Transportation Safety Board of Canada

Bureau de la sécurité des transp du Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Marine Occurrence Report

Bottom Contact

of the Bulk Carrier "CANADIAN EXPLORER"
St. Lawrence River
Near Lotbinière, Quebec
16 April 1993

Report Number M93L0001

Synopsis

On 16 April 1993, the fully loaded "CANADIAN EXPLORER" was navigating upbound in the St. Lawrence River under winter navigation conditions. The vessel, which was under the conduct of a pilot, touched bottom on the south side of the channel off Lotbinière, Quebec, in daylight and in fine weather conditions.

The Board determined that, while transiting the Richelieu Rapids under the conduct of a pilot, the "CANADIAN EXPLORER" touched bottom because neither the pilot nor the officer of the watch effectively monitored the vessel's progress in an area of strong current.

Ce rapport est également disponible en français.

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1.0 *Factual Information*

1.1 *Particulars of the Vessel*

	"CANADIAN EXPLORER"
Official Number	323003
Port of Registry	Toronto, Ontario
Flag	Canadian
Type	Bulk carrier
Gross Tons[1]	16,353
Length	217.79 m
Draught (at time of occurrence)	F[2]: 7.87 m A: 7.90 m
Built	1965, rebuilt in 1983 Lauzon, Quebec
Propulsion	Sulzer five-cylinder, 6,100 BHP
Owners	Upper Lakes Shipping Corp. Toronto, Ontario

1.1.1 *Description of the Vessel*

The "CANADIAN EXPLORER" is a bulk carrier with all aft accommodation.

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

2 See Glossary for all abbreviations, acronyms, and definitions.

3 All times are EDT (Coordinated Universal Time (UTC) minus four hours) unless otherwise stated.

1.2 *History of the Voyage*

On 16 April 1993, the "CANADIAN EXPLORER" was en route from Port Cartier, Quebec, to Hamilton, Ontario, with 23,870 tonnes of iron ore. On board were 22 crew members, including the master. There was a change of pilot at Québec, Quebec, at 0330[3]. After a cursory exchange of formalities between the pilot and the master, the latter left the bridge for his cabin at about 0350. The bridge was now manned by the officer of the watch (OOW), the helmsman was at the helm, and the pilot had the conduct of the vessel.

At about 0640, under orders from the pilot, the vessel's course was altered to 222° Gyro (G) as the vessel entered the Richelieu Rapids (see Appendix A). The vessel was stemming a strong ebb tide. There is conflicting evidence respecting the vessel's speed. The pilot maintained that the vessel's average speed over the ground in the Richelieu Rapids was three to four knots (kn).

At about 0647, when the vessel was off Richelieu Island, the pilot ordered the course to be adjusted to 225°(G). The helmsman maintained that course for over 15 minutes, until the vessel struck bottom and sheered to starboard. There was no other traffic in the vicinity. The helmsman called out to the pilot, who was seated in front of him, and asked for instructions. As he did not get an immediate response, he resorted to trying to get the pilot's attention physically by shaking him. The pilot then stood up, looked out of the window, and ordered the helmsman to steer in the middle of the river.

The OOW immediately summoned the master and plotted the vessel's position. The time of bottom contact was 0707, and the position was recorded as 46°37'15"N,071°57'W.

The master arrived on the bridge and, upon asking the pilot, was advised that the pilot had fallen asleep. This communication was overheard by the helmsman. There was no further communication between the pilot and the master. The master remained on the bridge until the pilots changed at Trois-Rivières, Quebec.

The "CANADIAN EXPLORER" reported the occurrence to the Quebec Vessel Traffic Centre (VTC) at 0720 and continued on her passage. The vessel arrived at Hamilton at 1652 on 18 April 1993 without further incident.

The forepeak and the forward holds were sounded, and no ingress of water was found. A subsequent survey noted some distortion of the shell plating at the bilge radius and of the floors in the No. 1 port ballast tank. There was no injury.

1.3 *Vessel Certification*

The "CANADIAN EXPLORER" was certificated, equipped, and manned in accordance with existing regulations.

1.3.1 *Personnel Certification*

The crew members of the "CANADIAN EXPLORER" who were directly involved in this occurrence held the appropriate certification, and the pilot was appropriately licensed.

1.4 *Personnel History*

The master had 20 years' experience as an officer. He had 14 years' experience as a master and had been on the "CANADIAN EXPLORER" since 1988.

The first mate, who was the OOW, had 13 years' experience as an officer. He joined the company in July 1989 and the "CANADIAN EXPLORER" in March 1993.

The helmsman had 20 years' experience as a deck-hand. His tenure as a helmsman was with this company. He had joined the "CANADIAN EXPLORER" in March 1993.

The pilot had 16 years' experience piloting vessels in District No. 2, Québec/ Trois-Rivières. The last 11 of these years were as a Class A pilot. He was familiar with the "CANADIAN EXPLORER", having piloted the vessel several times in the past.

1.5 *Weather Information*

The weather forecast for the area was consistent with that experienced by the vessel. Weather conditions included a north-easterly wind at 10 kn and visibility of over 10 miles. The time of sunrise, as calculated, was 0600.

1.5.1 *Current and Tidal Information*

On 16 April 1993, high tide at Barre à Boulard, Quebec, was at 0354; low tide was at 1120. At the time of the occurrence, the tide was ebbing. The ebb current as depicted on Canadian Hydrographic Service chart No. 1334 for the Richelieu Rapids and Barre à Boulard

runs parallel to the channel. It runs in the direction 042° at 5.6 kn for the Richelieu Rapids and in the direction 054° at 5.6 kn for Barre à Boulard. The ebb current at the Richelieu Rapids can reach a maximum of 8 kn under certain conditions (*Sailing Directions, St. Lawrence River, Cap-Rouge to Montréal*).

1.5.2 *Water Level*

The depths on charts are referenced to a "lower water level", called "chart datum," so that the water surface will seldom fall below the given figures.

The water level recorded at the gauge at the Portneuf, Quebec, wharf, which is some three miles downstream from Lotbinière, was as follows:

Date	Maximum	Minimum
16 April	4.4 m	0.8 m

The depth at the position where the "CANADIAN EXPLORER" touched bottom was, therefore, more than the charted depth (see Appendix A).

1.6 *Navigation Equipment*

1.6.1 *Vessel Equipment*

The vessel's navigation equipment included two radars, a Loran C, a gyrocompass, a magnetic compass, and an echo-sounder. Only the compasses and one radar were in use at the time of the occurrence; the second radar was on stand-by. The navigation equipment and machinery in use were functioning satisfactorily.

1.6.2 *Fixed and Floating Navigational Aids*

From Cap-Rouge to Trois-Rivières, the shoreline is quite low and lightly wooded. The main ship channel, which has a least depth of 10.7 m and a least width of 244 m, is marked by buoys and leading lights (ranges). The lighted buoys in the Richelieu Rapids and Barre à Boulard channels had been lifted and replaced by spar buoys for the winter. The fixed navigation aids in the area were reported to be operating normally at the time of the occurrence.

The Lotbinière leading lights are situated some 2.5 miles above Richelieu Island. These lights, in line bearing 222°, lead through the Richelieu Rapids and are visible in line of range only. The Barre à Boulard leading lights are situated on the south-east shore south of Portneuf. These lights, in line with the Richelieu Island light bearing 054°, lead through the Barre à Boulard dredged channel and are visible in line of range only. These lights are astern for an upbound vessel, but there is good visibility astern from the wings of the bridge on the "CANADIAN EXPLORER".

The alter-course position from 222° to 234° is off buoy Q73.

1.7 *Conduct of Navigation*

The hand-over procedure between the relieved pilot and the relieving pilot was described as very informal. There was no communication between the OOW and the pilot respecting the navigation of the vessel, nor was there a formalized relationship between them. The last communication between them took place

at 0635, when the vessel was abeam of Portneuf. This conversation concerned the ice trapped behind the wharf.

The pilot, who had the conduct of the vessel, gave steering orders directly to the helmsman. Reportedly, he checked the vessel's position by radar, but he could not recollect how frequently he did so. He further indicated that the high water and strong current had submerged the spar buoys and that the current in the area was three to four times the normal rate. He estimated that the vessel had been on the last course of 225°(G) for about 15 to 20 minutes and alleged that the strong current had pushed the vessel out of the channel in a matter of seconds.

The OOW used the radar and referred to the chart to monitor the progress of the vessel and make appropriate entries in the log. He was unable to confirm or deny if any of the spar buoys were under water, but he did see some of them during the passage from Québec. At the time of the bottom contact, the OOW was walking from the chart table to the starboard radar and was unable to tell if the pilot was awake or asleep.

During the watch, the helmsman was periodically relieved briefly by the OOW so that he could make coffee. The helm orders from the pilot were first repeated by the helmsman and then executed. Once executed, they were reported again to the pilot. Before bottom contact occurred, the last course ordered by the pilot and executed by the helmsman was 225°(G).

1.7.1 Navigation with Pilot Embarked

Acknowledging the need for training requirements and reinforcement of the basic principles relating to the keeping of a navigational watch, the Canadian Coast Guard (CCG) published the *Recommended Code of Nautical Procedures and Practices*, in keeping with the IMO's *International Conventional on Standards of Training, Certification and Watchkeeping for Seafarers, 1978*. The Code states that:

> Despite the duties and obligations of a pilot, his presence on board does not relieve the master or officer in charge of the watch from their duties and obligations for the safety of the ship .... The master and the officer of the watch shall co-operate closely with the pilot and maintain an accurate check of the ship's position and movement.

The owners' Manual of Standard Procedures also points out that the presence of a pilot does not relieve the master (or deck officer) of the responsibility for the safe navigation of the vessel. The manual states the need for the OOW to monitor the vessel's position and to assist and advise the pilot. In this instance, the OOW did not effectively monitor the vessel's position but rather relied implicitly on the pilot.

1.7.2 Position Discrepancy

The position of bottom contact as reported by the pilot to the VTC was the same as that recorded in the ship's logbook. However, during the investigation, the

pilot maintained that the position was further north.

1.8 Rest and Work Schedule

The OOW worked a four-hours-on/ eight-hours-off watch system. His watch period was 0400-0800 and 1600-2000. On 15 April 1993, he went to bed at 2230 and was called for his watch at 0330. He felt rested and fit for his duties.

The helmsman worked the same watch system as the OOW and was reportedly rested.

The pilot's schedule called for 12 days of work followed by 12 days off work, no more than one assignment a day, and a minimum of 14 hours off duty between assignments. He maintained two residences, one in Québec and the other in Trois-Rivières.

The pilot reported that he does not drink or smoke and that he did not take any drugs prior to this assignment. He further indicated that this was his "third consecutive night assignment" and that he was tired.

According to the work schedule provided by the Laurentian Pilotage Authority (LPA), the pilot had performed the following pilotage assignments:

Vessel Name	Date	Time
"SAUNIÈRE"	10 April 1993	0015 to 1358
"ENERCHEM CATALYST"	12 April 1993	2310 to 1325
"CANADIAN EXPLORER"	16 April 1993	0320 to 1115

1.9 Irregular Work Schedule and Human Performance

Extensive research has been conducted on the subject of the impact of shift work and irregular work patterns on human performance.

Physiological activity varies throughout the day according to circadian rhythms. Working during periods when people normally sleep has certain predictable consequences. Alertness decreases and reaches a low point in the early morning hours. This decreased alertness, coupled with a shortage of sleep, predisposes an individual to inattention, a breakdown in the ability to monitor situations or instruments, and drowsiness to the point of falling asleep. The effect can be cumulative with repetition and can be more pronounced when night work is combined with irregular schedules, which make adjustment even more difficult. People can become susceptible to micro-naps lasting from seconds to a few minutes without their awareness.

In this instance, the pilot drove his car from Québec to Trois-Rivières on 15 April 1993. He went to bed at about 2230 and slept well until 0020, 16 April 1993, when he received a telephone call for an assignment in Québec. He spent two hours travelling to Québec by taxi.

The pilot could not recall having admitted to the master that he had fallen asleep, but he emphasized that he was tired. He spoke a lot about fatigue and stated that he was unable to sleep during the day after working through the night.

1.10 Training and Safety

The negative effects of shift work and irregular work schedules can, however, be mitigated by a combination of sleep schedules and control of one's environment and diet. Training and educational programs to help these workers maintain optimum performance despite irregular work/rest schedules have been developed and can be customized to meet specific needs.

The pilot was aware of material available on work-related stress, fatigue and performance maximization for people with irregular work schedules. However, the LPA has neither a directive nor an educational program in place to provide guidance for pilots.

1.11 The Role of the Pilot

In Canada, the *Pilotage Act* requires that, in a compulsory pilotage area, a licensed pilot or holder of a pilotage certificate have the conduct of the vessel subject to compulsory pilotage.

The pilot is responsible to the master for the safe navigation of the vessel, and he is retained to direct the navigation of the vessel.

2.0 *Analysis*

2.1 *Winter Navigation*

Whether the winter spar buoys in the area were clearly visible above the waterline could not be established. However, as floating aids can go missing or become displaced, particularly those that have been exposed to winter conditions, their positions cannot be relied upon. Thus pilotage must be conducted primarily using fixed aids and familiar shore-based landmarks. In this instance, as ranges were available to guide the vessel through the Richelieu Rapids and Barre à Boulard channels, the status of the floating aids should have had no influence on the outcome of this occurrence.

2.2 *Lack of Close Monitoring of the Vessel's Progress*

During the transit of the Richelieu Rapids, the vessel's course had been adjusted to 225°(G) when she was about 0.7 nautical mile (M) from the alter-course position off buoy Q73. This would suggest that either an adjustment of course was essential to maintain the vessel on the recommended track or that the vessel's course was altered to stay close to the west side of the channel. In any event, close monitoring of the vessel's position and progress would have been in order. However, neither the pilot nor the mate effectively monitored the vessel's progress as she navigated through the channel, where a strong current was being experienced. This conclusion is reflected in and consistent with the lack of action by both the pilot and the OOW for some 5 to 10 minutes before bottom contact.

2.2.1 *Conflicting Evidence Respecting the Position of Bottom Contact--Impact on Occurrence*

The pilot maintained that the actual position of bottom contact was further north of the position reported to the VTC.

If the position reported to the VTC was accurate, then the vessel would have made good a course of 227°(G). The vessel's average speed over the ground between 0647 and the time of bottom contact would have been about 6 kn. As can be seen from Appendix A, the distance between the position of bottom contact and the point at which the vessel would have crossed the next course line is about one mile, and the "CANADIAN EXPLORER" would have continued past the alter-course position for about 10 minutes before bottom contact was made.

On the other hand, had the vessel made good a course of 225°(G), her position at the time of bottom contact would have been some 0.75 M in a north-easterly direction from the reported position. This would have given the vessel an average speed over the ground of about 4 kn, and the vessel would then have continued on a course of 225°(G) for an additional 6 minutes past the alter-course position before bottom contact was made.

Regardless of the course made good, the vessel continued well past the alter-course position for several minutes without action on the part of the pilot or input from the OOW.

2.2.2 *Contradictory Evidence Respecting the Current*

The pilot maintained that the strong current pushed the vessel out of the channel in a matter of seconds; that is, that the vessel drifted some 130 m. For this to occur, the easterly component of the set at right angles to the channel had to have been at a rate greater than 4 kn. However, there is no evidence to suggest that such a cross-current existed in the area. It also was not possible for the current to be three to four times stronger than the usual 5 kn (3 x 5 kn = 15 kn).

In any event, the pilot had to have been knowledgeable about the current conditions, and he therefore should have exercised extreme caution and effectively monitored the progress of the vessel.

2.3 *Bridge Team Concept*

The practice of OOWs relying on pilots and rarely questioning a pilot's actions is quite widespread. As pilots are engaged because of their local knowledge and as varying conditions can be experienced, it is essential that the OOW be aware of the pilot's intentions and of the difficulties and constraints of the pilotage area. The OOW is never in a good position to question the pilot regarding the progress of the ship or a situation at any time, unless the OOW knows what should be happening at that time. In this instance, the conduct of the OOW suggests that he was unaware of the pilot's intentions and of the developing situation.

The pilot's immediate action after the bottom contact was to look out of the window to determine the vessel's position and then to order the helmsman to steer in the middle of the river. This would indicate that the pilot had lost positional awareness for a time before the vessel touched bottom.

The procedures in place on the bridge allowed the pilot and the OOW to operate independently. The opportunity for teamwork to maximize performance was not exploited. A greater degree of interaction between the pilot and the OOW could have resulted in the effective monitoring of the vessel's progress and upgraded performance. It also could have alerted the OOW to potential problems and might have enabled him to initiate preemptive remedial action.

2.4 *Pilot Performance*

The vessel grounded because neither the pilot nor the OOW effectively monitored the vessel's progress through the water. Factors significant to the bottom contact were that, before the occurrence, the pilot was tired and had lost positional awareness, and that the vessel continued past the alter-course position for several minutes. In addition, after the occurrence, the pilot's instructions to the helmsman were to steer in the middle of the channel, where neither buoys were visible and where the only ranges were astern of the vessel. These factors are consistent with the pilot having been asleep at the time of the bottom contact, as was initially indicated to the master. The pilot's performance was degraded by a combination of the work schedules and lack of sleep, and the OOW was not aware that the pilot had fallen asleep.

Although the pilot was aware of some of the effects of irregular work schedules, his behaviour pattern and sleep discipline on the period of rest before the occurrence were not conducive to maximizing his performance during the assignment on the night of 15/16 April 1993. This is reflected in the pilot's having been tired despite having been off duty for over 54 consecutive hours between each of his last three assignments. Further, as he had had only about two hours of sleep before this assignment, the pilot was susceptible to inattention to tasks and a lower standard of work, and became vulnerable to falling asleep.

3.0 Conclusions

3.1 Findings

1. There was no interaction between the pilot and the officer of the watch (OOW) regarding the safe navigation of the vessel, nor had any formal procedure been adopted.

2. The practice of OOWs relying on pilots and rarely questioning a pilot's actions is relatively widespread.

3. Neither the pilot nor the OOW effectively monitored the progress of the vessel while transiting an area of strong current under winter navigation conditions.

4. The pilot had had over two days of rest period since his last assignment, but was tired at the start of this assignment.

5. The pilot's behaviour pattern and sleep discipline during rest periods were not conducive to maximizing his performance.

6. The pilot had had the conduct of the vessel for some three and a half hours and was asleep at the time of bottom contact.

7. The "CANADIAN EXPLORER" overshot the alter-course position and steamed for several minutes before making bottom contact.

8. The Laurentian Pilotage Authority (LPA) has neither directive nor educational programs in place to provide guidance for the pilots on matters relating to work-related stress, fatigue, and performance of people working irregular schedules.

3.2 Causes

While transiting the Richelieu Rapids under the conduct of a pilot, the "CANADIAN EXPLORER" touched bottom because neither the pilot nor the officer of the watch effectively monitored the vessel's progress in an area of strong current.

4.0 Safety Action

4.1 Action Taken

4.1.1 Pilot-Master Relationship

Poor communications on the bridge, interrupted procedures, lack of situational awareness, lack of teamwork between pilots and ships' officers, etc. have been contributory factors in several other similar occurrences in recent years.

The Board is currently conducting a safety study with respect to the operational relationships between ships' masters, officers of the watch (OOW) and marine pilots. This study is nearing completion and, based on the findings of the study, the Board will make appropriate safety recommendations to improve the effectiveness of bridge team management practices on vessels in Canadian waters.

4.1.2 Employee Assistance Program for Pilots

As a result of this occurrence, the Laurentian Pilotage Authority (LPA) and the Corporation des pilotes du Saint-Laurent are exploring the development of an employee assistance program to assist their pilots in safety performance. The LPA reported that it is more vigilant now on the conduct of pilots in general.

4.1.3 Bridge Resource Management (BRM)

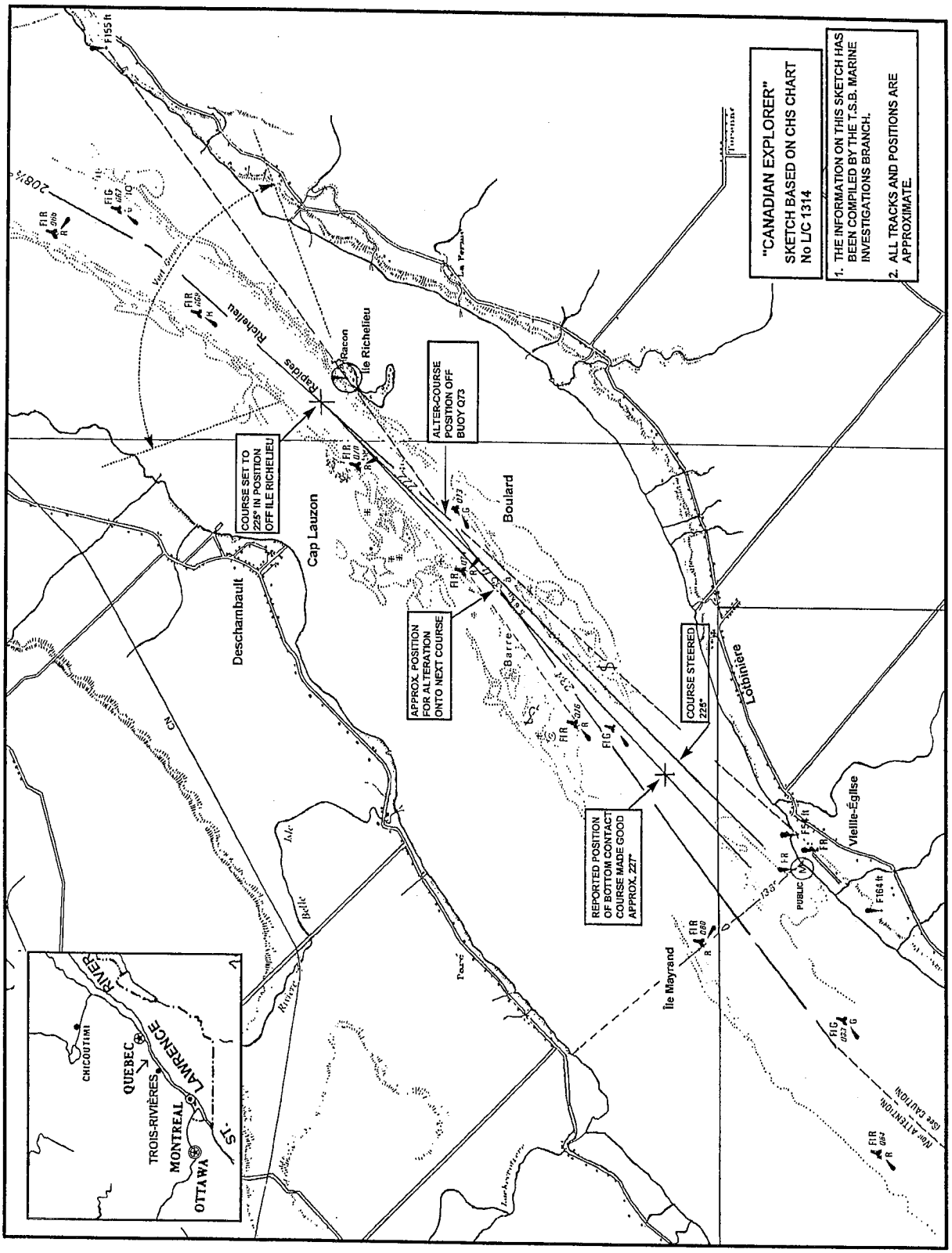
The Canadian Coast Guard (CCG) has drafted a BRM discussion paper that is presently being reviewed by selected marine schools and pilotage authorities. Once finalized, this paper will form the basis for the development of an optional training course on this subject. In response to this occurrence, both the shipowners and the LPA acknowledged the need for greater interaction between deck officers and pilots.

4.1.4 Study on Fatigue Aboard Canadian Ships

A research project by the Transportation Development Centre in Montreal is being completed on the subject of manning and fatigue aboard Canadian ships. This study focuses primarily on hours of work and time of day in order to understand and minimize the effects of fatigue.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson, John W. Stants, and members Zita Brunet and Hugh MacNeil, authorized the release of this report on 05 July 1995.

Appendix A - Chart Depicting the Track of the Vessel



Appendix B - Glossary

A	aft
BHP	brake horsepower
BRM	Bridge Resource Management
CCG	Canadian Coast Guard
EDT	eastern daylight time
F	forward
G	Gyro (degrees)
IMO	International Maritime Organization
kn	knot(s): nautical mile(s) per hour
LPA	Laurentian Pilotage Authority
m	metre(s)
M	nautical mile(s)
N	north
OOW	officer of the watch
ranges	Lights or markers placed in line to indicate a recommended course to steer.
SI	International System (of units)
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VTC	Vessel Traffic Centre
W	west
°	degree(s)
′	minute(s)
″	second(s)