remain a residual risk that vessels will be built and placed into service despite being non-compliant with the standards and possibly unsafe. The Board will continue to monitor this situation with a view to assessing the need for further action on this issue.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 29 September 2010.

Visit the Transportation Safety Board's Web site (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

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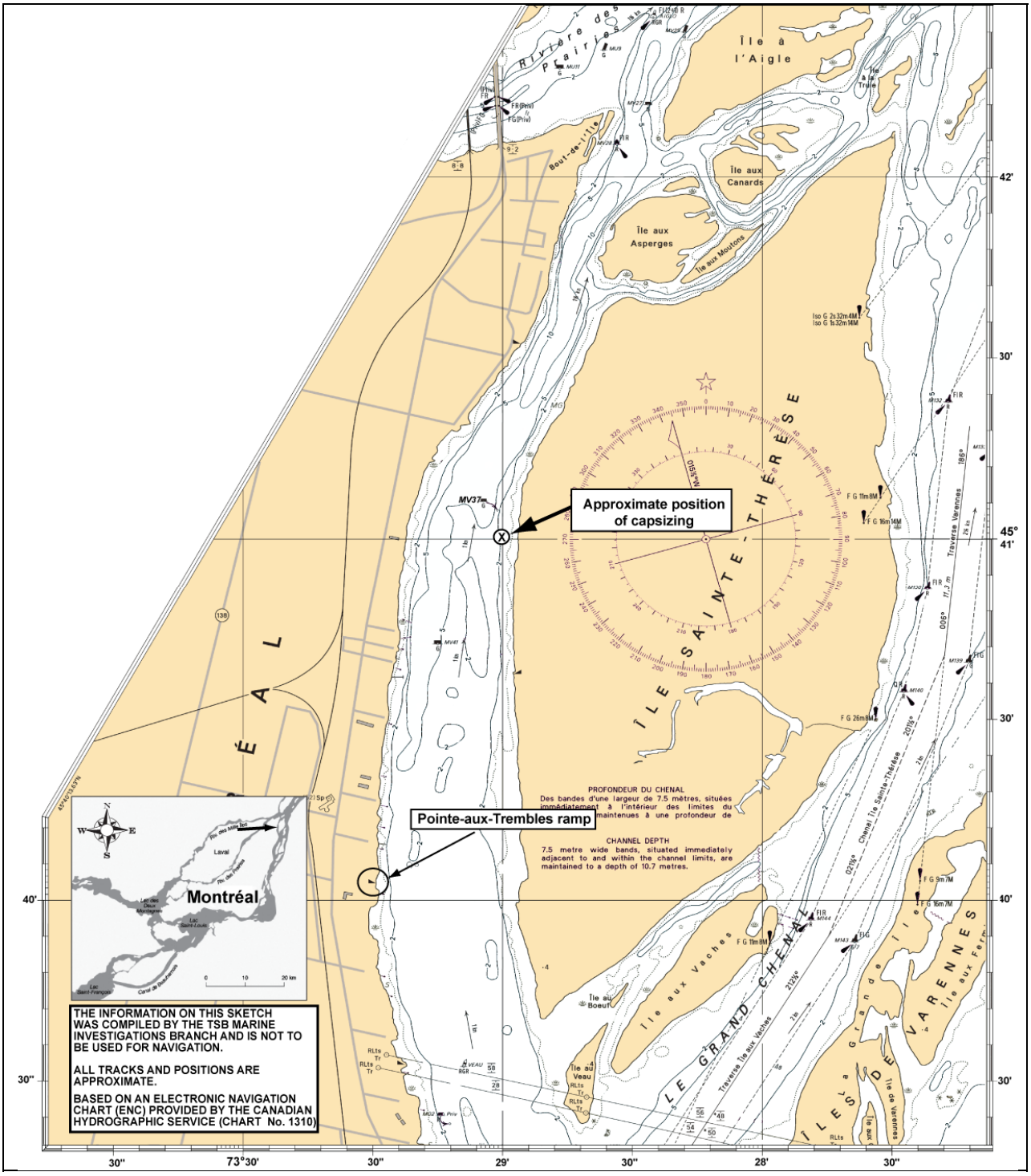
37 *Canada Gazette, Part II*, Vol. 144, No. 10 (12 May 2010).

38 TSB reports M01W0116 (*Wasca II*) and M02C0030 (*Lady Duck*).

Appendix A – Area of the Occurrence



Appendix B – Excerpt from ISO 12217-1

Option	1	2	3	4	5	6
Categories possible	A and B	C and D	B	C and D	C and D	C and D
Decking or covering	Fully decked	Fully decked	Any amount	Any amount	Partially decked	Any amount
Downflooding openings	Yes	Yes	Yes	Yes	Yes	Yes
Downflooding height test	Yes	Yes	Yes	Yes[A]	Yes	Yes
Downflooding angle	Yes	Yes	Yes	Yes[A]		
Offset-load test	Yes	Yes	Yes	Yes	Yes	Yes
Resistance to waves + wind	Yes		Yes			
Heel due to wind action		Yes[B]		Yes[B]	Yes[B]	Yes[B]
Flotation requirements			Yes	Yes		
Flotation material			Yes	Yes		

A: This test is not required for boats assessed using option 4 if, during the swamped load test, the boat has been shown to support an equivalent dry mass of 133 % of the maximum total load.

B: The application is only required for boats where the windage area is greater than length x beam.