MARINE INVESTIGATION REPORT

M98C0004

GROUNDING

OF THE TANKER "ENERCHEM REFINER"

ST. LAWRENCE SEAWAY, OFF THOMPSON ISLAND, ONTARIO

2 APRIL 1998

Transportation Safety Board of Canada

Bureau de la scurit des transports du Canada

Marine Investigation Report

Grounding

of the Tanker "ENERCHEM REFINER"
St. Lawrence Seaway, off Thompson Island, Ontario
2 April 1998

Report Number M98C0004

Synopsis

While transiting the St. Lawrence Seaway en route from Sarnia, Ontario, to Montreal, Quebec, the "ENERCHEM REFINER" was under the conduct of the second officer with the assistance of the third officer. A course alteration was not carried out on time and the vessel ran aground near buoy D-57 off Thompson Island, at about 1250 Eastern daylight time.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 Particulars of the Vessel

	"ENERCHEM REFINER"
Official Number	329353
Port of Registry	Toronto, Ontario
Flag	Canada
Type	Tanker
Gross Tonnage[1]	4,502
Length[2]	119.18 m
Draught	Forward: 7.0 m Aft: 7.5 m
Built	1969, Lauzon, Quebec
Propulsion	Two Fairbanks Morse marine diesel engines, 2,450 kW, driving two fixed-pitch propellers
Cargo	8,145 tonnes of Bunker "C"
Crew	21
Owners	Enerchem Transport Inc. Montreal, Quebec

1.1.1 Description of the Vessel

The "ENERCHEM REFINER" is a tanker, with the bridge, accommodation, and engine-room located aft of the 12 port and starboard cargo tanks. It operates seasonally and is laid-up during the winter months.

1.2 History of the Voyage

The vessel was chartered unexpectedly and, on 30 March 1998, departed Sarnia, Ontario, en route to Montreal. A replacement master and chief officer were hired as the vessel's regular officers were on training before the start of their operational season.

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 at Appendix C for all abbreviations and acronyms.

The vessel was operated in compulsory pilotage waters of the St. Lawrence Seaway, but was not subject to compulsory pilotage based on criteria contained in Article 4.1 of the *Great Lakes Pilotage Regulations*. The navigation and the pilotage was carried out by the navigating personnel on the bridge for the duration of the transit.

At 1200,[3] after exiting the Snell Lock, the bridge was crewed by the second officer (2/O), who had the conduct of the vessel and was performing pilotage duties. The third officer (3/O) was assisting the 2/O by performing the duties generally carried out by the officer of the watch (OOW). The wheelsman was at the helm. The vessel was proceeding at eight knots, and the visibility was known to be one and one-half to two miles. The master was resting below-deck.

While on a course of 061° and approaching buoy D-64 (see Appendix A), the 2/O was using binoculars to visually identify the next set of ranges in order to ensure the next alteration of course. The 3/O was engaged in verifying the position of recently established floating aids vis-à-vis known landmarks. The vessel's speed over the ground in the channel was about 10 knots; there was no other traffic in the vicinity. The vessel passed buoy D-64 at approximately 1245 and proceeded past the course alteration point.

The wheelsman noticed that the vessel had passed the turning point but did not communicate this information to the officers because he believed that the responsibility for course alteration rested with them. By the time the 2/O realized that the vessel had overshot the alter-course position, the vessel was outside the navigable channel, having passed buoy D-59 to port at approximately 1248. The 2/O immediately drew the 3/O's attention to this. The 3/O then ordered hard-to-port helm while the 2/O took charge of the engine controls. The port engine was placed on full astern in an attempt to return the vessel to the channel. These efforts were unsuccessful. The vessel continued outside the channel and grounded at 1250, on a shoal south of buoy D-57 on a heading of 311°, in position latitude 45°04' 07"N and longitude 074°31' 08"W. The channel remained unobstructed for the transit of other traffic.

Ballast was pumped out; some 500 tonnes of cargo were discharged into the barge "McASPHALT 401". The vessel was eventually refloated at 1230 on 4 April 1998 with the assistance of the tugs "JOHN SPENCE" and "JERRY NEWBERRY". The vessel proceeded on its own power to an anchorage off Cornwall where, following inspection, permission was granted for the vessel to transit the Seaway to undergo repairs.

1.3 Injuries to Persons

No one was injured.

1.4 Damage to Vessel and Environment

An underwater inspection of the hull was carried out following the grounding. Damage was sustained to the

[3] All times are Eastern daylight time (Coordinated Universal Time minus four hours).

bilge and bottom plating. Several scratches and scuff marks along her bottom plating were observed. The vessel had sustained a 110-cm long crack in way of frame 63, plate "B" on the port side. No pollution was observed or reported.

1.5 Certification

1.5.1 Certification of Vessel

The vessel was equipped and operated in accordance with existing regulations for its trade. The vessel had a valid International Safety Management (ISM) certificate issued by Det Norske Veritas in December 1997.

1.5.2 Certification and History of Personnel

The master was properly certificated and had many years of experience in the navigation and pilotage of vessels in these waters. He was not part of the bridge team at the time of the grounding and was acting as a replacement for the regular master. The relief master was hired for a week. He had no previous training in Bridge Resource Management (BRM) nor was he familiar with Electronic Chart Systems (ECS). He had not received training related to the application of the Safety Management System (SMS) of the ship.

The 2/O and the 3/O were properly certificated to perform their duties. Each was appropriately qualified to carry out pilotage for this sector of the Seaway. The 2/O has been carrying out pilotage duties since 1978 and the 3/O since 1970. Neither had previous training in BRM or in the use of ECS.

1.5.3 International Safety Management Code (ISM Code)

The *International Safety Management Code (ISM Code)* was adopted in 1993 by the International Maritime Organization (IMO) as Resolution A.741 (18). It has been made mandatory subsequent to this occurrence by virtue of the entry into force on 1 July 1998 of Chapter IX, "Management for Safe Operation of Ships", of the *International Convention for the Safety of Life at Sea* (SOLAS). The *ISM Code* provides an international standard for managing and operating ships safely and for preventing pollution.

The International Chamber of Shipping (ICS) publication *Guidelines on the Application of the IMO International Safety Management Code* is designed to assist companies in the development of an SMS. Article 6 deals with resources and personnel. The guidelines suggest that records of crew certification be maintained by the owner and that, in assigning crew to vessel, consideration be given to ensure the following:

- that the master is properly qualified for command and is fully conversant with the company's SMS;
- that the master is given the necessary support so that the master's duties can be safely performed;
- that the crew is capable of safely executing normal operational and emergency-related tasks;
- that the crew is given proper familiarization of the vessel and its equipment; and
- that training needs of the crew are identified.

Following an ISM audit, the "ENERCHEM REFINER" was issued an ISM certificate in December 1997, towards the end of the operating season, some four months before the occurrence. No training was planned over the winter lay-up period.

1.5.4 Crew Training

In 1997, the regular crew had been given three days' in-house training on the ship's SMS, which included ISM-related training. The relief master was not conversant with the above standards nor was he familiar with the ship's SMS.

The navigating officers had received a one-and-one-half-hour introductory briefing on the ECS and had communicated to company officials the need for further in-depth training on the ECS. The system was new and had not been configured properly which led them to question the accuracy of the ECS. Consequently they were unwilling to trust the system.

According to company policy, only senior personnel, i.e. the master and the chief officer, were given BRM and ECS training with the understanding that they, in turn, would provide on-the-job training to the rest of the crew. There is no regulatory requirement for such training. The regular master and chief officer had not received ECS training during the winter months, but were receiving training at the time of the occurrence. The navigating officers who formed part of the regular crew hired by the owners had not received training on the ECS.

1.6 Weather and Current Conditions

At the time of the occurrence, the weather was good, but visibility was reduced to approximately 1.5 to 2 miles in mist.

At this time of year, the current in the area is known to be approximately two to three knots, follows the direction of the channel, and in this instance was setting in the same direction as the vessel.

1.7 Communication and Decision Making

Communication between the 2/O and the 3/O with respect to the navigation of the vessel was minimal. There was no language barrier. The 2/O was responsible for making decisions. He was supported by the personnel on watch and by navigational information from Vessel Traffic Services by very high frequency (VHF) radio.

1.8 Navigation Equipment

The vessel's navigation equipment included the following:

- two radar sets, neither fitted with automatic radar plotting aid (ARPA) capabilities;
- one global positioning system (GPS);
- an ECS[4] capable of providing a wide range of information, such as ship's heading, course made good, speed, way point and cross track information, depth information, and alarms to meet changing navigational needs;
- a gyro compass with repeaters appropriately positioned;
- a speed log, depth sounders, and VHF and medium frequency (MF) radios; and
- Canadian Hydrographic Service (CHS) chart No. 1413, which was in use at the time of the grounding.

No equipment malfunction was reported.

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4 For an ECS to be considered an Electronic Chart Display and Information System (ECDIS), it must comply with *IMO Performance Standards* in which ECDIS is defined as a "navigation information system" which, with adequate back-up arrangements, can be accepted as complying with the up-to-date chart required by Regulation 20, Chapter V of the SOLAS, 1974.

1.8.1 Bridge Layout

The bridge was comprised of a console located to the starboard of the centre line against the bridge front bulkhead which included engine controls. The starboard radar was positioned to the right of the console. The ECS was positioned aft of the starboard radar between the radar and the chart table. It was mounted on a swivel permitting the display to rotate some 180°. The steering position was located along the centre line of the vessel, aft and to port of the console. The port radar was positioned behind the bridge front bulkhead and to port of the centre line.

1.9 Navigation in Pilotage Waters

In accordance with company policy, two officers were on the bridge in confined pilotage waters, the 2/O performing pilotage duties and the 3/O performing OOW duties. In accordance with the *ISM Code*, the company's standing instructions to navigation personnel make reference to the *Regulations for Preventing Collisions at Sea* (COLREGS) and to the *Recommended Code of Nautical Procedures and Practices*. Their application meant the following:

- that the 3/O was to cooperate closely with the 2/O and maintain accurate position and movement checks;
- that the presence of the 2/O on the bridge did not relieve the 3/O from his duties and obligations to ensure safety of the ship;
- that, when in doubt as to the 2/O's actions or intentions, the 3/O seek clarification from the 2/O; and
- that, when the 2/O relinquishes the handling of the vessel underway, he clearly indicate this fact to the 3/O.

1.10 Conduct of Navigation

As the vessel approached Cornwall Island, the 2/O was positioned on the starboard side of the wheelhouse, between the radar and the ECS, while the 3/O was positioned behind the radar on the port side. During the transit, the 3/O was in charge of plotting the vessel's position and/or cross-referencing with the chart in use. The last position plotted was some 25 minutes before the occurrence. The 2/O referred to the radar to monitor the vessel's progress. He was identifying the leading markers ahead. As the buoy system had been put in place for the season a week before the occurrence, the 3/O was also busy verifying the positions of the floating aids.

1.11 BRM and BRM-Related Issues

The essence of BRM is the effective use of all available resources to complete an operation safely. BRM addresses managing attention, operational tasks, stress, attitudes, and risks. BRM recognizes that individual, organizational, and regulatory factors are involved in safe and effective operations.

Optimizing the management of these elements will have a direct effect on four factors critical to the successful outcome of any operation, namely, recognizing and defining the nature of the problem encountered (situational awareness); reflecting on and regulating one's own judgements or decisions (metacognition); involving others in the problem-solving process (shared mental models); and understanding tasks to be performed, their priorities, and required and available resources (resource management).

Successful BRM programs address several key areas, such as team building and maintenance, communication and decision-making processes, workload management, situational awareness, watch systems, and working environments.

1.11.1 Team Building and Maintenance

Characteristics of individual team members are important. However, in a team, work is shared, tasks are performed in a more timely and effective manner, and a higher level of performance is achieved than that by the best individual working alone. Research has demonstrated that it is during the team formation process that patterns of communication and interaction are established.[5] Once established, the process continues and leads to activities that can maintain patterns of effective (or ineffective) group communication.

[5] Robert L. Helmreich and Clayton H. Foushee, "Why Crew Resource Management? Empirical and Theoretical Bases of Human Factors Training in Aviation", *Crew Resource Management,* E. Weiner, B. Kanki, and R. Helmreich, eds., San Diego: Academic Press.

1.11.2 *Communication and Crew Decision-Making Processes*

Crew decision making is managed decision making. In this instance, the 2/O is responsible for making decisions but is supported by input from the crew, both on the bridge and from shore (e.g. traffic services). This requires a group climate that encourages participation and the exchange of information. Poor communication can result in crews not sharing a common understanding of a situation, or in a misunderstanding of the 2/O's intentions.

1.11.3 *Workload Management*

The tasks essential for safe navigation of the vessel are allocated to different persons best equipped or experienced to perform them so that no member of the bridge team carries a workload that is beyond his/her capabilities.

1.11.4 *Situational Awareness*

Situational awareness is the accurate perception of the factors and conditions that affect a vessel and its crew during a defined period of time.[6] More simply stated, it is knowing what is going on around you.

The safety of the voyage depends on the level of situational awareness of the individual who has the conduct of the vessel. The ease and effectiveness of communication is a fundamental factor in maintaining optimal situational awareness. It is essential that each member of the bridge team does everything feasible to support the person in charge to maximize his level of situational awareness.

1.11.5 *Watch Systems*

Normal (sea) watches on the bridge were four-hours-on watch and eight-hours-off, except when all hands are required to transit the locks. However, while transiting the St. Lawrence Seaway, the vessel adopted a dual-watch system composed of an officer in charge of pilotage assisted by an additional officer. The additional officer is assigned to navigation, cross-referencing the vessel's position, and assisting the person in charge in the pilotage of the vessel. The wheelsman executes helm orders and ensures that the courses ordered are steered in accordance with the orders of the officer in charge.

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[6] Geiss-Alvarado Associates, "Human Error Accident Training", *U.S. Coast Guard Training Manual*, July 1991.

1.11.6 Working Environment on the "ENERCHEM REFINER"

The working environment on the bridge was less than formal and the 2/O and 3/O had sailed together for many years on this vessel. There was no explicit arrangement between the 2/O and the 3/O. Furthermore, company procedures did not call for a clearly defined arrangement. There was no agreement as to who should give alter-course orders to the wheelsman. During previous transits of the area, the 2/O gave these commands.

1.12 Work, Rest, and Sleep History

1.12.1 Second Officer (2/O)

During the 72 hours prior to the occurrence, the 2/O was operating under a four-hours-on and eight-hours-off shift, with his duty hours being 0000 to 0400 and 1200 to 1600.

The 2/O indicated that he had no problem sleeping. He indicated that he normally obtained a total of six to eight hours of sleep per day, a four- to five-hour sleep period in the early morning and a two-hour period in the evening. In the morning before the occurrence, he went to bed at 0430 and awoke at 0900. His 72-hour history is presented below:

Date	Time of sleep	Duration of sleep (hours)
March 31	0500 - 1030 1900 - 2100	5.5 2.0
April 1	0630-1030 1900 - 2100	4.0 2.0
April 2	0430 - 0900	4.5
3-day Total		18.0

1.12.2 Third Officer (3/O)

The 3/O indicated that on average, he obtained a total of eight to nine hours of sleep per day during two sleep periods of approximately four hours each, one in the afternoon and one in the early morning. The night before the occurrence, he went to sleep at 0230 and woke up at 0630.

1.12.3 Wheelsman

The wheelsman indicated that on average he slept a total of approximately 10 to 11 hours per day, 6.5 hours at night and 4.5 hours in the early evening. The night before the occurrence, he slept between 0415 and 1045.

1.13 Electronic Chart System (ECS)

The chart information in the ECS presents navigational information in real time. The OOW must continuously analyse and evaluate the position of the ship, intended track, and manoeuvring characteristics in order to warn of approaching dangers. In addition, the ECS provides alerts and prompts for planned course alterations and many other sophisticated navigation and safety features, including continuous data recording for later analysis.

A review of the ECS following the occurrence indicated the following:

- that the vessel position record data prior to the grounding was missing; and
- that the malfunction was attributable to the computer clock and the GPS time not being synchronized.

The manufacturer reviewed certain software parameters and ensured that corrections will be made to avoid future malfunctions of the ECS data recorder.

2.0 Analysis

2.1 General

This analysis focuses on the three major components that affect safe vessel operation in Canadian pilotage waters: BRM and BRM-related issues and fatigue-related issues.

2.2 Bridge Resource Management (BRM)

Compulsory pilotage areas have been established by pilotage authorities to ensure safe and efficient vessel navigation in Canadian waters where local knowledge is essential. Ships' officers who possess such local knowledge and meet the criteria set out in the *Pilotage Act* and corresponding regulations are certified to conduct pilotage on their vessels. Navigation in confined pilotage waters is mentally demanding. Hence, effective team work—which includes good communication, timely input, and cooperation of all bridge team members—is essential for the success of a mission.

Each officer was qualified to pilot the "ENERCHEM REFINER" for this sector of the Seaway. As such, each was capable of meaningfully contributing to the safe navigation of the vessel. However, as the division of responsibility was not clearly defined, each officer assumed that the other had total control of the situation. Prior to the occurrence, each officer was engrossed in his respective task, the 2/O in identifying the leading markers ahead and the 3/O in verifying the positions of floating aids. Despite reduced visibility and difficulty in identifying range lights, the vessel's speed was not reduced. Both lost track of time and, by the time both realized that the vessel had overshot the alter-course position, it was too late. Despite hard-to-port helm and an engine movement, the vessel grounded in the vicinity of buoy D-57, some 0.75 miles beyond the intended alter-course position.

Positions were plotted infrequently on the chart and the vessel's progress was not closely monitored. Communication between the 2/O and the 3/O was minimal and imprecise, and each was concentrating on a secondary priority as the vessel approached the alter-course position. Consequently, both lost situational awareness. It was not until some three minutes later that the error was realized and action taken.

The use of sound navigational practices to monitor the vessel's progress (e.g. communication, sharing of information, distribution of workload, determining navigational priorities, close monitoring of the vessel's progress by deploying techniques such as parallel indexing) would have helped both the 2/O and the 3/O to realize the error in ample time to take remedial measures.

In this instance, although the wheelsman was aware that the vessel had reached and passed the alter-course position, he did not bring this to the attention of the bridge team because he believed that navigation, including course alteration, was the officers' responsibility. In doing so, he did not recognize that he was part of the bridge team and did not take all reasonable and necessary precautions to ensure that vessel safety was not compromised.

2.3 BRM Training and ISM Certification

According to ISM certification criteria, the onus is upon owners to ensure that the crew hired is appropriately certificated and trained and capable of executing normal operations or emergency-related tasks safely.

In this case, certification had been issued at the end of the 1997 season, and the vessel was laid up for the winter months. According to the company's training plan, the master and the chief officer were to proceed with BRM and ECS training a week prior to the start of the 1998 season. However, the unforeseen charter of the vessel resulted in the company hiring a replacement master and chief officer, neither of whom was familiar with BRM concepts or ECS use.

2.4 Lack of BRM Training

Close monitoring of a vessel's movement is critical for navigating safely in confined waters. Time is of the essence when initiating and executing manoeuvres. Therefore, it is essential that each bridge team member fully understands his/her role and ensures that any information that can favourably or adversely affect vessel navigation be communicated to the person in charge of pilotage/navigation.

The non-implementation of BRM precepts and the lack of effective communication or exchange of information have been identified as contributing factors in a number of occurrences.[7] Concerned with the fact that a lack of BRM training among ships' officers increases the probability of accidents in confined Canadian pilotage waters, the Board recommended to Transport Canada (TC) that BRM training be made a pre-requisite to the issuance of new competency certificates as well as to that of continued proficiency certificates.[8] In response to this recommendation, Transport Canada Marine Safety (TCMS), in consultation with industry representatives, has finalized the BRM training syllabus. Some Canadian marine training institutions now offer this training program. Currently, there is no plan to make this course mandatory. However, TCMS encourages shipping companies to take the initiative in implementing BRM concepts on their vessels.
In this instance, the lack of communication between the two officers resulted in each assuming that the other was aware of the vessel approaching an alter-course position, and neither communicated this information to the other. Although the wheelsman, who is considered to be part of the BRM team, was aware that no action had

[7] TSB Report Nos. M97W0197 ("RAVEN ARROW"), M98C0082 ("FEDERAL BERGEN"), and M99C0027 ("SUNNY BLOSSOM").

[8] TSB Report No. SM9501, *A Safety Study of the Operational Relationship Between Ship Masters/Watchkeeping Officers and Marine Pilots*, Recommendations M95-09 and M95-10.

been initiated to alter the vessel's course, he did not communicate this concern to the 2/O, the bridge team member in charge of navigation. In doing so, BRM principles were not implemented effectively. By not receiving BRM training, the crew lacked appreciation for BRM, and information vital to the vessel's safety was not communicated.

2.5 Company Hiring Practices and Training

Although the company's Management Representative/Designated Person was responsible for monitoring ISM compliance, he was not consulted by the Operations Manager prior to the hiring of the relief crew (which was appropriately trained and certificated). In addition, company policy was in conflict with ISM provisions in that the 2/O and 3/O assigned to the vessel were not familiar with all of the equipment or its use. Furthermore, they were unaware of the equipment's advantages and limitations. Thus, safe vessel operation was adversely affected.

The safety of vessels operating in narrow and confined waters is enhanced by the use of modern, up-to-date technology. However, training is critical to ensure that the user is fully aware of the effectiveness of the system in order to reap the optimal benefits it offers while appreciating the limitations it imposes. Such is the case with the ECS. The more one is familiar with the system, the less time one needs to process essential information. This would allow for assimilating information orderly and quickly and for leaving time to deal with other navigational cues and issues (e.g. visual navigation techniques, course alterations, and collision avoidance measures) and other bridge duties (e.g. communications and record keeping).

2.6 ECS and Ergonomics

An ECS can improve marine safety by providing mariners with real-time information for navigating vessels. When used effectively, the system can improve overall safety. Using an ECS in conjunction with conventional navigation methods can reduce the navigation workload. The major factor in this reduction in workload is the automation of position-fixing, which allows for continuous monitoring of the vessel's progress. However, in this instance, the benefits of the system were not reaped because the crew had not received the appropriate training and was unfamiliar with it.

On this vessel, the ECS was mounted on a swivelling base, and its console was positioned behind the radar instead of beside it. Had the ECS been positioned ahead of the navigator in the direction of the vessel travel, visual references could have been maintained and the radar could have been accessible for traffic and target monitoring. At the time of the occurrence, the radar overlay feature on the ECS was not available for use. Since the ECS was positioned behind the radar, the mariner was required to move back and forth between the two stations.

Ergonomic guidelines highlight the importance of display positioning. Frequently-used primary displays, such as the ECS and radar, should be located within the operator's easily readable field of view. When necessary, infrequently-used displays may be located outside the operator's easily readable field of view.[9] Since a vessel may be navigated using visual and radar information, the ECS could not be used to its full advantage because its display was not grouped together with other primary displays, so that the display is facing the front of the wheelhouse. If the ECS is rotated 180 degrees so that it is facing the rear of the bridge, the orientation of the chart is reversed from that of the vessel's travel. The problems associated with transforming map information from one orientation to another has been shown to be troublesome and time consuming and provides a source for error.[10]

When fitting vessels with an ECS, ergonomic principles should be employed whenever possible in order to reap all of the system's benefits.

2.7 Fatigue-Related Issues

Fatigue is a physiological state characterized by impaired performance and diminished alertness. Causes of fatigue include insufficient and/or poor quality of sleep, as well as disruption of circadian rhythm. These causes can be attributed to irregular work schedules, extended duty, or altered work/rest schedules, and have been identified as contributory factors in many industrial accidents.[11]

Figure 2 represents the 2/O's sleep history and accumulated sleep debt prior to the occurrence, based on the information provided by him. A rough calculation of sleep debt can be determined by allowing two hours of credit for every hour of sleep per day, up to a maximum credit of 16 hours, and one hour of debit for every hour awake.

The sleep credit diagram depicts an overall downward trend in the 2/O's sleep credits over the three days prior to the occurrence.

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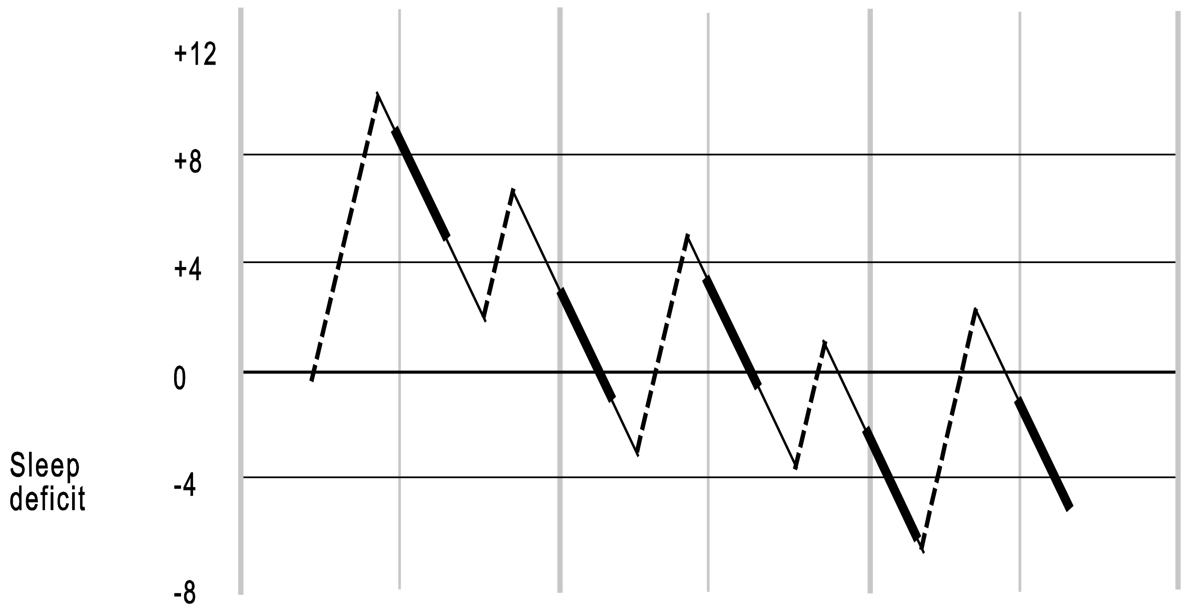
9 American Bureau of Shipping. *Guidance Notes on the Application of Ergonomics to Marine Systems.* New York: American Bureau of Shipping, 1998.

10 Gavriel Salvendy. *Handbook of Human Factors and Ergonomics.* New York: John Wiley and Sons, 1997.

11 Mark R. Rosekind, Philippa H. Gander, Linda J. Connell, and Elizabeth L. Co, "Crew Factors in Flight Operations X: Alertness Management in Flight Operations", *NASA Technical Memorandum DOT/FAA/RD-93/18* (NASA Ames Research Center, 1994).



Though fatigue is not necessary to explain the actions of the 2/O, his actions are consistent with errors involving decreased concentration and memory typical of the fatigued state. While preparing for the turn in reduced visibility, the 2/O's attention had shifted to identifying the next set of ranges, the Butternut Ranges. Having fulfilled his immediate goal of locating the ranges, the 2/O did not revert to the immediate task at hand, which was to execute a course alteration at buoy D-63. He continued with other duties instead, and it was not until the vessel had passed D-59 to port that he realized that the vessel had overshot the turning point.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. Neither the navigating officer performing pilotage duties nor the officer assisting him maintained situational awareness which caused a delay in making a course alteration and, thus, the vessel left the channel and ran aground.

2. The second navigation officer was concentrating on confirming the position of newly laid buoys by radar, consequently the vessel's position was not plotted with sufficient frequency to adequately warn of the approach of the alter-course point.

3. The officers had worked together often and had developed an informal approach to the division of bridge responsibilities between pilotage and positioning.

3.2 Findings as to Risk

1. The need for a proper division of responsibilities, effective team work, and communications by all the personnel working on the bridge had not been adequately reinforced through the provision of Bridge Resource Management (BRM) training.

2. The vessel was pressed into service a week earlier than expected from the winter lay-up for an unscheduled charter when the regular master and chief officer were on scheduled training.

3. The replacement master and chief officer, neither of whom was familiar with BRM concepts, ECS use, or the company's SMS, were hired by the Operations Manager without consulting the company's ISM management level Designated Person, whose responsibility it was to ensure that the crew was ISM compliant.

3.3 Other Findings

1. The work/rest schedule of the second officer would indicate the possible development of sleep debt which could have resulted in decreased concentration on the tasks at hand.

4.0 Safety Action

4.1 Action Taken

The ECS manufacturer reviewed some of the software features to ensure proper recording of a vessel's tracks and courses. The manufacturer also ensured synchronization of the GPS and the computer software.

The manufacturer of the ECS in use on board the "ENERCHEM REFINER" at the time of the occurrence increased the recording time from 12 to 72 hours, over the 12-hour requirement called for in the IMO standards for ECDIS.

4.2 Safety Concern

In this occurrence two safety defences which could have trapped this error failed:
1) communication between the helmsman and the 2/O (i.e. BRM); and 2) the use of ECDIS, with its range of predictive features and alarms.

Firstly, while aware that the vessel had reached and passed the alter-course position, the wheelsman did not bring this to the attention of the other bridge team members because he believed navigation, including course alteration, was the officers' responsibility. Further, the officers had an informal working relationship with regard to pilotage and plotting. The crew members had not benefitted from a BRM course, which has at its core the improvement of communication between team members of all ranks.

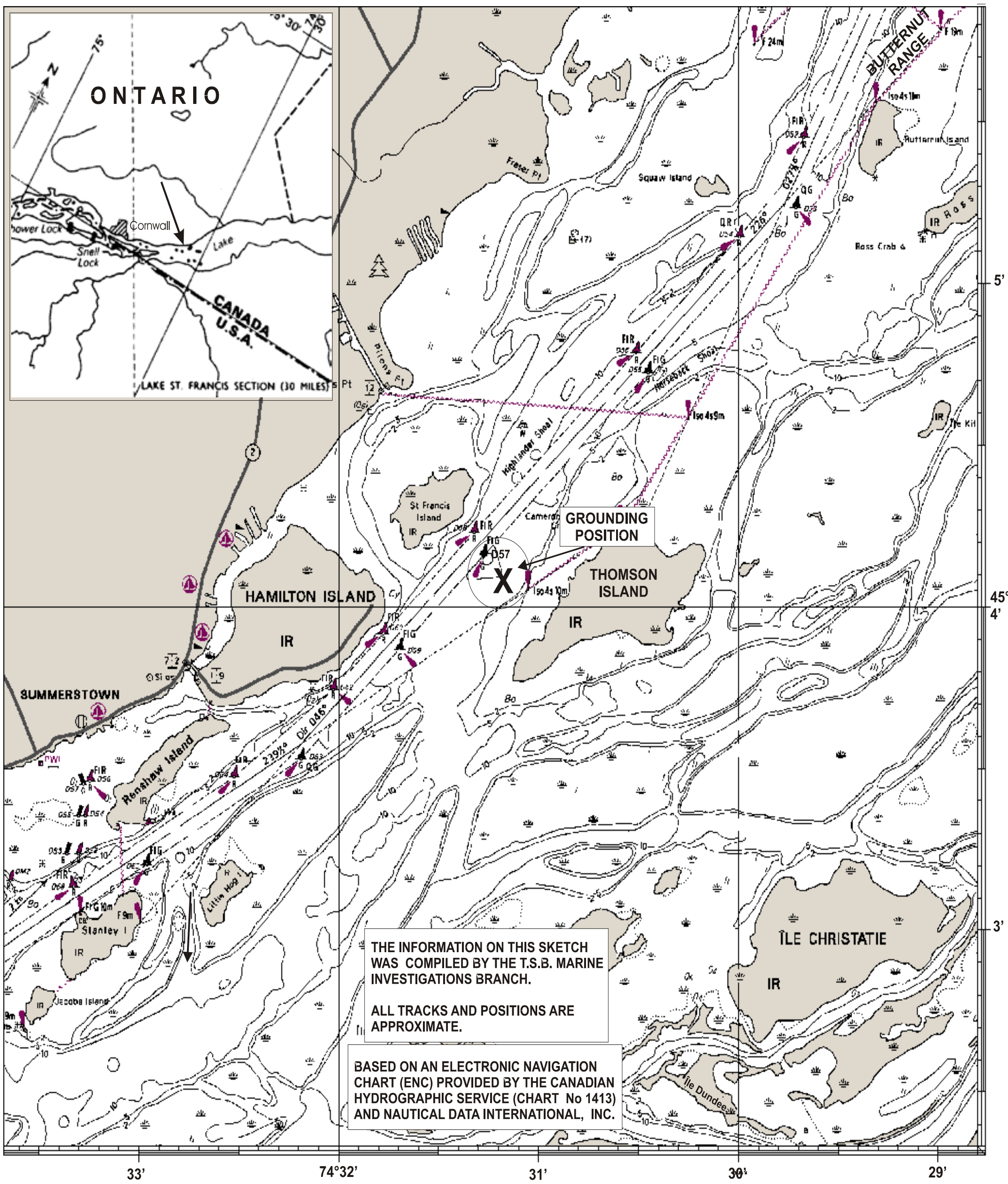
Secondly, this occurrence highlights the importance of ergonomic and training considerations associated with the introduction of new technology such as ECDIS. These considerations will allow crews to take full advantage of the technology while taking into account the limitations present in the system. The carriage of ECDIS is not currently mandatory for all vessels. Meanwhile this technology and its use is on the increase within the industry to further navigation safety and reduce navigation workload.

The importance of training mariners in the use of ECDIS has been recognized internationally. The IMO has prepared a model course for ECDIS/ECS with the purpose of assisting maritime training institutes and their teaching staff in organizing and introducing new training courses for ECDIS. To date in Canada, there is no requirement for formal training in the use of ECDIS/ECS.

The Board has commented on BRM training in the past and will continue to monitor the effectiveness of crew coordination and communication between bridge team members. Further, the Board is concerned about the efficiency of application of procedures involving the introduction, integration, and use of new technology on board vessels and will monitor this concern in future investigations.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 13 August 2001.

Appendix A - Sketch of the Occurrence Area



Appendix B - Photographs


ENERCHEM REFINER
D
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Appendix C - Glossary

ARPA	automatic radar plotting aid
BRM	Bridge Resource Management
CHS	Canadian Hydrographic Service
cm	centimetre(s)
COLREGS	*Regulations for Preventing Collisions at Sea*
ECS	Electronic Chart System
ECDIS	Electronic Chart Display and Information System
GPS	global positioning system
ICS	International Chamber of Shipping
IMO	International Maritime Organization
ISM	International Safety Management
ISM Code	*International Safety Management Code*
kW	kilowatt(s)
m	metre(s)
MF	medium frequency
N	north
OOW	officer of the watch
SI	International System (of units)
SMS	safety management system
SOLAS	*International Convention for the Safety of Life at Sea*
TC	Transport Canada
TCMS	Transport Canada Marine Safety
TSB	Transportation Safety Board of Canada
VHF	very high frequency
W	west
2/O	second officer
3/O	third officer
°	degree(s)
‘	minute(s)
“	second(s)