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

MARINE INVESTIGATION REPORT
M04N0086

CAPSIZING AND LOSS OF LIFE

SMALL FISHING VESSEL *RYAN'S COMMANDER*
5 NAUTICAL MILES EAST OF CAPE BONAVISTA, NEWFOUNDLAND AND LABRADOR
19 SEPTEMBER 2004

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Synopsis

On 19 September 2004, the small fishing vessel *Ryan's Commander* departed Bay de Verde, Newfoundland and Labrador, for a trip to its home port of St. Brendan's (Cottel Island), Newfoundland and Labrador. The trip was uneventful as the vessel proceeded on a northerly course with the wind and seas on the starboard bow. At approximately 1800 Newfoundland daylight time, the vessel was about seven nautical miles east-southeast of Cape Bonavista, Newfoundland and Labrador, and the course was altered toward the northwest. During the next 30 minutes, with the vessel running beam to gale-force winds and sea, it experienced three heavy rolls to port. It recovered from the first two; however, the third roll left the vessel on its beam-ends. A distress message was transmitted and the crew of six abandoned ship into an inflatable liferaft. One crew member was subsequently rescued from the liferaft by a search and rescue helicopter. The remaining five crew members were thrown from the liferaft into the water as it came ashore. Three survived; two did not.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 Particulars of the Vessel

Name	*Ryan's Commander*
Official Number	826129
Port of Registry	St. John's, Newfoundland and Labrador
Flag	Canada
Type	Small fishing vessel
Gross Tonnage[1]	149.41
Length[2]	19.79 m (64 feet 11 inches)
Draught	Forward: 1.98 m Aft: 3.14 m
Built	2004, Triton, Newfoundland and Labrador
Propulsion	804V12 Detroit diesel developing 618 kW, single fixed-pitch propeller, bow thruster
Crew Members	Six
Owners	J&Y Fishing Inc. and D&M Fishing Inc., St. Brendan's, Newfoundland and Labrador

1.1.1 Description of the Vessel

The *Ryan's Commander* was a small fishing vessel (SFV) of closed construction with a round bilge hull form that incorporated a bulbous bow. The vessel was of composite wood and fibreglass construction and the hull below the main deck was subdivided by six transverse watertight bulkheads enclosing (from forward) the bulbous bow, main engine room, shrimp hold, port and starboard refrigerated salt water (RSW) tanks for crab, crew accommodation and galley, and a lazarette in which the hydraulic steering gear and a pair of fresh water tanks were located. A total of eight oil fuel tanks were provided; four under the shrimp hold and the RSW tanks, two in the main engine room, and two in the generator room above the main deck. The bulbous bow was arranged for the carriage of salt water ballast (see Appendix A).

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

[2] See Glossary at Appendix F for all abbreviations and acronyms.

A weather deck extending the full length of the vessel was constructed above the main deck, providing a sheltered space that was open at the stern and fitted with main deck freeing ports on each side. The sheltered space incorporated two fishing gear and crab trap loading openings in each of its port and starboard sides. These openings were fitted with lightly constructed, hinged spray-tight covers. The wheelhouse, anti-roll tank (ART), shrimp trawling gear, warps, winches, nets, and a crab trap hydraulic crane were located above the weather deck, such that the vessel had significantly greater windage than traditional vessels of similar size. The ART was located immediately forward and extended the full breadth of the wheelhouse front.

Photo 1. The small fishing vessel *Ryan's Commander*

1.2 History of the Voyage

At 0700 Newfoundland daylight time[3] on 19 September 2004, the fishing vessel *Ryan's Commander* with a crew of six arrived at Bay de Verde, Newfoundland and Labrador, to discharge a load of shrimp and then proceed to its home port of St. Brendan's (Cottel Island),

[3] All times are Newfoundland daylight time (Coordinated Universal Time minus two and one-half hours).

Newfoundland and Labrador, to repair fishing gear. Discharge of cargo commenced at 0900 and was completed at approximately 1100. The weather forecast was received (northeast gales at 35 to 45 knots forecast for overnight) and the decision to sail was made jointly by the crew.

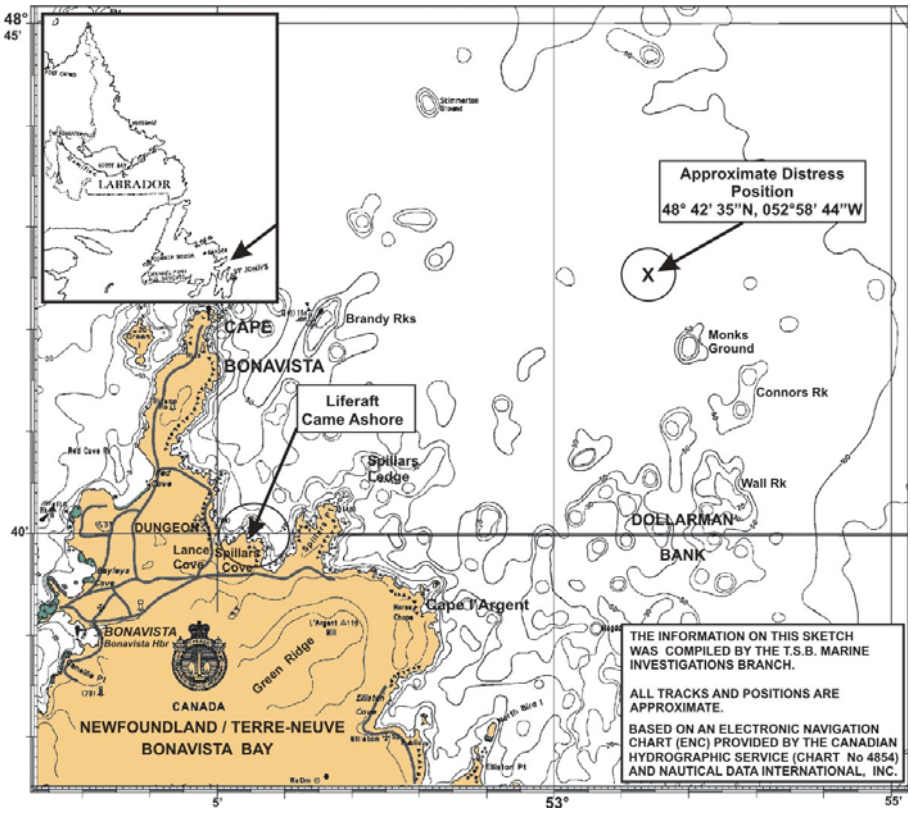

Figure 1. Sketch of the area

Before departure from Bay de Verde, the fresh water tanks in the lazarette were topped up. The oil fuel tanks under the RSW tanks and shrimp holds were virtually full at about 98 per cent capacity; the oil fuel tanks in the engine room and generator room were in use and were reported to be about 35 per cent and 50 per cent full, respectively. The water level in the ART remained at the working level of some 280 mm. On or shortly after departure, the bulbous bow tank was filled with salt water ballast.

The *Ryan's Commander* sailed for its home port at noon, with the RSW tanks and shrimp hold empty. The visibility at the time was five miles in light rain with northeast winds at 40 to 45 knots. The vessel was rigged with a complete outfit of shrimp trawling gear, and a damaged trawl net, which was awaiting repair, was secured on the upper deck forward of the wheelhouse. To facilitate ease of access and catch stowage during shrimp fishing operations, the two watertight doors at the forward end of the RSW tanks had been removed and stored ashore.

After departure from Bay de Verde, courses and speeds were various until after passing through Baccalieu Tickle (the west coast of Baccalieu Island). Once clear of Baccalieu Tickle, course was set to 004° True (T) to pass an estimated five to six miles off Cape Bonavista, Newfoundland and Labrador. The first six hours of the voyage were uneventful.

At about 1800, course was altered to a heading of 330° to make good a course of 290° T; the speed was 5.8 knots. The increasing wind and swell was now on the starboard beam and the vessel was rolling from 10° to starboard to 24° to port. Over the next 30 minutes, the vessel twice rolled to about 35° to port, these rolls being separated by an interval of about 15 minutes. At about 1830, the vessel took a third heavy roll to port, from which it did not recover.

The vessel rolled approximately 80° to port and stayed there. The main engine shut down when the propeller lifted out of the water. The crew managed to transmit a distress message to St. Anthony Marine Communications and Traffic Services (MCTS) at 1835. An eight-man liferaft was launched and the crew successfully abandoned the vessel. The Class I emergency position indicating radio beacon, which was mounted on the port side of the main mast above the wheelhouse, was not taken into the liferaft by the crew but did eventually self-deploy and activate. The liferaft was clear of the vessel by 1845.

At 1835, St. Anthony MCTS received the distress message from the *Ryan's Commander* and informed the Marine Rescue Sub-centre in St. John's who alerted the Joint Rescue Coordination Centre (JRCC) in Halifax, Nova Scotia.

At 1842, a 103 Squadron Cormorant helicopter was tasked to assist by JRCC Halifax. It took off from Gander, Newfoundland and Labrador, at 1942. This was within the required two-hour standby response time.[4] A 413 Squadron Hercules aircraft departed Greenwood, Nova Scotia, at 2050. Canadian Coast Guard auxiliaries *Cedar Point*, *Michael Mariner III*, and *Atlantic Sea Venture*, Canadian Coast Guard ship *Shamook*, fishing vessels *August Gale*, *Ivan Keel*, *Atlantic Pride*, and *Atlantic Conquest*, and the anchor handling tug supply vessel *Atlantic Kingfisher* were also tasked to assist.

At 2055, the Cormorant helicopter arrived on the scene and, shortly thereafter, the liferaft was located approximately one nautical mile offshore. At this time, the winds were estimated at northeast 45 knots and seas of 6 to 9 m. A search and rescue technician (SAR TECH) was lowered to the liferaft at approximately 2105 by means of the helicopter's inboard hoist. The helicopter was fitted with two hoist systems. After a short period of time, a "hoist warning light" condition temporarily caused the hoist to automatically switch to "slow speed." The heavy seas

[4] The Department of National Defence maintains a maximum 30-minute response capability during "working hours" and a maximum two-hour response capability during "quiet hours"; the Canadian Coast Guard maintains a 30-minute response standard 24/7 for primary search and rescue vessels.

and the buffeting of the helicopter caused the hoist wire to snap tight and pull the SAR TECH violently from the liferaft, damaging his safety equipment and causing him minor injuries. The injured SAR TECH signalled the helicopter that he needed to be recovered immediately. After recovery, it was discovered that the pick-up hook was damaged so as to render it inoperable. As a result, the inboard hoist was now unusable.

A second SAR TECH was lowered by means of the helicopter's outboard hoist. He made contact with the occupants of the liferaft and directed them to control the ropes attached to the sea anchors to stop them from entangling his compressed air breathing apparatus gear. At 2144, the SAR TECH brought one survivor up to the helicopter. The crew of the liferaft understood the SAR TECH's instructions to mean that he wanted them to cut away the anchors, which they did. The result was that the liferaft was now more unstable and drifted more rapidly toward the shore.

After lowering the second SAR TECH for a second rescue, the rear spotter in the helicopter, fearing imminent tail rotor contact with the cliff, assertively instructed the pilot to move the helicopter forward. In these few seconds, the SAR TECH was pulled twice from the water and hurled through the air. The air crew then had to cut the cable or risk seriously injuring the SAR TECH. At 2159, the inboard hoist cable was inadvertently cut before the outboard hoist cable (to which the SAR TECH was attached) was cut. The SAR TECH was now swimming free in the ocean, and both hoists were now unserviceable.

The helicopter crew was able to rescue the floating SAR TECH by using a wire-mesh rescue basket attached to the helicopter airframe by a rope. They lowered the basket manually to the sea, then the helicopter flew in close to the SAR TECH on the surface of the water, who swam to the basket and boarded it on his own. The helicopter crew then landed at Cape Bonavista and transferred the survivor to a waiting ambulance. Both SAR TECHs then prepared themselves for a land-based rescue.

Meanwhile, the crew, having been thrown from the liferaft, found themselves in the water close to the cliff's base. The SAR TECHs rescued two more survivors, who by now were ashore, from the cliff's base, while a fourth was rescued by Royal Canadian Mounted Police (RCMP) ground search and rescue (SAR) personnel. One deceased was recovered on September 20, the second on September 24. The second liferaft on board the *Ryan's Commander* self-deployed sometime after the vessel capsized; it was identified and recovered on September 23.

The Canadian Forces air accident investigation team has tested both hoists to identify what technical problems affected their performance (see Section 4.1.1 of this report for Safety Action Taken).

1.2.1 Use of Immersion Suits

A crew member, who was in the galley at the time of the capsizing and had the opportunity to retrieve his immersion suit from his port cabin, proceeded to the bridge, and put the suit on. A second crew member, who was a non-swimmer, retrieved his suit from his cabin before the vessel rolled for the third and final time. He donned his immersion suit immediately after the vessel capsized. A third crew member attempted to retrieve his immersion suit from his starboard cabin before the capsizing, but the vessel's list prevented him from doing so. None of the other crew members attempted to retrieve their suits from the port cabins. One of the two persons who wore their immersion suit survived, whereas the other lost his life due to head trauma.

1.3 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	2	–	–	2
Missing	–	–	–	–
Serious	–	–	–	–
Minor/None	4	–	–	4
Total	6	–	–	6

1.4 Damage to the Vessel and Environment

The *Ryan's Commander* drifted ashore under the cliffs at Spiller's Point, Newfoundland and Labrador, and was declared a total loss after breaking up. There was no damage to the environment.

1.5 Certification

1.5.1 Vessel Certification

The *Ryan's Commander* had a valid safety inspection certificate (SIC) at the time of the occurrence. The certificate (SIC 29) was due to expire on 21 September 2004 because Transport Canada (TC) had not yet confirmed registry and tonnage measurement approval. The vessel was to be subject to regular inspections every four years under the *Small Fishing Vessel Inspection Regulations* (SFVIR).

1.5.2 Personnel Certification

The master held a fishing master fourth-class certificate whereas a fishing master third-class certificate was required to operate this vessel. TC had granted the master verbal permission for the lower certification for the 2004 fishing season only, with the understanding that the master would complete the fishing master third-class certificate before the next fishing season. The remaining crew members of the *Ryan's Commander* were certificated in accordance with existing regulations. Five members of the six-person crew had taken Marine Emergency Duties training.

The owners, who were on board as crew members, held no marine certificates of competency. However, their experience was a factor in the inspector's decision.

1.6 Personnel History

The master had over 10 years' experience in the fishing industry and had sailed on this vessel as master for every trip since it was built about four months previously. All remaining crew members were fishers with between 5 and 41 years of experience. All had sailed previously on the *Ryan's Commander*.

1.7 Weather and Forecast

The weather forecast issued on September 19 called for northeast gales at 35 to 45 knots. At 1830, the wind and sea conditions at Cape Bonavista were northeast at 35 to 48 knots with seas estimated at 3 to 4 m. The air temperature was 9°C.

1.8 Relationships Between Owners, Builder, Marine Consultant (Naval Architect) and Transport Canada

The builder was contracted by the owners to build the *Ryan's Commander* according to the owners' requirements. The marine consultant (naval architect[5]) was engaged to provide technical support services to the builder for and during the construction of the *Ryan's Commander*. On the builder's behalf, the naval architect (NA):

- met with the owners to define the owners' requirements;
- provided general arrangement drawing for review and TC approval;

[5] Marine consultant's service was in the capacity of naval architecture; he is referred to in the report as naval architect (NA) for consistency.

- provided a free surface tank drawing (ART plan) for potential review and TC approval if a stability booklet was required; and

- attended sea trials.

On 15 January 2004, the general arrangement for the *Ryan's Commander*, as submitted, was approved subject to notations in red by the TC technical office in St. John's. Approved copies of this plan were sent to the NA, TC Headquarters in Ottawa, Ontario (for retention purposes only), and the TC district office in Lewisporte, Newfoundland and Labrador, with a copy retained by the St. John's office. This plan with covering letter was then forwarded by the NA to the builder. The ART plan had not been returned by TC to the NA at the time of the occurrence. The diagram below represents relationships (contractual and otherwise) between the owners, builder, NA and TC.

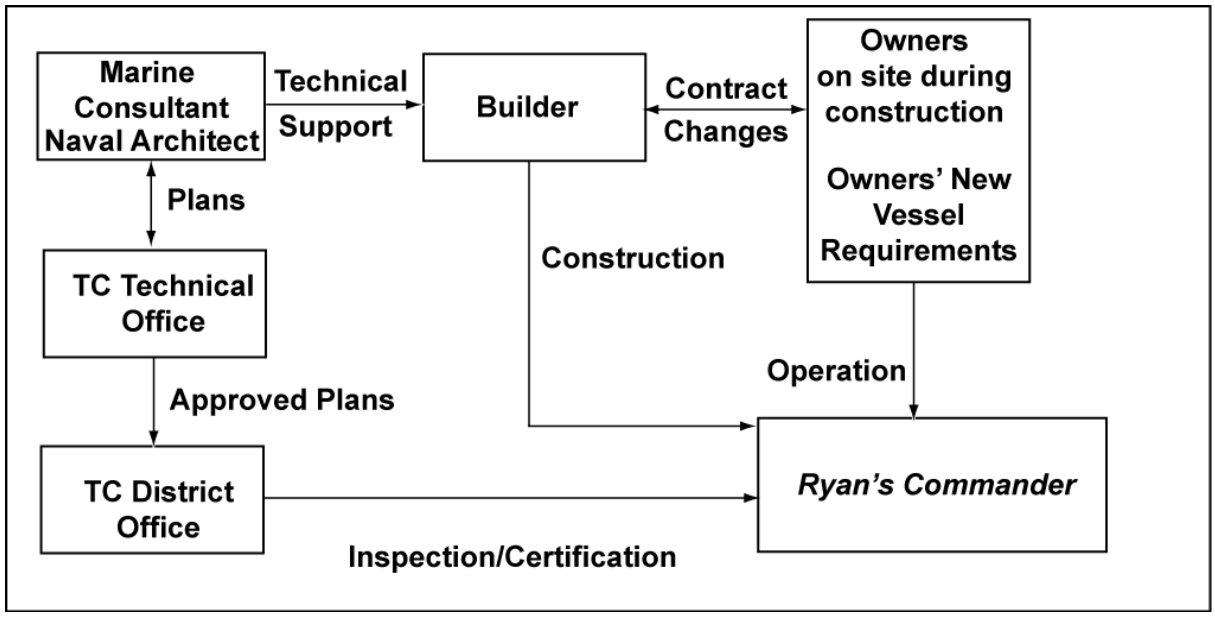

Figure 2. Relationships between owners, builder, marine consultant (naval architect) and Transport Canada

1.8.1 Plan Approval and Inspection Process for Small Fishing Vessels

The SFVIR set out the rules governing the construction and inspection regime or process intended to ensure that these vessels remain seaworthy. The inspection process for small fishing vessels includes the following steps:

1. submission of documents (more often than not in the form of plans) related to the vessel to a TC centre;

2. review of the documents by TC (approved documents will bear a stamp of approval);

3. inspection during construction and follow-up testing of the vessel by an inspector from TC to ensure compliance with the approved plans; and

4. issuance of an inspection certificate by a TC inspector once all the regulatory provisions applicable to the vessel have been met and the vessel is considered seaworthy.

The *Ryan's Commander* plans were submitted by the NA for review and approval by the TC office in St. John's, and the inspection of the vessel and issuance of the certificate was carried out by the TC office in Lewisporte.

1.9 Stability

1.9.1 Stability Requirements for Small Fishing Vessels

As a vessel not exceeding 150 in gross tonnage (GT) and not exceeding 24.4 m in length, the *Ryan's Commander* was classified as a SFV and was subject to the requirements of the SFVIR. The regulations do not require the owners of SFVs like the *Ryan's Commander* who fish for shrimp or crab to submit stability data for approval. This is in contrast to vessels of the same size employed in catching herring or capelin, which must submit stability data for approval by TC. The minimum criterion for determining the stability of these vessels is STAB 4 of the TC publication *Stability, Subdivision and Load Line Standards* (TP 7301).

1.9.2 TSB Recommendation on Small Fishing Vessel Stability

In August 2002, the TSB investigated an occurrence involving the capsizing of the SFV *Cap Rouge II*.[6] Of the seven persons on board the fishing vessel at the time of the capsizing, five persons remained in the overturned hull and drowned. The TSB found that SFVs, such as the *Cap Rouge II*, employed in fisheries other than herring or capelin, are not required to submit trim and stability data for approval, nor is there any mandatory requirement for owners of these vessels to forward this information to TC for safety review or information purposes.

Subsequent to the capsizing of the *Cap Rouge II*, TC initiated a project to determine and extend the application of appropriate stability requirements to all SFVs, regardless of the type of fishery in which they are engaged. Any new requirements to address fishing vessel stability would be incorporated in the new Fishing Vessel Safety Regulations, scheduled (at that time) to come into force in 2006. While encouraged by the initiation of this project and noting that TC was in the process of actively addressing a major safety risk to which crews of small fishing vessels have been and continue to be exposed, the Board recommended that, until such time as new small fishing vessel safety regulations are introduced:

[6] TSB Report M02W0147

> The Department of Transport require all new inspected small fishing vessels of closed construction to submit stability data for approval. (M03-05, issued November 2003)

In response to the recommendation, TC indicated that any new requirements to address fishing vessel stability concerns must follow due regulatory development process and were expected to be incorporated in the new Fishing Vessel Safety Regulations, scheduled (at that time) to come into force in 2006. There was no indication in the response by TC that, prior to such time as the new regulations are introduced, new inspected SFVs would be required to submit stability data for approval. At the time of the capsizing of the *Ryan's Commander*, TC was continuing its work to address the extension of appropriate stability requirements by mid-2007.

The TC Vessel Registration Query System indicates that, of the 150 registered SFVs built since 2004, under five per cent had submitted stability data for approval. This means that SFVs continued to remain at risk.

1.9.3 Regional Requirements for Small Fishing Vessel Stability

Over and above the requirements of the SFVIR, the TC office in St. John's applied a discretionary requirement for SFVs under 150 GT. The intention was to make these vessels subject to a mandatory inclining experiment witnessed by TC and to require stability data, if the vessel's design incorporated features with a potentially negative impact on stability – such as an ART or RSW tanks. The vessel's stability data would then be assessed against the STAB 4 standard, and if they did not meet it, the vessel would have to be modified to meet the standard.

In accordance with the St. John's office policy,[7] the following notation was typed on the approved general arrangement plan: "Following completion, stability and tonnage are to be submitted to Marine Safety." Another notation on the plan, in the form of a stamp, stated: "Vessel not to be employed in catching herring or capelin unless approved stability data for the use of the master is on board, as required by Section 4 of the Small Fishing Vessel Inspection Regulations." This notation is typically used in the plan approval of SFVs as a reminder, should the vessel convert to either of those fisheries.

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[7] Transport Canada, Draft: *Marine Safety's Recommended Guidelines for the Installation of Refrigerated Sea Water Systems Onboard Small Fishing Vessels*, St. John's, Newfoundland and Labrador, 1999.

1.9.4 District Approvals

The TC inspector in Lewisporte was not aware of the St. John's office policy regarding the stability assessment of SFVs. Furthermore, he was not aware of the existence, approval or receipt of the general arrangement plan specifically intended for the *Ryan's Commander*. The inspector had been referring to the approved plans for the "revolution series" of vessels (of which the *Ryan's Commander* was the second) during the construction inspections of the *Ryan's Commander*. There was no policy or procedure that dictated that each vessel in a series was required to have a distinct set of approved plans. Furthermore, it was common that the timeframe for receiving approved plans for new construction in Lewisporte varied anywhere from one to four months and there were occasions when vessels had been certified and were in operation by the time the Lewisporte office had received approved plans from St. John's.

TC also uses the Ship Inspection Reporting System, an electronic database available to all inspectors for entering and downloading information on the status of inspections. The database includes information on plan approval. The approval of the general arrangement plan for the *Ryan's Commander* had not been entered in this system.

There was an inconsistency in the application of TC's policy between the regional and district offices. In previous years, the policy in the Lewisporte district office was to have every new fishing vessel over 15 GT inclined and the resulting stability booklet submitted for review. The resulting workload in the plan approval process created a backlog at the regional office. This led to the policy being discontinued.

In addition to the above, the first vessel of the "revolution series," *Elite Voyager*, had been formally inclined and its stability data submitted to the St. John's office. These data indicated that the vessel's stability met the requirements of STAB 4. As a result, the inspector did not request an inclining experiment and the provision of stability data from the *Ryan's Commander*. However, the main dimensions and the design of the *Elite Voyager* were different from those of the *Ryan's Commander* (see Appendix B for a comparison between the *Ryan's Commander* and the *Elite Voyager*). Further, there were no plan details to account for the changes to the design of the tanks and their arrangement that were made during construction of the *Ryan's Commander*.

1.9.5 Stability-Related Experiments and Trials

On 22 April 2004, when construction of the *Ryan's Commander* was near completion, sea trials were conducted with a TC inspector, the NA, the owners and the crew on board. During the trials, the vessel was exposed to slight seas and wind speeds of up to 20 knots. The ART remained empty and its roll-reduction characteristics were not tested or assessed. Its operation was discussed: the NA mentioned that an initial depth of 355 to 406 mm (14 to 16 inches) of water could be loaded into the ART, and that this depth should be adjusted as the crew gained operating experience with it under various loading and sea conditions. The NA gave no written

guidelines or instructions on the operation of the ART to the owners such as severe weather limitations and any recommended emergency discharge parameters, nor was it requested by the owners.

It was reported that persons attending the sea trials were satisfied with the performance of the vessel. The TC inspector subsequently issued a SIC 29 without requesting an inclining experiment or the development of a stability booklet. The NA and the owners discussed conducting an inclining experiment. The owners were aware that there was no regulatory requirement for the submission of stability data for this class of SFV and declined having a formal inclining experiment conducted in order that a trim and stability booklet could be prepared for their own information or for review by TC. However, the NA requested and carried out an abbreviated inclining experiment for record purposes. The experiment involved the use of one pendulum rather than the recommended minimum of two, and two transverse weight shifts instead of the recommended eight. A detailed survey of the tanks and their as-built arrangement was not performed.[8] The attendance of a TC inspector was not requested and the procedure and recorded data of the experiment were not witnessed officially.

On the basis of the abbreviated inclining experiment, it was determined that the vessel had a transverse metacentric height (GMt) of 1.33 m (4.37 feet) in its as-tested loading condition. Post-occurrence calculations by the TSB show that this estimate was high, as it was based on an incorrectly estimated displacement figure and did not account for several changes to the design of the tanks and their general arrangement that were made during construction. Given the favourable impressions of the vessel's performance during the trials in addition to stability information from a similar vessel, an officially witnessed inclining experiment was not conducted despite the TC notation on the approved plans.

The vessel's building specifications called for the installation of permanent concrete ballast of up to 6 cubic metres (13.75 tons). The actual quantity and location of the ballast was to be determined when the vessel was completed and an assessment of the as-built stability had been made. In view of the relatively large GMt estimated after the abbreviated inclining experiment and the favourable performance of the vessel during the sea trials, a decision was made by the owners not to install permanent concrete ballast on the ship at that time.

[8] Several changes from the as-designed arrangement were made to the fuel tanks during the construction of the vessel.

1.9.6 Occurrence Stability

On the basis of the changes to the design and general arrangement of the tanks during construction, new lightship data were derived and used as the basis for TSB post-occurrence calculations to assess the transverse stability[9] of the vessel under the following loading conditions:

- departure from Bay de Verde with no water ballast, the ART not in use, and no wind;
- at the time of capsizing with water ballast, the ART in use, and no wind; and
- at the time of capsizing with water ballast, the ART in use, and wind.

The results of the calculations[10] for the first two conditions were compared with STAB 4 and are presented in Table 1, below.

STAB 4 Criteria	Minimum Required Value	Departure from Bay de Verde	At Capsizing (with water ballast, the ART in use, and no wind)
GZ area to 30° (in foot-degrees)	10.34	18.62	14.52
GZ area to 40° (in foot-degrees)	16.92	23.57	16.46
GZ area 30 to 40° (in foot-degrees)	5.64	4.95	1.94
GZ at 30° or more (in feet)	0.67	0.73	0.49
Angle of maximum GZ (in degrees)	25	21	20
GMt (in feet)	1.15	3.27	2.6
Range of positive stability (in degrees)	See below	43	39

Table 1. Calculations of transverse stability for departure and capsizing (no wind) conditions. The shaded areas indicate those values below that of STAB 4.

[9] The TSB report titled *Report of Vessel Stability-Related Aspects* is available upon request.

[10] The TSB intact transverse stability calculations incorporate some of the unverifiable basic data recorded during the abbreviated inclining experiment. However, it should be noted that the reported behaviour of the *Ryan's Commander* in the prevailing weather conditions before and at the time of the capsizing is consistent with the calculated stability characteristics that incorporate TSB revised lightship data, actual oil fuel tank capacities and locations, and the reported loading condition.

The loading condition of the vessel on departure does not meet the minimum criteria for the area under the righting lever (GZ) curve between 30 and 40° heel angles or for the angle at maximum GZ, and the vessel has a positive stability range of about 43°.

The results for the loading condition at the time of capsizing (with water ballast, the ART in use, and no wind) show that the vessel did not meet most STAB 4 criteria. Its stability beyond 30° is about 34 per cent of the criteria, and the maximum GZ occurs at 20° rather than the minimum 25° recommended in STAB 4. Furthermore, the vessel's range of positive stability is limited to a maximum of 39° while the STAB 4 typical range is about 48°, and angle ranges greater than 50 to 55° are generally to be expected for typical SFVs of this size (see Appendix C).

At the time of capsizing, the vessel was exposed to strong gale force winds estimated at 40 to 42 knots and a beam swell and seas of 3 to 4 m in height that were acting broad on the starboard side. The crew noted that the *Ryan's Commander* was rolling some 10° to starboard and 24° to port, and that on two occasions the vessel rolled about 35° to port before making a very slow recovery. The asymmetric rolling is indicative of a steady heel to port of some 7°, which is attributable principally to the force of the wind acting on the considerable windage and top hamper of the lightly loaded vessel. The steady heel caused by the wind was augmented by the gravitation to port of oil fuel in cross-connected fuel tanks and the slack water in the ART.

The results for the loading condition at the time of capsizing were compared with the weather criteria of the proposed TC document Stability Standard - Small Fishing Vessels under 24 m[11] and the International Maritime Organization (IMO) *Code on Intact Stability*. They show that the transverse stability and windage of the *Ryan's Commander* were such that the action of a beam wind would cause a steady heel of about 7° and that the range of positive statical stability would be limited to about 34° (see Appendix D). These figures are consistent with the vessel's heeled condition and the slow recovery characteristics the crew observed shortly before the capsizing. The results also show that the severe wind and rolling criteria of the standard mentioned above would be partly met. The angle of heel under action of steady wind (7°) would not exceed the minimum criteria of 16°, but the residual area B above the gust wind heeling lever (LW_2) and below the GZ curve would be equivalent to only 20 per cent of area A, while the set criterion is at least 100 per cent (see Appendix D).

1.9.7 Anti-Roll Tanks

The purpose of an ART is to reduce the rolling motion of the vessel and provide a steadier and more comfortable working platform for the crew. Roll reduction is principally due to the damping effect caused by the athwartships motion of the water inside the tank being similar to, but out of phase with, the natural rolling motion of the vessel.

[11] A copy of the document was distributed by TC at the Canadian Marine Advisory Council in May 2005.

The successful design of an ART is based on relatively complex calculations, which, of necessity with a new vessel, initially rely on preliminary design data. For optimum results in service, the ART must be tuned relative to the natural rolling frequency of the as-built vessel. However, the rolling period of a vessel changes as the displacement, hydrostatic trim particulars, and location of the vertical centre of gravity (VCG) vary with different loading conditions. In practice, optimum tuning is accomplished by adjusting the depth of water in the tank to suit the particular vessel's loading condition and the prevailing weather conditions.

Paradoxically, while a precisely tuned ART dampens a vessel's natural rolling motion, producing the slower more comfortable and apparently safer motion, the transverse stability is actually reduced by the weight and free surface effect of the slack water in the tank. These detrimental effects can be eliminated by discharging the tank content overboard. Without proper tuning and synchronization, the weight and free surface effect of the slack water inside the ART can have a detrimental effect on transverse stability, particularly when located high up in the vessel. Furthermore, because optimum ART performance is largely dependent on an equally balanced athwartships flow of water within the tank, this is only achieved when the vessel is free-rolling about its vertical axis.

Currently, the introduction of ARTs in Canada is limited and their installation has been primarily on board Newfoundland–based SFVs. Stability-related casualty statistics of the United Kingdom (UK), the United States and the Australia regulatory agencies recording and investigating SFV casualties do not have any occurrences in which an ART or similar roll-reduction tank was involved. Currently, the regulatory stability requirements of Canada, the UK, the United States, and Australia make no specific reference to such installations, nor have any recommended standards or operational guidelines been introduced.

The ART installed on board the *Ryan's Commander* was of the free-surface type, with freely interconnected port and starboard spaces fitted with internal baffles, and was located above the weather deck immediately forward of the wheelhouse. The ART was equipped with port- and starboard-side drain valves that were operable from inside the wheelhouse and fitted with identification notices. Reportedly, neither of the drain valves was activated before the capsizing, and it is most likely that this was due to the limited operational experience of the ART by those on board the *Ryan's Commander*.

1.10 Transport Canada's Quality Management System

At the time when the *Ryan's Commander* was built, TC's Quality Management System (QMS) did not have any specific policies, procedures, or work instructions for the plan approval process to deal with issues such as the timeliness of plan approvals, the requirements for the submission of plans for series vessels, or the entry of plan approval data into the Ship Inspection Reporting System.

Several TC policies and procedures, however, did address the issue of SFV stability assessment. In addition to the provisions in the SFVIR and the various discretionary policies and procedures adopted by the St. John's and Lewisporte offices (both part of the Atlantic region) noted above, the following were also in place:

- The St. John's office in the Atlantic region had adopted the policy that inspectors were to take into consideration the application of Section 48 of the SFVIR[12] when approving drawings with equipment that can affect stability.

- The Quebec regional office had adopted a policy,[13] dated 01 April 2004, which defined specific conditions for the full stability assessment of new and existing SFVs. It considered factors including the length of the vessel, the limitations of the voyage, the arrangement of the vessel, and the installation of anti-roll equipment.

- The 1984 TC document titled Notices to Surveyors[14] defined a process by which inspectors could satisfy themselves on the stability of an SFV by first considering the operational history of similar vessels and evaluating the performance of the vessel during sea trials. If still in doubt, an inspector could request a roll test, as well as further steps, if the GMt was found to be under one foot. If the vessel had been involved in an incident that indicated the possibility of a stability problem, an inclining experiment and detailed stability calculations could be requested.

In the absence of either inclusive regulations or detailed policy and procedures, discretionary measures were adopted by some regional offices and by some district inspectors. Often, there was a reluctance to go beyond requirements in the regulations, particularly if owners, builders or designers could be expected to challenge the basis of the inspector's authority.

1.11 Fishing Vessel Size Restrictions in the Fisheries

Controlled access to the fishery by limited entry licensing and regulating the length of fishing vessels are but two strategies adopted by the Department of Fisheries and Oceans (DFO) to improve the conservation and management of the fisheries in Canada. Licence holders wanting to retire their vessel for a newer build may do so only in accordance with the vessel replacement rules.

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12 This section of the regulations states that inspectors may require any test to assure themselves that anything that may affect the seaworthiness of a fishing vessel is safe.

13 Transport Canada document SGDDI: 715537 (Système de gestion des dossiers, des documents et de l'information), version 1 (French) or RDIMS: 715551 (Records Documents and Information Management System), version 1 (English), April 2004.

14 Transport Canada, Notices to Surveyors, Section XVII-7.

First introduced in 1981, vessel replacement rules have undergone a number of changes. In general, a vessel in a particular class of length may be replaced with a vessel having the same length and cubic number[15] up to a maximum.

Before 1988, DFO controlled the length of the vessel. Since 1988, new procedures required that owners provide information on the capacity of the to-be-built replacement vessel.[16] An Application for Fishing Vessel Replacement is required to be submitted and contains information on the vessel's cubic capacity based on measurements certified by a marine surveyor.

In Newfoundland, the current vessel replacement rules apply to vessel lengths up to 19.79 m (64 feet 11 inches) and 600 cubic metres (21 192 cubic feet).

In response to the owners' requirements, the revolution design was modified so that the length and the capacity of the *Ryan's Commander* were maximized, while still remaining within the confines of both the DFO's vessel replacement rules and TC's SFV thresholds.

1.12 Rescue Hoist Systems

After at least 20 hoist-related safety incidents in 2002-2003, the military decided that the Cormorant's rescue hoist "stop-start" function was unacceptable and posed a threat of serious injury. The rescue hoists were found to be too unresponsive to the start and stop buttons. To avoid further problems, the Air Force ordered crews not to use the hoist for marine rescues when winds are more than 30 km/h (16.2 knots) and waves are more than 1.2 m in height, known as Sea State 4. If the waves were any higher, the hoist operator could not quickly compensate for the bobbing of boats during rescues and the hoist could not be used for any rescues–land or sea–when winds exceeded 74 km/h (40 knots) because the safety of the person being hoisted could not be reasonably assured.

At the time of the occurrence, the Cormorant helicopter was fitted with one original hoist, which had limitations placed upon it when used for marine rescues, and a modified hoist, which had been upgraded and did not have these limitations. The original hoist took four seconds for the winch to stop and reverse direction. The modified hoist has a reversal time of 0.08 seconds, which provides an almost instantaneous reversal. Both hoists can be used for land rescues. However, the original hoist was restricted to use in marine conditions of less than 30 km/h (16.2 knots) wind and 1.2 m waves.

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15 Cubic number is the vessel's length X breadth X depth. Depth is the vertical distance between the uppermost continuous deck and the keel.

16 *1991 Report of the Auditor General of Canada*, Chapter 3.

2.0 Analysis

2.1 Sequence of Events at the Time of Capsizing

During the voyage, the lightly loaded vessel's range of positive transverse stability was below the minimum criterion of STAB 4 and what is generally expected for typical SFVs of this size (see Appendix C). The steady wind-induced heel of 7° to port, together with its range of positive transverse stability to not more than 35°, further reduced the vessel's power of recovery on that side. The situation was further compounded by the dynamic effects of beam and quartering seas, which caused significant fluctuations in trim and stability characteristics.

Regulatory stability criteria are based on static water surfaces. In service, however, the distribution of buoyant support varies as wave crests pass under or along a vessel's hull, causing transitory and occasionally marked reductions in the calculated stability of vessels with apparently satisfactory characteristics.[17]

The slow recovery of the *Ryan's Commander*, which had twice before rolled some 35° to port, was indicative of the vessel's highly vulnerable state in the prevailing conditions, as such angles are very close to the limit of its positive stability. The recovery from those two rolls was most likely due to somewhat lower wind forces and less extreme wave-induced reduction of dynamic transverse stability than at the time of the capsizing.

Just before the capsizing, the combined effects of beam seas and increasing or gust wind force caused the vessel to roll slowly to port. The slowness of the rolling motion, in conjunction with the initial wind-induced 7° heel angle, gave the slack fluids in the oil fuel and fresh water tanks enough time to gravitate to the port side. The significant weight of some 1.6 tons of slack water in the ART was not evenly balanced, as it also gravitated to the port side, and, with the liquids in the other tanks, contributed to the heeling effect. The detrimental effects due to the asymmetrical weight transfer and free surface effect of the slack water in the ART could have been eliminated by discharging the contents overboard.

When the *Ryan's Commander* slowly rolled approximately 35° to port, its recovery was initially slowed down by the combined dynamic effects of a reduction of righting momentum caused by wave motion, the wind force heeling effect, and the free surface and gravitation to port of all slack liquids. The vessel's righting ability was further reduced, and the slow heeling continued, when its main deck freeing ports and the crab trap loading openings on the port side of the hull became partially immersed and water was shipped at the boundaries of their ungasketed spray-tight covers. The accumulation of shipped water on the port side of the main deck continued until eventually it overcame the vessel's inherent ability to right itself.

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[17] Food and Agriculture Organization, *Fishing Boats of the World*, volume 2, p. 574.

The *Ryan's Commander* remained afloat for a short time while heeled approximately 80 to 85° to port, but the vessel continued to ship water through the open stern until it finally capsized. Subsequently, the capsized vessel was driven ashore by the storm-force onshore wind and high seas, sustained extensive structural damage, and became a total loss.

2.2 *Stability and Vessel Design*

The desire to maximize capacity within the DFO and TC regulatory limits and thresholds has had a negative influence on the design of some fishing vessels including the *Ryan's Commander*.

When a fishing vessel is being replaced in Newfoundland and Labrador, to qualify under DFO's replacement rules, the vessel length may not exceed 65 feet (19.81 m). In addition, if the vessel is under 150 GT, the TC regulatory requirements are less stringent. Under the SFVIR, fishing vessels are inspected every four years and are not required to submit stability data for approval unless they are employed in catching herring or capelin. In comparison, vessels exceeding 150 GT are inspected annually, and the submission of stability data for approval is mandatory.

While it is possible to build an SFV to the tonnage and length thresholds of TC's SFVIR and to the "capacity limits" of DFO's vessel replacement rules, careful consideration must be given to the design, and the arrangement of its tanks and equipment to ensure adequate stability.

In the case of the *Ryan's Commander*, the range of positive stability was less than expected for a typical SFV of this size. As a consequence of the tonnage thresholds, the working space on the main deck could not be fully enclosed without raising the GT over the limit of 150. The resultant design of the *Ryan's Commander* therefore incorporated a non-weathertight shelter deck area on the main deck, which diminished the range of stability. Furthermore, the wheelhouse, ART and fishing gear, all located one deck level above, had the effect of raising the vessel's VCG and increasing the surface area affected by the wind. It also meant that, except for the forecastle, the superstructure made no contribution to the vessel's reserve buoyancy.

Typically, the effect of a submerging weathertight superstructure is experienced when the vessel heels to larger angles. The additional buoyancy provided improves the righting ability of the vessel at those angles. The lack of such a structure on the main deck of the *Ryan's Commander* is reflected in the shape and the area under the GZ curve, which are adequate only at angles of up to approximately 30°; however, the righting ability of the vessel beyond 30° was compromised by the insufficient area under the GZ curve.

The result was that the calm-water static stability characteristics of the vessel at the time of capsizing were lower than the minimum STAB 4 criteria, with the range of positive stability at less than 40°. Further calculations of other representative in-service loading conditions show that, while the vessel had satisfactory initial stability characteristics, the range of positive GZ and

dynamic stability beyond 30° of heel were either below STAB 4 criteria or lower than that of typical SFVs of this size (see Appendix C). This is indicative of a stability problem associated with the design of the vessel.

2.3 *Influence of the Anti-Roll Tank and Permanent Ballast on Stability*

The ART was in operation before the capsizing while the *Ryan's Commander* was rolling some 17° to each side of the steady wind-induced heel of 7° to port. Consequently, the weight of the cross-flow of water in the ART was not evenly balanced but predominantly on the port side, where it contributed to the heeling moment on that side.

To examine the effect of permanent ballast on the vessel's stability, additional calculations incorporating permanent concrete ballast were conducted. The results indicate that, while the stability of the vessel would have been close to the minimum criteria of STAB 4, its range of positive stability would be consistently lower than the expected range of typical SFVs of this size.

The installation of permanent concrete ballast and the discharge of water from the ART may not have guaranteed the safety of the *Ryan's Commander* in the prevailing rough weather conditions, but such measures would have improved its initial stability and increased its somewhat limited range of positive stability—conditions that would have made the vessel less prone to capsizing.

2.4 *Operator Knowledge of Vessel Stability*

To operate a vessel safely, operators must be fully aware and understand the stability characteristics of their vessel using the data provided in the stability booklet. However, no stability booklet was available for reference on board. In this instance, a damaged trawl net, which was secured on the upper deck forward of the wheelhouse and awaiting repair, could have been better positioned at a lower level. Additionally, the crew was unaware of the detrimental effect of the unsafe operation of the ART in adverse weather conditions. The vessel rolled heavily twice before the third and final roll and no action was taken to ascertain and correct the situation. Not having an adequate knowledge of vessel stability information has serious adverse consequences when making decisions pertaining to safe operating conditions.

Since 2003, a successful applicant for a fishing master third-class certificate must demonstrate comprehensive knowledge of stability. Exempting the master from having a fishing master third-class certificate to operate the *Ryan's Commander* may have compromised the ability of the master to recognize stability-related risks.

2.5 *Stability Approval for Small Fishing Vessels*

Following its investigation into the *Cap Rouge II*, the Board believed that, irrespective of the type of fish being caught, all SFVs should meet minimum transverse intact stability characteristics. While encouraged by TC's intention to introduce these requirements in the new Fishing Vessel Safety Regulations sometime in 2006, the Board was of the opinion that the risk ought to be addressed immediately. In November 2003, the Board recommended that, in advance of the new regulations, "the Department of Transport require all new inspected small fishing vessels of closed construction to submit stability data for approval." TC moved forward in establishing stability requirements for SFVs, but indicated that any new standards would have to be incorporated in regulations. The result was that, in the spring of 2004, there was no clear requirement for the *Ryan's Commander* to meet the minimum intact stability criteria of STAB 4.

In place of the clear national requirements recommended by the TSB, a patchwork of ad hoc regional policies remained in place for new SFVs. For instance, the St. John's office attempted to go beyond the mandatory regulatory requirements and assess the vessel's stability characteristics before issuing a certificate on a discretionary basis under Section 48.

In contrast, the inspectors in Lewisporte decided not to request an inclining experiment or stability booklet submission for the vessel. Their decision was taken in consideration of the following:

- Under the SFVIR, SFVs like the *Ryan's Commander* do not have to undergo an inclining experiment or have approved stability information on board.

- The TC inspectors in Lewisporte were not aware of the St. John's office policy on SFV stability assessment. Lewisporte inspectors did not get the guidance that may have been available in the approved general arrangement plan before they certified the vessel. The plan was not readily available, and the inspectors did not look for one because a record of the plan approval was not entered into the Ship Inspection Reporting System. Vessels of novel designs such as the *Ryan's Commander* pose unique challenges from a safety perspective. Despite this, there was no procedure for the plan approval of "series" vessels to ensure that the Lewisporte office would have expected specific plans for the *Ryan's Commander*, and it was not unusual for SFVs to be certified before the plans had been approved and received from St. John's.

- The inspectors in Lewisporte were under the impression that they had limited authority to request inclining experiments and stability submissions for SFVs.

- The first vessel of the "revolution series," the *Elite Voyager*, had been satisfactorily inclined and stability data had been submitted to the St. John's office. Although the results of that review were not yet known at the time of the *Ryan's Commander* sea trials, the NA report indicated that the vessel met the requirements of STAB 4.

- The *Ryan's Commander* was considered to have performed satisfactorily during the sea trials.

The decision to approve the *Ryan's Commander* for service in this context was made by the district office without reference to all pertinent vessel information on file, and without knowledge of national or regional policies, or well-defined inspection procedures. Such a decision was consistent with the inspection regime commonly used for similar vessels. As such, the QMS that TC had in place for marine operations did not ensure that policies and attendant procedures were in place for

- the assessment of SFV stability,

- plan submission and approval of "series" built vessels,

- the recording of plan approval information into the Ship Inspection Reporting System,

- the timely approval of plans, and

- the review of all pertinent vessel information by inspectors prior to the issuance of a safety inspection certificate.

As a consequence, the *Ryan's Commander* was certified for operation by TC without stability data. An assessment against STAB 4 criteria would have provided information essential to make an informed decision, and an opportunity to institute effective measures to improve the vessel's inadequate righting ability.

2.6 Fisheries and Safety Regulatory Framework

The Board, concerned about fishing vessel safety, has initiated safety communications to TC relating to shortcomings in stability requirements,[18] training and education,[19] promotion of a safety culture,[20] and conflicting requirements between regulators having jurisdiction over

[18] TSB recommendations M94-30, M94-32, M94-33, M03-05, M03-06

[19] TSB recommendations M92-06, M94-31, M96-13, M03-07

[20] TSB Recommendation M03-02

fishing vessel operation and management of fisheries.[21] Changes to the safety regulatory regime and measures instituted to foster fishing vessel safety culture will, over time, lead to higher standards and greater safety.

As previously stated, the DFO vessel replacement rules influenced the design of the vessel, which, in this occurrence, affected the stability aspects of the *Ryan's Commander*. Other operational considerations were also affected by these rules.[22]

The need to consider fishing vessel safety in the development of fisheries management plans and policies has been recognized in DFO studies[23] and the DFO has maintained that it will work with federal and provincial agencies and the fishing industry to improve fishing vessel safety.[24]

Although DFO and TC participate together at forums such as the Canadian Marine Advisory Council, TC has not been involved as an active joint partner in formulating vessel rules, regulations, policies, or integrated fisheries management plans. Cooperation between DFO and TC is essential to maintaining a safety regime for SFVs.

In the absence of effective cooperation, the fisheries continue to be managed in an environment that does not fully address fishing vessel safety concerns, and fishers continue to be placed at undue risk.

2.7 Responsibility for Operational Safety

It is essential that owners ensure that their crew members have been provided with all pertinent information on the operation of the vessel and its limitations, so that they can make fully informed operational decisions. Owners have to provide the crew with the information it needs about on-board systems and equipment to operate the vessel safely. In this occurrence, the owners, who were also part of the crew, did not seek out detailed information on the operation of the ART or the stability of the vessel, nor was such information provided. As a result, they were not fully aware of the operational limitations of the vessel or the ART, and did not appreciate the dangerously developing situation, thus precluding effective, timely measures to remedy the situation.

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21 Marine Safety Advisory 02/03

22 *Fishing Vessel Safety Review (less than 65 feet)* by the Canadian Coast Guard Maritime Search and Rescue, Newfoundland Region, November 2000.

23 *Ibid*.

24 Fisheries Management, Department of Fisheries and Oceans, *Vessel Replacement Rules and Procedures on the Atlantic Coast*, discussion paper, 2002.

2.8 *Design and Build Process*

The design process has to find an appropriate balance between many elements such as arrangement, strength, seaworthiness, stability and habitability. Furthermore, this process has to consider each of these elements in terms of the constraints imposed by the requirements of the client (be it an owner or a builder) and various regulatory bodies, as well as the terms of the building contract. In the occurrence, significant design shortcomings affecting the vessel's stability went undetected.

In November 2003, approximately five months before the vessel entered service, preliminary stability calculations were performed by the NA for several crab fishing loading conditions. Of necessity, these calculations were based on estimated values for vessel displacement and the location of the centre of gravity, as well as the designed arrangement of fuel tanks and other weights on board the vessel. When compared against the requirements of STAB 4, the results showed that the vessel would meet the stability standard for all operating conditions considered.

Typically, such preliminary stability calculations are carried out during the design process to provide a level of assurance that, once the construction is complete, the vessel will meet any appropriate or required standards. In addition, they may be used to assess the impact of any design changes during construction. Once the vessel has been built, however, it should be subjected to an inclining experiment to determine its actual weight and the location of its centre of gravity. This information should then be used to assess the stability of the vessel accurately under a variety of loading conditions that reflect actual operating conditions.

The owners' contract with the builder for the construction of the *Ryan's Commander* did not include an inclining experiment or the development of a stability booklet, nor were they required by regulation. The preliminary stability calculations were not reviewed to assess the impact of changes from the as-designed arrangement made during the construction of the vessel. After the sea trials on 22 April 2004, TC issued a short-term inspection certificate that did not require the performance of an inclining experiment or submission of a stability booklet as conditions for certificate extension. The NA, however, was permitted by the owners to perform an abbreviated inclining experiment for his own records.

The way this abbreviated test was performed meant that the GMt calculated at the time could only be considered a rough estimate. Furthermore, GMt information alone, for one condition of loading, does not provide a complete picture of a vessel's stability. However, as this estimated GMt was relatively high, it was used to support the decisions that a full assessment of the vessel's stability and the installation of the permanent ballast (stipulated in the contract between the owners and builder) were unnecessary.

The owners' and crew's favourable impressions of the vessel's performance during the trials in 20-knot winds and the issuance of a certificate by TC reinforced the previous decision by the owners not to have a complete and officially witnessed inclining experiment conducted. Subsequently, the abbreviated inclining experiment overestimated the GMt.

NAs provide important information to owners, regulators, and builders, who rely on their expertise and guidance to make decisions and take actions that affect the safety of the vessel. When this information is based on incomplete data, good practices suggest that NAs explain those limitations and their implications, so that owners, regulators, and builders can make informed decisions. This approach would help reduce the risk to vessels and their crews.

2.9 Stowage and Accessibility of Life-Saving Equipment

Crews of SFVs often store their immersion suits in their cabins. In a developing emergency situation, crew members might not have access to their cabins or time to retrieve their suits. As a result, they would be forced to abandon ship without the benefit of adequate protection from hypothermia during inclement weather.

This is what happened at the capsizing of the *Ryan's Commander*. With the vessel on its port beam-ends, one crew member was unable to enter his starboard-side cabin because the doorway was above his head. Others were reluctant to enter their cabins for fear of becoming trapped in them if the vessel capsized. Of the two crew members who were able to retrieve their suits before abandoning the vessel, one had retrieved his suit from his cabin before the vessel rolled for the third and last time; the other, who was in the galley when the vessel was on its beam-ends, happened to be near his port-side cabin.

The stowage of immersion suits in areas that may become inaccessible when a vessel is listing heavily precludes their use. This compromises the safety of the crew.

The Board, concerned that the rapid capsizing and sinking of fishing vessels often left crews insufficient time to avail themselves of on-board life-saving equipment, recommended that the Department of Transport conduct a formal evaluation of current practices for the stowage of immersion suits on fishing vessels with a view to ensuring immediate accessibility.[25]

In response, TC revised regulations that called for float-free arrangements for liferafts and issued Ship Safety Bulletin 07/2001, on 04 September 2001, which addressed the accessibility of life-saving equipment. As part of its regulatory reform process, TC is presently consulting with industry on the proposed new Fishing Vessel Safety Regulations, which will address the stowage and accessibility of all life-saving equipment, including immersion suits. The proposed new regulations are now expected to come into force by mid-2007.

[25] TSB recommendations M94-05 and M94-08, issued May 1994

2.10 Search and Rescue Response

The *Ryan's Commander* capsized outside of regular Department of National Defense (DND) working hours, and the primary SAR air resources at Canadian Forces Base Gander were operating on a maximum of two-hour response basis. The response helicopter departed for the scene within the prescribed response time. However, by then, the liferaft had drifted closer to shore. The minimum difference in response time between the maximum 30-minute response in use during working hours and the actual deployment during the occurrence amounts to 30 minutes. While it is difficult to determine whether the outcome of this occurrence would have been different had the SAR helicopter arrived 30 minutes earlier, it is possible that the effect of the winch and hook problems on the rescue would not have been as critical and that, with the liferaft further offshore, the SAR crew would not have been hampered by the close proximity of the shore and cliffs.

In 1992, the Auditor General of Canada, after conducting a review[26] of the national SAR program, noted that neither the Canadian Coast Guard (CCG) nor the DND had established service standards that cover all the time elements of a SAR response. The Auditor General of Canada also noted that, while service standards need to be developed, for less populated areas in which there are few incidents and resources may be located some distance away, response times for these resources may have to be longer.

The Auditor General of Canada's 1994 follow-up on action taken in response to the 1992 observations and recommendations noted that the CCG and DND have "neither established nor used time-based search and rescue service standards to plan for resources and indicate to the public the expected response standards for search and rescue resources. They continue to believe that time-based service standards would not be beneficial or practical because they do not provide a true indication of the effectiveness of the search and rescue program."[27]

In 1999, the National Search and Rescue Secretariat (NSS) conducted a review of SAR response services,[28] which noted that while the DND prescribed a maximum 30-minute response capability during "working hours" and a maximum two-hour response capability during "quiet hours," the CCG maintained a maximum 30-minute response standard 24/7 for primary SAR vessels. The report noted that resource availability determines the DND SAR standby position and that the maximum 30-minute response standard during DND "working hours" does not

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[26] *1992 Report of the Auditor General of Canada*, Chapter 8, Section 8.39, accessed 12 September 2006 at www.oag-bvg.gc.ca/domino/reports.nsf/html/ch9208e.html.

[27] *1994 Report of the Auditor General of Canada*, Chapter 2, Section 2.57.

[28] National Search and Rescue Secretariat, *Review of SAR Response Services*, sections 40 to 43, 1999, accessed 12 September 2006 at www.nss.gc.ca/site/reports/responsereview_e.asp.

always coincide with the days or time of peak SAR activity. A TSB review of reported marine occurrences involving air SAR response between 1995 and 2005 indicates that at least 60 per cent of those occurrences took place during DND "working hours."

The NSS report concluded, *inter alia,* that "a lack of strategic management within the SAR program has resulted in each department developing standby postures in isolation, without consultation with other SAR departments. As a result, there is no common rationale driving standby postures."

The report went on to recommend that the standby position of primary SAR resources should be determined primarily through an analysis of demand for services.

No further review of SAR readiness and standby position has been conducted by the NSS since 1999. While local DND SAR commanders have the discretion to realign SAR standby periods so that they coincide with periods of greatest SAR activity, DND policy limits the 30-minute standby position to 40 hours per week.[29]

[29] National SAR Manual, Section 4.8.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. The lightly loaded vessel capsized when the wind-induced heel and dynamic rolling motions in the prevailing sea conditions, the gravitation of slack liquids in tanks, including the anti-roll tank (ART), and the weight of sea water shipped and retained on the main deck overcame the vessel's limited range of positive stability.

2. The stability of the recently built vessel was compromised by the weight and buoyancy distribution of the shelter deck, wheelhouse and fishing gear, the lack of ballast to counteract the vessel's limited righting ability, and the ART, which allowed slack water to gravitate to the port side.

3. The decision not to conduct a formal inclining experiment ran counter to the condition on the Transport Canada (TC)–approved general arrangement plan and meant that the vessel's stability characteristics were neither fully assessed nor fully understood by the owners, the builder, the naval architect or TC.

4. The master and owners were not fully aware of the operational limitations of the vessel or ART, and did not appreciate the dangerously developing situation, thus precluding effective, timely measures to remedy the situation.

3.2 Findings as to Risk

1. Exempting the master from having a fishing master third-class certificate to operate the *Ryan's Commander* may have compromised the ability of the master to recognize stability-related risks.

2. In the absence of effective cooperation between TC and the Department of Fisheries and Oceans (DFO), the fisheries continue to be managed in an environment that does not fully address fishing vessel safety concerns, and crews continue to be placed at undue risk.

3. The desire to maximize capacity within the DFO and TC regulatory limits and thresholds has had a negative influence on the design of some fishing vessels, placing them at risk.

4. TC did not require all new inspected small fishing vessels of closed construction to submit stability data for approval, pursuant to Board Recommendation M03-05 issued in November 2003.

5. The stowage of life-saving equipment that is not readily accessible precludes its use during an emergency when abandoning a vessel.

6. The weaknesses identified in the inspection regime and inconsistencies in the application of discretionary powers indicate that there were certain inadequacies in the performance of TC's Quality Management System.

3.3 Other Findings

1. The Department of National Defence search and rescue standby times for response vary from a maximum of 30 minutes during work periods to a maximum of two hours during quiet hours. A total of 60 per cent of search and rescue activity takes place during the 30-minute response time.

2. The crew did not take into the liferaft the Class I emergency position indicating radio beacon, which was mounted on the port side of the main mast above the wheelhouse, but it did self-deploy and activate.

4.0 Safety Action

4.1 Action Taken

4.1.1 Department of National Defence

Subsequent to the occurrence, the Department of National Defence (DND) modified all the original hoists on board Cormorant helicopters. By 2005, all Cormorant helicopters were equipped with hoists capable of high-speed reversals.

The DND Transport and Rescue Standards and Evaluation Team issued an e-mail to all CH-149 Cormorant units amending the hoist switching procedure in the CH-149 Standard Manoeuvre Manual. The new procedure will preclude both hoists from being enabled and powered at the same time.

4.1.2 Transport Canada

On 15 February 2005, a Marine Safety Advisory (MSA) was sent to Transport Canada (TC) concerning the lack of regulatory requirements, standards, or guidelines addressing the installation and operations of roll-reduction devices, including paravanes and anti-roll tanks (ARTs) for any vessels. The MSA suggested that TC may wish to initiate measures to ensure that operators of vessels fitted with anti-roll devices, such as paravanes or ARTs, are informed of the safe operation and limitations of this equipment and that codes of practice and/or regulations are drafted to ensure the safe installation and operation of these devices.

In response, TC indicated that, on 20 November 2000, it had issued Ship Safety Bulletin 15/2000 entitled *The Use of Roll Dampening Paravane Systems*, which addressed certain hazards associated with the use of paravane stabilizers. In June 2005, TC issued Ship Safety Bulletin 01/2005. The bulletin cautions operators of vessels fitted with passive ARTs about the safety hazards associated with their use and provides information on the design and operation of ARTs, combining anti-roll devices, and the training of masters and crew members.

In July 2005, TC indicated that the Ship Inspection Reporting System database was upgraded for enhanced input of historical plan approval details, sister ship information, specific drawing titles, etc. This upgrade provides inspectors with information as to whether plans for a vessel exist, whether they were changed, and when they were approved.

In January 2005, a discussion document proposing new stability regulations was drafted by TC and distributed to the fishing industry. The proposed draft regulations, which would apply to new and existing fishing vessels under 24 m in length, would require an inclining experiment if the vessel is fitted with an ART.

4.1.2.1 Plan Approval Process

In May 2005, a TC National Plan Approval Committee was established to review existing policies and practices, and revise and update them as required. The review will include the TSB concerns expressed regarding the plan approval process.

4.1.2.2 Inspection Process

All new inspectors appointed after October 2004 are required to undergo TC's Marine Safety National Training Program.

4.1.3 Interim Recommendation on Stability Approval for Small Fishing Vessels

As a result of this investigation, on 21 November 2005, the Board issued an interim recommendation respecting the stability requirements for small fishing vessels (SFVs).

Over the years and since 1990, the Board has expressed concern that the lack of stability assessment of SFVs compromises the safe operation of these vessels. In November 2003, following the capsizing of the *Cap Rouge II*,[30] which resulted in the loss of five lives, the Board recommended that:

> The Department of Transport require all new inspected small fishing vessels of closed construction to submit stability data for approval. (M03-05, issued November 2003)

and that:

> The Department of Transport require all existing inspected small fishing vessels currently without any approved stability data be subject to a roll period test and a corresponding freeboard verification not later than their next scheduled quadrennial inspection. (M03-06, issued November 2003)

In its 2004 Annual Report to Parliament, the Board assessed TC's response to the two recommendations as "Unsatisfactory," citing the continued risk for these vessels until effective action has been taken.

[30] TSB Investigation Report M02W0147

It is recognized that a primary line of defence is to help ensure that all SFVs are designed and operated with adequate stability throughout a range of loading conditions related to the vessel's intended service. The absence of formal requirements has led to inconsistency and confusion over which SFVs must submit stability data for approval on a regional basis. This allows vessels that may have inadequate stability characteristics to continue to be in service.

The Board is aware that Section 48 of the existing *Small Fishing Vessel Inspection Regulations* (SFVIR) allows inspectors to require any test to be made to satisfy themselves that a vessel is seaworthy for its intended purpose. This, in conjunction with uniform guidelines, would provide an opportunity to identify vessels at risk for which stability assessment would be required. The Board is also aware that the new Fishing Vessel Safety Regulations are due to come into effect no earlier than mid-2007. Given that, since the loss of the *Cap Rouge II*, five SFVs including the *Ryan's Commander* have capsized with a loss of 11 fishers, and in the absence of meaningful action to address past recommendations, fishers continue to be placed at undue risk.

The Board, therefore, has recommended that:

> The Department of Transport ensure that the Board's previous recommendations M03-05 and M03-06 are immediately implemented. (M05-04, issued November 2005)

In response to Recommendation M05-04, TC indicated that, in advance of the new Fishing Vessel Safety Regulations, it has established an interim policy for determining, based on a list of risk factors, whether a small inspected fishing vessel requires a stability booklet. A stability booklet is a document that sets out, in standard form, the results of various flotation and stability calculations and is used to instruct the master and the crew about the safe limits of the vessel under a variety of loading and operating conditions. This interim measure will provide important additional information for the master and takes effect immediately.

TC has issued Ship Safety Bulletin 04/2006, entitled *Safety of Small Fishing Vessels: Information to Owners/Masters about Stability Booklets*. The bulletin outlines the process that vessel owners and operators must follow to determine if their vessel requires a stability booklet and how to obtain one. The bulletin applies to all owners and operators of fishing vessels, new and existing, between 15 and 150 in gross tonnage and less than 24.4 m in length.

The interim actions and measures taken by TC will substantially reduce the risks associated with safety deficiencies identified in recommendations M03-05 and M03-06. The response was therefore assessed as Fully Satisfactory.

The proposed Fishing Vessel Safety Regulations will require that, at periodic intervals, not exceeding five years, or upon completion of modifications or alterations to a vessel, a lightship survey be conducted by the vessel's authorized representative and witnessed by a marine inspector. The results of that survey will determine if the vessel will require a new stability assessment.

4.2 Safety Concern

4.2.1 Fishing Vessel Safety at Sea in Fisheries Management Plans

In past investigations, the Board has identified common elements that affect safety, such as poor seamanship practices, improper loading, lack of understanding of stability information, training, overall operator competency, and inadequate harmonization of vessel safety and fisheries management objectives.

There are also other elements that influence safety. Commercial fishing in Canada, as in many other countries, is a highly competitive environment and economic pressures induce fishers to accept and take risks to maximize the catch. Such safety implications are not adequately taken into account in current fisheries resource management measures. Dwindling resources, for instance, have forced fishers to operate further offshore, and in all weather and sea conditions – often exceeding the capability of their vessels.

Fishery resource management plans, including measures such as conservation harvesting plans, licensing, allocation or access, can have an impact on vessel safety in a variety of ways. Since 1995, the TSB has conducted several investigations in which it has noted the impact of the fishery resource management measures of the Department of Fisheries and Oceans (DFO) on the operational safety of fishing vessels:

- M95W0187 *Arctic Taglu/Link 100* and fishing vessel *Roxana Glen*
- M97W0236 *Pacific Charmer*
- M97L0021 *Gilbert D*
- M02W0102 *Fritzi-Ann*
- M05W0110 *Morning Sunrise*

In two recent separate but similar occurrences (M02W0102 and M05W0110), modifications to the bows or the construction of platforms to conform with the conditions of DFO fisheries management measures adversely affected vessel safety and seaworthiness. Deck-extension

platforms are permitted to carry cargo or fishing gear and are excluded from overall length measurements as long as no buoyancy is added to the vessel – effectively negating a feature that would enhance vessel's stability.[31]

As demonstrated in the current investigation, the 65-foot length restriction prescribed by DFO's vessel replacement rules influenced the design and construction of the *Ryan's Commander*. The length-restriction measure, which did not fully consider safety and operational environment, led to a design to maximize the catch but was not conducive to minimizing the risks associated with the operating practices prevalent in the commercial fishing environment.

The resultant design had a reduced range of positive stability under normal operating conditions—meaning that the vessel was unable to recover from angles of roll that could be expected under normal operating conditions. Moreover, the length restriction and vessel safety (including the stability) requirements were established in isolation by DFO and TC respectively. An independent 1991 report prepared by the Oceans Institute of Canada noted that such a lack of consistency between the two departments' rules "may encourage unsafe vessel design."[32]

A November 2000 report titled *Fishing Vessel Safety Review (less than 65 feet)* by the Canadian Coast Guard (CCG) Maritime Search and Rescue, Newfoundland Region, found that one of the external influences affecting safety was that "fisheries management is being carried out with conflicting objectives, where safety was either subordinated or given no consideration at all."

Subsequent to the substantial increase in the number of accidents at sea in Newfoundland and Labrador between 1993 and 1999, a review conducted by the DFO concluded that vessel size was a factor in many accidents.[33]

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31 *DFO Pacific Region's Guidelines for Vessel Measurements*

32 *Jurisdictional Issues Affecting Marine Operations and Safety*, report prepared by the Oceans Institute of Canada for the Canadian Coast Guard Marine Advisory Council, September 1991.

33 Fisheries Management, Department of Fisheries and Oceans, *Vessel Replacement Rules and Procedures on the Atlantic Coast*, discussion paper, 2002.

It is understood that the DFO, recognizing that it does not have expertise in fishing vessel safety, is committed[34] to fostering the safety of fishers by

- providing for flexibility in the fisheries management practices and ensuring that DFO will not encourage unsafe behaviour or fishing under unsafe conditions;[35]
- working with federal and provincial authorities and the fishing industry;[36]
- giving increased consideration to the potential risks associated with its fisheries management measures on the safety of fishers.[37]

The Board is encouraged that the DFO is committed to addressing some of these deficiencies and that TC has recently taken specific interim measures to require stability assessments of inspected high-risk fishing vessels. The Board also notes that DFO and TC established a Memorandum of Understanding to provide a framework for cooperation, including a commitment to hold regular head office and regional meetings, and national and regional Fishing Vessel Safety Advisory Committees.[38]

However, despite the need for greater cooperation and harmonization of regulations, policies and practices between TC and the DFO, the Board believes that it is not sufficient to address fishing vessel safety solely within the confines of the vessel-based and crew-based regulatory approach. Rather, safety should also be addressed within the broader context of fishery management.

Given the influence that fisheries management can have on aspects of fishing vessel safety, the Board is concerned that the safety risks associated with fisheries management measures are not adequately identified and addressed. The Board, therefore, will continue to monitor occurrences involving fishing vessels with a view to assessing the need for further safety action on this issue.

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34 Memorandum from Assistant Deputy Minister, Fisheries Management, to Regional Director Generals dated 15 February 2001, titled *Safety at Sea Consideration in Fisheries Management Plans*

35 Fisheries Management, Department of Fisheries and Oceans, *Vessel Replacement Rules and Procedures on the Atlantic Coast*, discussion paper, Section 4, The Safety-at-Sea Issue, 2002.

36 Ibid

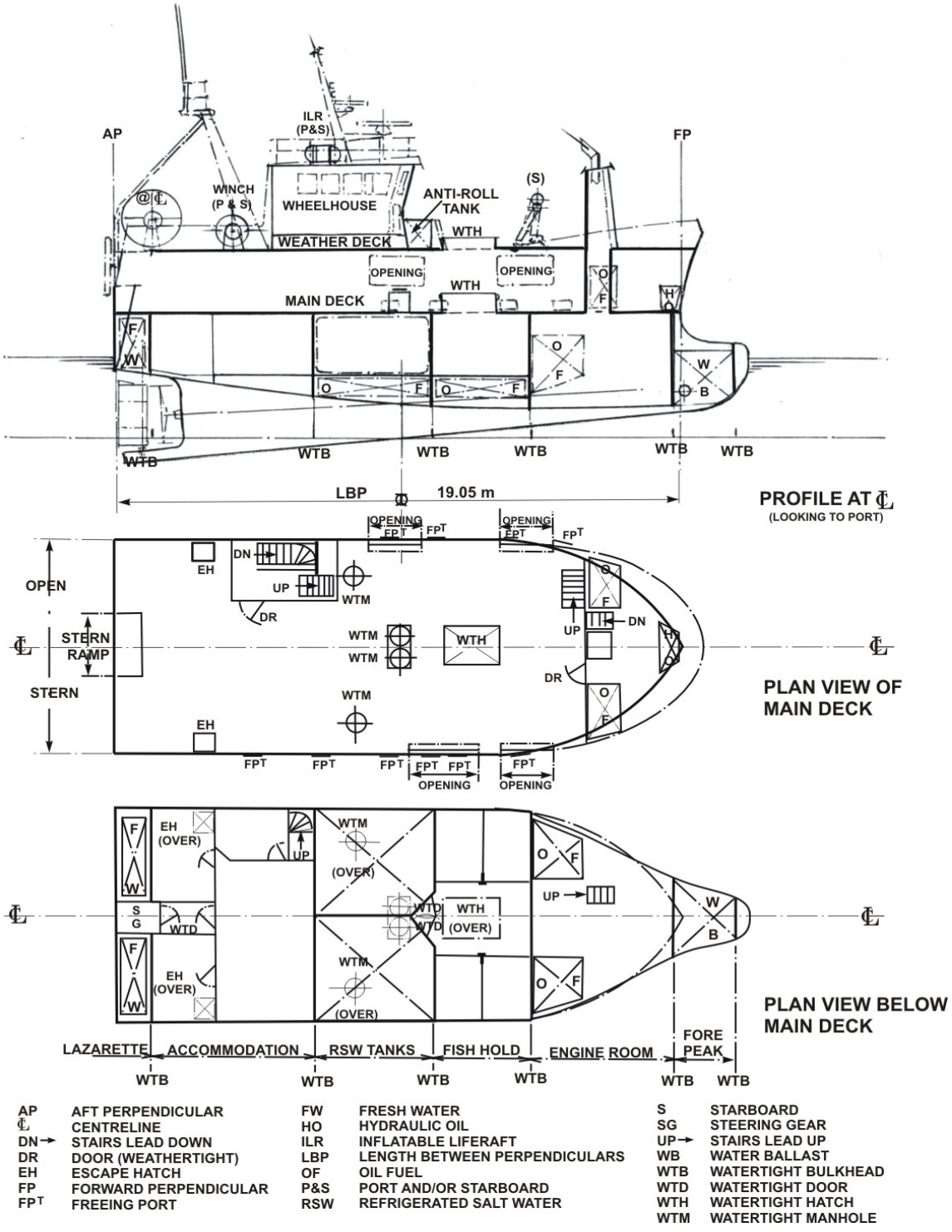
37 Department of Fisheries and Oceans response to MSA 01/06

38 Signed in Ottawa, Ontario, 06 November 2006

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 13 September 2006.

*Visit the Transportation Safety Board's Web site (**www.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.*

Appendix A – General Arrangement Plan of the Ryan's Commander

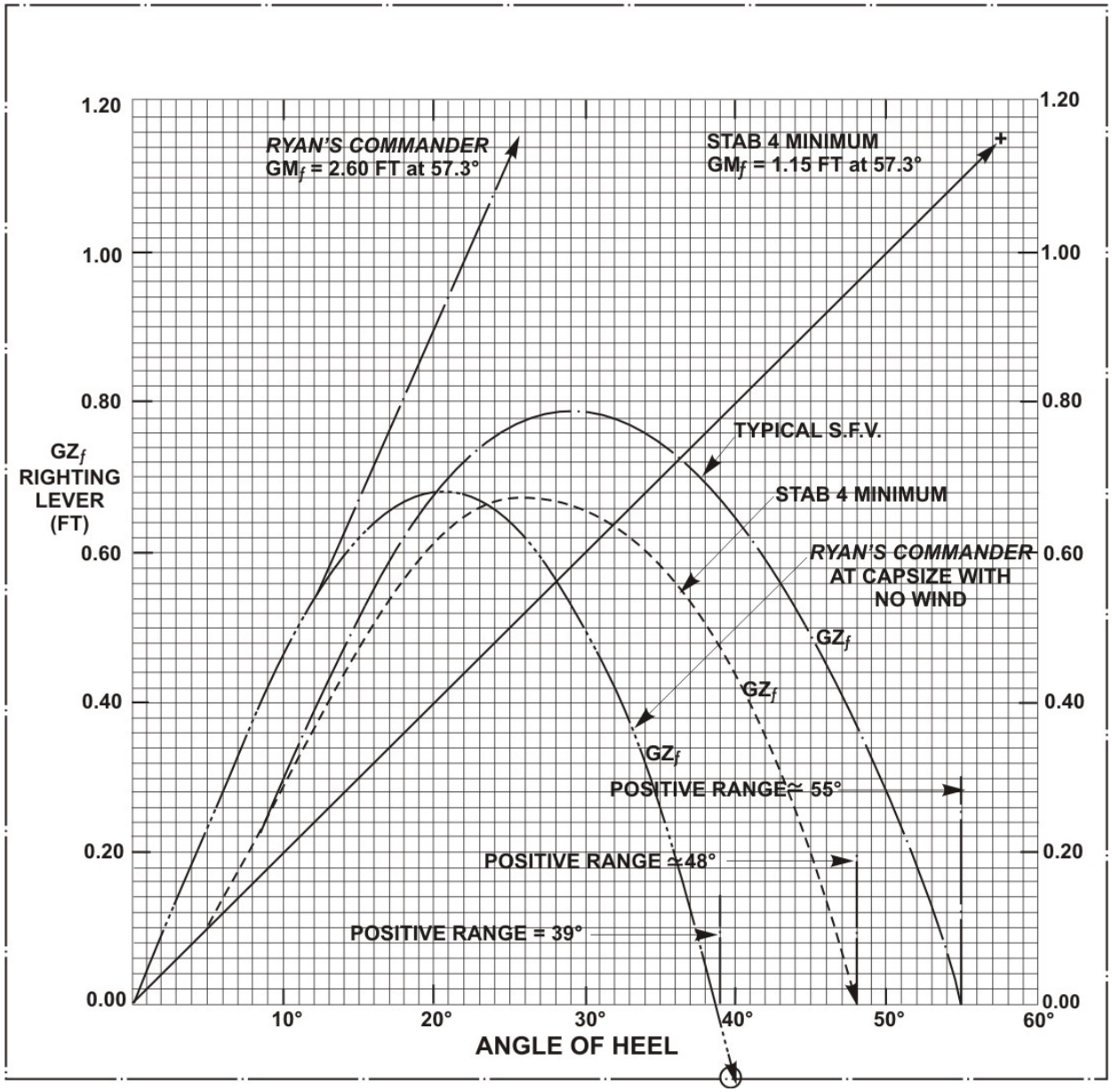


AP	AFT PERPENDICULAR	FW	FRESH WATER	S	STARBOARD
℄	CENTRELINE	HO	HYDRAULIC OIL	SG	STEERING GEAR
DN→	STAIRS LEAD DOWN	ILR	INFLATABLE LIFERAFT	UP→	STAIRS LEAD UP
DR	DOOR (WEATHERTIGHT)	LBP	LENGTH BETWEEN PERPENDICULARS	WB	WATER BALLAST
EH	ESCAPE HATCH	OF	OIL FUEL	WTB	WATERTIGHT BULKHEAD
FP	FORWARD PERPENDICULAR	P&S	PORT AND/OR STARBOARD	WTD	WATERTIGHT DOOR
FP^T	FREEING PORT	RSW	REFRIGERATED SALT WATER	WTH	WATERTIGHT HATCH
				WTM	WATERTIGHT MANHOLE

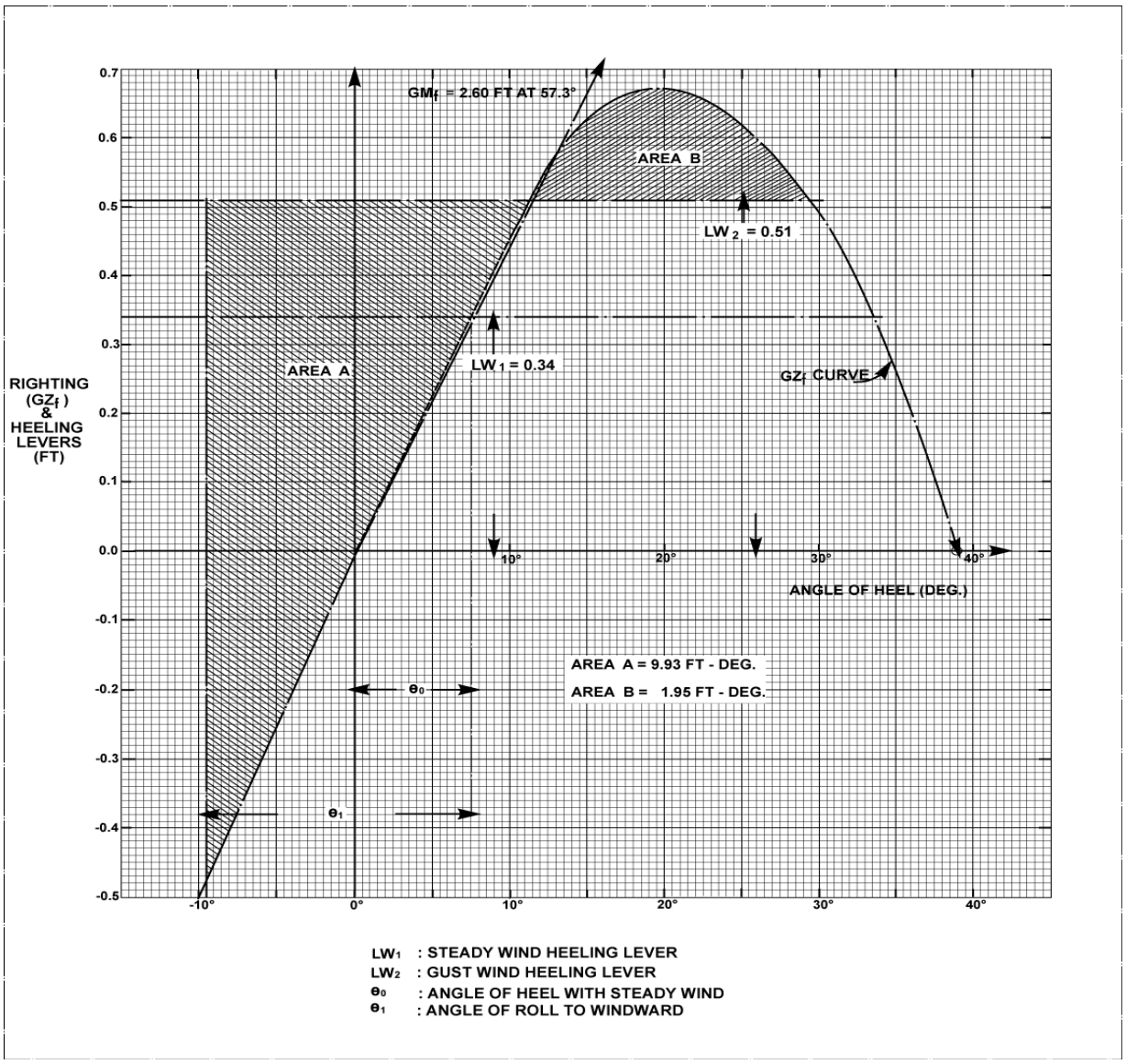
Appendix B – Comparison Between the Ryan's Commander and the Elite Voyager

Items	*Ryan's Commander*	*Elite Voyager*
Length Overall (feet)	64.92	60
Breadth (feet)	24	22
Depth to Main Deck (feet)	10.5	10.5
Displacement (long tons)	115.93	97.19
Longitudinal Centre of Gravity (lightship) (feet)	3.44a	0.87a
Vertical Centre of Gravity (lightship) (feet)	13.7	12.88
Location of Wheelhouse	20 inches above weather deck	weather deck
Location of Trawl Winches	weather deck	main deck
Location of Fuel Oil Tanks	double bottom, engine room and generator room	double bottom and engine room
Fitted with Permanent Ballast (long tons)	None	7.5
Fitted with Anti-Roll Tank	Yes	Yes
Fitted with Refrigerated Salt Water Tanks	Yes	No

Appendix C – Comparison of GZ Curves for the Ryan's Commander, STAB 4, and a Typical Small Fishing Vessel



Appendix D – Comparison of the GZ Curve for the Ryan's Commander with the Weather Criteria



Appendix E – List of Supporting Reports

The following TSB report was completed and is available upon request:

S.F.V. *Ryan's Commander – Report of Vessel Stability-Related Aspects with Supplement*

Appendix F – Glossary

a	abaft
ART	anti-roll tank
CCG	Canadian Coast Guard
DFO	Department of Fisheries and Oceans
DND	Department of National Defence
GMt	transverse metacentric height
GT	gross tonnage
GZ	righting lever
IMO	International Maritime Organization
JRCC	Joint Rescue Coordination Centre
km/h	kilometres per hour
kW	kilowatts
LW_2	gust wind heeling lever
m	metres
MCTS	Marine Communications and Traffic Services
mm	millimetres
MSA	Marine Safety Advisory
N	north
NA	naval architect
NSS	National Search and Rescue Secretariat
QMS	Quality Management System
RCMP	Royal Canadian Mounted Police
RSW	refrigerated salt water
SAR	search and rescue
SAR TECH	search and rescue technician (Canadian Forces)
SFV	small fishing vessel
SFVIR	*Small Fishing Vessel Inspection Regulations*
SI	International System (of units)
SIC	safety inspection certificate
T	True (degrees)
TC	Transport Canada
TP 7301	Transport Canada publication entitled *Stability, Subdivision and Load Line Standards*
TSB	Transportation Safety Board of Canada
UK	United Kingdom
VCG	vertical centre of gravity
W	west
°	degrees
°C	degrees Celsius
'	minutes
"	seconds