Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

MARINE INVESTIGATION REPORT M16A0141

Close-quarters crossing

Passenger vessels *Grandeur of the Seas* and *Summer Bay*
Halifax Harbour, Nova Scotia
29 June 2016

Canada

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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.

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Summary

On 29 June 2016, at 0942 Atlantic Daylight Time, the passenger vessel *Summer Bay*, with 39 people on board, crossed the bow of the passenger vessel *Grandeur of the Seas*, with about 2770 people on board, in Halifax Harbour, Nova Scotia. The smaller vessel passed within 25 m of the *Grandeur of the Seas* in thick fog and did not make contact.

Le présent rapport est également disponible en français.

Factual information

Particulars of the vessel

Table 1. Particulars of the vessel

Name of vessel	*Grandeur of the Seas*	*Summer Bay*
International Maritime Organization (IMO) number / Official number (ON)	IMO 9102978	ON 819136
Port of registry	Nassau	Halifax
Flag	Bahamas	Canada
Type	Passenger/cruise	Passenger
Gross tonnage	73 817	60
Length (registered)	237.52 m	14.78 m
Draft at time of occurrence	7.8 m	
Built	1996, STX Finland Oy, Finland	1997, Bay Bulls, Newfoundland
Propulsion	4 x 12 600 kW, diesel electric	2 x 179 kW, diesel
Crew	776	4
Passengers	2440	100
Registered owner/manager	Royal Caribbean Cruises, Ltd.	Murphy Sailing Tours Limited

Description of the vessels

Grandeur of the Seas

The *Grandeur of the Seas* (Figure 1) is constructed such that its superstructure extends the entire length of the vessel, abaft a short foredeck.

Figure 1. *Grandeur of the Seas* (Source: Tore Hettervik)

Four diesel-electric generators, producing 50 400 kW of power, supply energy to the vessel. Two stern and 3 bow thrusters enable the vessel to manoeuvre when the vessel's forward speed does not exceed 7 knots. The vessel has a service speed of 22 knots.

Given the vessel's size, it would take almost 4 minutes and a distance of 1171 m to stop when travelling at 19 knots. The vessel would take 2 minutes and 17 seconds to turn 90° at 12 knots, and would travel 690 m forward in that time.

The *Grandeur of the Seas* is owned and operated by Royal Caribbean International. It sails out of Baltimore, Maryland, year-round to various destinations, including cruises to the eastern

seaboard of the United States and the east coast of Canada. The *Grandeur of the Seas* makes Halifax a port of call several times a year, usually between the months of May and September, and typically arrives in the morning and sails on the evening of the same day.

Summer Bay

The *Summer Bay* is a small passenger tour vessel (Figure 2) that operates out of Halifax, Nova Scotia.

Figure 2. *Summer Bay*

The vessel is constructed of fibreglass and has 2 decks. The main deck is enclosed within a cabin that includes seating for passengers, while the upper deck is open and fitted with additional passenger seating. The upper deck is accessed via stairs at the stern of the vessel. The pilot house, at the forward end of the upper deck, houses the conning station.

The vessel is equipped with the following navigational equipment:

- a Furuno LCD radar, model 1623, with a 15 cm display screen
- a chart plotter with a 12.7 cm display screen
- 2 very high frequency (VHF) radios
- a global positioning system (GPS)
- a depth sounder
- a magnetic compass

The *Summer Bay* did not carry an automatic identification system (AIS). An AIS is a tracking system that can be used to identify other vessels and assist in collision avoidance by giving the operator the other vessel's course, speed, and closest point of approach (CPA). An AIS supplements radar by integrating information from a VHF radio transceiver and GPS for vessel identification and tracking. The vessel's radar did not have a feature to automatically plot targets.

The operator of the *Summer Bay*, Murphy's the Cable Wharf, is the largest tour boat company in Halifax, with 11 vessels engaged in a variety of tourism activities. These include replica tall ship sailing tours, amphibious city/harbour cruises, and environmental/fishing excursions (the type of activity the *Summer Bay* was conducting in this occurrence). Vessels in the company range in size, with the largest certified to carry 191 passengers and the smallest to carry 40 passengers.

History of the voyage

On 29 June 2016, at about 0800 Atlantic Daylight Time,[1] the passenger vessel *Summer Bay* departed Bishop's Landing in Halifax Harbour with 35 passengers, 2 crew members, and the master and mate (who also acted as lookout) on board. The radar was turned on and its range was reduced from 3 to 0.75 nautical miles (nm). The environmental tour was expected to last 2½ hours and include viewing marine life and hauling a lobster trap in Halifax Harbour, despite the low visibility due to fog at the time of departure.

While the *Summer Bay* was outbound, the cruise ship *Grandeur of the Seas* was inbound at the mouth of the harbour, destined for Pier 20 at the Halifax cruise ship terminal. There were about 2000 passengers and 770 crew members on board the *Grandeur of the Seas*. The bridge team consisted of the master, the staff captain, the chief officer, and a pilot.

The pilot of the *Grandeur of the Seas* picked up an outbound radar target, 2.7 nm to the northwest (Figure 3).[2] At 0933, he contacted Halifax Marine Communications and Traffic Services (MCTS) to inquire about traffic in the harbour. Halifax MCTS replied that the *Summer Bay* was the outbound vessel.

The pilot then contacted the master of the *Summer Bay* on VHF radio channel 12 in order to make passage arrangements.[3] The *Summer Bay* requested to change frequencies to channel 6. Once they were both on channel 6, the master of the *Summer Bay* informed the pilot of the *Grandeur of the Seas* that the *Summer Bay* would keep well clear by staying to the west of the *Grandeur of the Seas*, which meant a port-to-port passing.

After making this arrangement, at about 0936, the *Summer Bay*, maintaining its speed of 7.5 knots, altered course to starboard to 170°, which would allow for a safe port-to-port passing. The bridge team of the *Grandeur of the Seas*, which was proceeding along the preferred course in the traffic separation scheme, saw the course alteration on their radar and maintained their course and speed of 10 knots. After that point, the bridge team of the *Grandeur of the Seas* continued to monitor the *Summer Bay*'s position on their radar until the target was lost on the screen due to the proximity of the vessel.

At about 0939, the *Grandeur of the Seas* appeared on the *Summer Bay*'s radar at a distance of 0.75 nm. At 0939:35, the *Summer Bay* altered course to 142° toward the *Grandeur of the Seas*. When the *Grandeur of the Seas* closed to 0.25 nm, the master of the *Summer Bay* picked up another echo on the radar bearing about 45° off the starboard bow at a distance of 0.25 miles.

At 0941:15, the master of the *Summer Bay* altered course to 110° at a distance of 0.12 nm from the *Grandeur of the Seas*.

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1 All times are Atlantic Daylight Time (Coordinated Universal Time minus 3 hours).

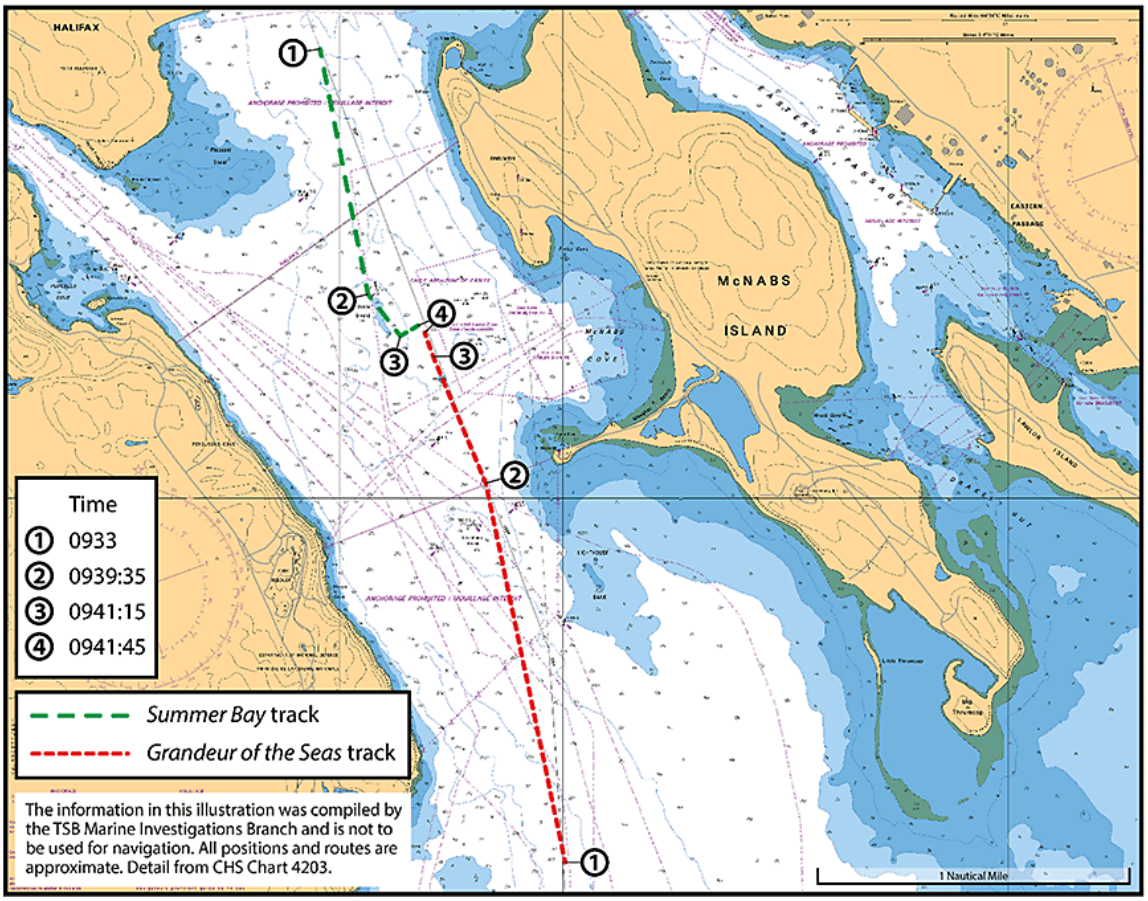
2 Data for vessel tracks were obtained through voyage data recorder data and MCTS recorded radar data.

3 Channel 12 is the calling and working frequency that MCTS requires all marine traffic to use in the Halifax Harbour area.

At 0941:45, the master of the *Summer Bay* altered course to 071° and crossed the bulbous bow of the *Grandeur of the Seas* at a distance of about 25 m. The fog signal from the *Grandeur of the Seas* was heard on the *Summer Bay* about 10 seconds prior to the course alteration.[4] The *Grandeur of the Seas* bridge team was unaware that the *Summer Bay* was crossing their bow until the pilot saw the *Summer Bay*'s mast as it appeared from underneath the bow on the starboard side, after it had already crossed.

Following the close-quarters crossing, the *Grandeur of the Seas* continued its passage and ultimately docked at Pier 20 in Halifax, and the *Summer Bay* continued its harbour tour, returning to port at 1100. The pilot of the *Grandeur of the Seas* reported the incident to MCTS.

Figure 3. Tracks of the *Summer Bay* and the *Grandeur of the Seas*



Environmental conditions

The wind at the time of the occurrence was southwest by south at 15 knots with seas of about 0.5 m. The visibility was restricted to 100 to 200 m due to thick fog.

[4] The fog signal was activated on the *Grandeur of the Seas*, but not on the *Summer Bay*.

Vessels' certification

Both the *Summer Bay* and the *Grandeur of the Seas* were certified and equipped in accordance with existing regulations, and were subject to annual and intermediate inspections.

Personnel certification and experience

Grandeur of the Seas

The master and the officers of the *Grandeur of the Seas* held qualifications appropriate for the tonnage of the vessel on which they were serving and for the voyage being undertaken. The master had taken command of the vessel 4 weeks prior to the occurrence and had been staff captain on another company vessel for 6 years before that.

The pilot on the *Grandeur of the Seas* held a Master Mariner certificate and had worked as a pilot in Halifax Harbour since 2010.

Summer Bay

The master of the *Summer Bay* held a Watchkeeping Mate certificate, acquired in 1998. As a prerequisite to obtaining that certificate, the master attended a training module on Simulated Electronic Navigation. He had been involved in marine tourism operations since 2007, mainly in Ontario. Prior to 2007, he had worked on fishing vessels in Nova Scotia for about 15 years. He was hired by Murphy's the Cable Wharf on 21 June 2016 and sailed as a master under the supervision of more senior masters on 3 other vessels in the company. On 27 June 2016, the master of the *Summer Bay* acquired a Master, Limited for a Vessel of 60 Gross Tonnage or More certificate. The following day, he started working as master, unsupervised, on the *Summer Bay*. Since joining the company, and until the day of the occurrence, the master had had no experience operating under conditions of limited visibility in Halifax Harbour.

The mate also held a Master, Limited for a Vessel of 60 Gross Tonnage or More certificate acquired in 2016. He had served as master on the *Summer Bay* for 2 voyages and had been working for the company on vessels for 4 years.

Collision avoidance

International Regulations for Preventing Collisions at Sea

The *International Regulations for Preventing Collisions at Sea* (COLREGS) are an international convention that establishes, among other things, the rules of conduct to follow at sea when a risk of collision exists between vessels. The rules have been adopted by Canada as the *Collision Regulations* and "apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels."[5] Governments or states may adopt special rules for

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5 *Collision Regulations*, C.R.C., c. 1416, Schedule 1, Part A, Rule 1(a).

their waterways. These special rules, however, must conform as closely as possible to the COLREGS.[6]

The COLREGS and proper seamanship go hand in hand; both require that any manoeuvres be taken in ample time and with sufficient information to determine whether they can be executed safely.

Close-quarters situations and assessing risk of collision

There is no set distance that defines a close-quarters situation; it varies depending on many factors and the perceptions of the crew involved.[7] In some cases, a risk of collision may not be evident, or the risk may be assessed as being minimal. Craig Allen's *Farwell's Rules of the Nautical Road* identifies a number of factors that must be considered by crews in weighing the risk of collision, including "the range between the vessels, their closing speed, projected CPA, visibility, and the presence of other navigation or collision hazards."[8] Rule 7 of the COLREGS dictates that proper seamanship be observed while navigating:

> (a) Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist.
>
> (b) Proper use shall be made of radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observation of detected objects.
>
> (c) Assumptions shall not be made on the basis of scanty information, especially scanty radar information.[9]

Actions to avoid collision

Rule 8 of the COLREGS deals with appropriate means of avoiding collision and specifies, among other things, that

- actions taken to avoid collision should be done with ample time; actions should be taken as early as possible.
- a vessel shall reduce speed or even stop or reverse propulsion if necessary to avoid collision or allow more time to assess the situation.
- the effectiveness of passing at a safe distance shall be "carefully checked until the other vessel is finally past and clear."[10]

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6 Ibid., Rule 1(b).

7 A. Cockcroft and J. Lameijer Cockroft, *A Guide to the Collision Avoidance Rules* (MPG Books Ltd., 2004), p. 139.

8 C. Allen, *Farwell's Rules of the Nautical Road* (Naval Institute Press, 2005), p. 215.

9 *Collision Regulations*, C.R.C., c. 1416, Schedule 1, Part B, rules 7(a), (b), and (c).

10 Ibid., Rule 8.

Reducing the vessel's speed not only gives the crew more time to assess the situation, but also lowers the general noise level around the vessel and may allow for the bridge team to better hear other vessels.

Rule 19 of the COLREGS further dictates actions to take when vessels come into a close-quarters situation in restricted visibility. When such a situation does arise, the COLREGS dictate that parties must attempt to, where possible, avoid the following:

> (i) an alteration of course to port for a vessel forward of the beam, other than for a vessel being overtaken,
>
> (ii) an alteration of course towards a vessel abeam or abaft the beam.[11]

Decision making and good seamanship

Effective, safe decision making depends on the accuracy of one's situational awareness, or perception of elements in the environment within a volume of time and space, comprehension of their meaning, and projection of their status into the future.[12] The accuracy of one's situational awareness depends on the availability, clarity, and comprehensibility of external cues and information sources (e.g., physical, cognitive, perceptual).

Overall understanding of a situation is based on experience, knowledge, and perception of external cues resulting in what is known as a "mental model." It is difficult to alter a mental model of an unfolding situation once it is developed, particularly in a short period of time. To change one's thinking, new information must be provided (and identified) that is sufficiently noticeable and compelling to result in an update of the mental model.

Mariners rely on a number of varied (e.g., technological, physical, auditory, visual) information sources to inform their situational awareness and construct a mental model. This is especially the case when they operate under high workload conditions, for example during periods of limited visibility, as in heavy fog. In these conditions, data from secondary sources, such as a vessel's radar display, become more important for safe navigation.

Although the vessel was equipped with an electronic chart system, the master of the *Summer Bay* developed his mental model of the situation based on radar data and his recollection of the harbour geography.

The *Summer Bay* had passed Pleasant Shoal about 5 minutes before the master decided to make the large course alteration to port. When he made the decision, although there was ample sea room on the starboard side, the master's mental model included the belief that Pleasant Shoal was still on the vessel's starboard side.

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11 Ibid., Rule 19(d).

12 M. Endsley, "Toward a theory of situation awareness in dynamic systems," *Human Factors*, Vol. 37, Issue 1 (1995), pp. 32–64.

Side lobe effect

Although the master of the *Summer Bay* saw an indication of vessel traffic on his starboard side on the radar, post-occurrence playback from the Halifax MCTS radar and the voyage data recorder from the *Grandeur of the Seas* determined that there was no vessel to the starboard side of the *Summer Bay*.

When the radar pulse is emitted from the antenna radiator, some of the emitted total energy escapes on each side of the main beam; this escaped energy is called a side lobe. These side lobes bounce on the target and return to the antenna while the main beam is not yet in line with the target. This is represented on the radar screen by several echoes appearing on each side of the true echo. As the strength of the return echo increases, so does the size of the false echo, making it difficult to distinguish between the two.

The *Grandeur of the Seas* appeared as a very large echo on the radar screen of the *Summer Bay*, indicating a strong echo return from the cruise ship. This echo return would have been even more prominent as the target drew nearer. Under such a condition, the phenomenon, called a "side lobe effect," could be experienced and may be expected when encountering a large vessel such as a cruise ship at close range.

The false echo occurring as a result of the side lobe effect can sometimes be mitigated by adjusting the gain[13] and/or the anti-clutter[14] on the radar. If a nearby false echo is suspected, a vessel can monitor it against the movement of the known target to help determine whether it is an actual target and whether there is a risk of collision. Vessels may need to slow down or stop to allow more time to assess the movement of the target. The bridge team can also use the technique of plotting (either manually or electronically on the radar) to assist in that assessment.

Marine Communications and Traffic Services

MCTS provides communication and traffic services for the marine community to ensure the safe and efficient movement of vessels. It coordinates communications related to distress and safety situations and regulates the movement of vessel traffic.

MCTS officers' responsibilities include identifying and resolving potentially hazardous situations, and issuing clearances, recommendations, directions, or warnings to shipboard authorities. When vessels are making passing arrangements using the frequencies that MCTS prescribes for that purpose, MCTS officers can analyze and disseminate marine safety and traffic movement information, monitor the situation, and inform bridge teams of factors of which they may not be aware. For example, there may be nearby vessel traffic or vessels that intend to move toward them. To analyze and determine what qualifies as relevant traffic for a particular vessel in an area of radar coverage, MCTS officers pose the following questions:

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13 Gain is a control feature on the radar used to increase or decrease the sensitivity of the receiver and thus the intensity of the echo.

14 Anti-clutter controls are used for reducing or eliminating sea- and weather-related interference.

- Does a risk of collision exist?
- Is there a possibility that the intentions of other vessels are unclear?
- Is there something non-routine associated with any vessel?
- Are any vessels unable to see one another?

MCTS supervising officers oversee the operational activities of the staff of the watch and provide for the safe and efficient movement of vessels in the centre's area of responsibility.

When bridge teams do not use the frequencies designated by MCTS to make passing arrangements, MCTS and other vessels in the area are unaware of imminent vessel movements, and MCTS cannot monitor those arrangements or be available to provide assistance if needed. In this occurrence, the vessels made their passing arrangement on a frequency that was not being monitored by MCTS.

Safety management

Safety management refers to an organization's ability to identify hazards that are associated with their operations and put mitigations in place to reduce the risks associated with those hazards to a level that is as low as reasonably practicable. All organizations engage in some form of safety management.

The principal objectives of safety management on board vessels are to ensure safety at sea, prevent human injury or loss of life, and avoid damage to the environment. Ideally, to manage safety, a vessel operator would identify existing and potential risks, establish safety policies and procedures to mitigate the risks, and then provide a means of continuously gauging effectiveness to improve organizational safety where necessary. A documented, systematic approach to safety management (known as a safety management system, or SMS) is one means of ensuring that individuals at all levels of an organization have the information and the tools needed to make sound decisions in both routine and emergency operations.

In terms of safety, risk assessment is a process that

- identifies hazards,
- analyzes or evaluates the risk associated with that hazard, and
- determines appropriate ways to eliminate or control the hazard.[15]

Effective hazard mitigation requires

- knowledge of, and competence in, the field being analyzed,
- processes to support the identification of hazards,
- means of identifying effective mitigations, and
- processes for tracking mitigations and identifying whether further action may be required.

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15 Canadian Centre for Occupational Health and Safety, "Hazard and Risk," at http://www.ccohs.ca/oshanswers/hsprograms/hazard_risk.html (last accessed 24 August 2017).

One means of mitigating safety risk is having (and enforcing) standard operating procedures (SOPs). The operating company of the *Summer Bay*, Murphy's the Cable Wharf, had no SOPs or other documented risk mitigation strategies or procedures for operating vessels in low-visibility conditions. The decision of whether or not to launch under those conditions was left to individual masters; no objective limits or thresholds regarding visibility were provided by the company to guide its decision making.

The *Summer Bay* had an SMS in place, although this was not required by regulation. However, the SMS had not been audited by an outside entity. Transport Canada's proposed amendments to the *Safety Management Regulations* would require an SMS on vessels that are 24 m or longer or that are carrying more than 50 passengers. The SMS on board the *Summer Bay* provided no guidance for navigation in restricted visibility or guidance on operating in Halifax Harbour when vessel traffic is present.

TSB Watchlist

The TSB Watchlist identifies the key safety issues that need to be addressed to make Canada's transportation system even safer.

Safety management and oversight is a Watchlist 2016 issue. An operator's SMS must be thorough in accounting for all operating conditions that pose a risk to operators, such as operating in low-visibility conditions, as in this occurrence. It is also important for an SMS to be audited by an external party.

Safety management and oversight will remain on the TSB Watchlist until

- Transport Canada implements regulations requiring all commercial operators in the air and marine industries to have formal safety management processes and effectively oversees these processes;
- transportation companies that do have SMS demonstrate that it is working—that hazards are being identified and effective risk-mitigation measures are being implemented; and
- Transport Canada not only intervenes when companies are unable to manage safety effectively, but does so in a way that succeeds in changing unsafe operating practices.

Analysis

The TSB's investigation into the close-quarters crossing between the *Summer Bay* and the *Grandeur of the Seas* determined that the master of the *Summer Bay* misinterpreted radar data and made a decision to cross the bow of the *Grandeur of the Seas* with insufficient information. The *Grandeur of the Seas* bridge team was unaware of the *Summer Bay*'s sudden course alteration, but, even if they had been aware of it, the size and manoeuvrability of their vessel meant that they would not have had time to react effectively.

This analysis will focus on the requirements of the *International Regulations for Preventing Collisions at Sea* (COLREGS), misinterpretation of radar information, and effective safety management systems (SMSs).

Factors leading to the close-quarters crossing

In restricted visibility, the *Summer Bay* and the *Grandeur of the Seas* agreed upon a port-to-port passing arrangement.

After continuing as per the arrangement, the master of the Summer Bay picked up an echo on the radar bearing about 45° off the starboard bow at a distance of 0.25 miles. However, the master's mental model included the belief that Pleasant Shoal was still on his starboard side. Given his limited experience operating in conditions of poor visibility in Halifax Harbour, as well as this inaccurate mental model, he decided that turning hard to port was the lowest-risk option to take.

The master of the *Summer Bay* then made a last-minute alteration hard to port, crossing the bow of the *Grandeur of the Seas* at a distance of about 25 m from its bulbous bow.

After the passing arrangement had been made, the Grandeur of the Seas bridge team saw that the Summer Bay had altered course, increasing the distance of the closest point of approach (CPA). The Grandeur of the Seas bridge team had continued to monitor the Summer Bay's position on their radar until it was lost, due to the Summer Bay's proximity, and were unaware of that vessel's alteration to port. In any event, given the Grandeur of the Seas' size and manoeuvrability, the vessel would not have been able to react effectively to avoid the close-quarters situation, because the Summer Bay's alteration was so sudden and so near.

International Regulations for Preventing Collisions at Sea

The COLREGS set out navigation rules to be followed by all vessels to prevent them from reaching "a close-quarters situation in which there is a risk of collision and in which decisions have to be taken without proper thought."[16]

[16] Lloyd's Representative, Queen's Bench Division (Admiralty Court), "The 'Maloja II'," 19 June 1992.

In this occurrence, the investigation determined that the vessels did not comply with the COLREGs in the following ways:

- The master of the *Summer Bay* misinterpreted the radar data without further verification, contrary to Rule 7, which cautions against making assumptions "on the basis of scanty information."[17]
- Although Rule 7 requires the use of long-range scanning to provide early warning of a possible collision, the *Summer Bay*'s radar range was short, set to 0.75 nautical miles.
- The master of the *Summer Bay* did not take action to reduce the vessel's speed, stop, or reverse in order to gain more time for assessing the situation, contrary to Rule 8.
- The bridge team of the *Grandeur of the Seas* did not continue to monitor the actions of the *Summer Bay* after its radar target was lost until the passing was fully complete, contrary to Rule 8.
- While Rule 19 advises all vessels to avoid altering course to port for a vessel forward of the beam, the master of the *Summer Bay* altered course to port and crossed the bow of the *Grandeur of the Seas*.

The "hallmark of a well-managed" vessel is one whose "crew ensures that seamanship, navigation, and collision avoidance procedures are initiated while there is still time to complete them before danger appears."[18] Adherence to the COLREGS helps bridge teams accomplish this. Therefore, if bridge teams do not adhere to the COLREGS, particularly when navigating in conditions of restricted visibility, there is a greater risk of collision between 2 vessels.

Misinterpretation of radar data

Although radar can be the most effective tool for navigators in assessing a risk of collision, care must be taken to account for the inherent errors associated with radar systems, and other means of confirming the accuracy of the information must be used. To determine if a risk of collision exists, the radar must be monitored carefully. If a large target suddenly appears, navigators must ensure that it is, in fact, a target, and plot its course relative to their own. This may require slowing the vessel down or stopping, adjusting the gain and anti-clutter controls, plotting (either manually or electronically on the radar) the other target(s), or all of the above.

In this occurrence, the master of the *Summer Bay* did not determine whether the target he saw on the radar on his starboard side was in fact a vessel, rather than a false echo. This could have been determined by manually plotting the target, slowing down or stopping to determine the relative course, or adjusting the gain and/or the anti-clutter. The master also had the option to call Halifax MCTS and enquire whether they had any knowledge of additional inbound traffic. Based on the assumption of a vessel on the starboard side, the master made the decision to alter course to port and cross the bow of the *Grandeur of the Seas*.

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17 *Collision Regulations*, C.R.C., c. 1416, Schedule 1, Part B, Rule 7(a).

18 Lloyd's Representative, Queen's Bench Division (Admiralty Court), "The 'Roseline'," 16 June 1981.

Although the false echo was most likely the result of the side lobe effect, the master did not identify it as such and misinterpreted the information presented on the radar as being other vessel traffic on the vessel's starboard side. He did not take action to further verify the radar information or determine that there was ample time to cross the bow of the *Grandeur of the Seas* at a safe distance.

An automatic identification system (AIS) may have assisted the master of the *Summer Bay* in determining a safe course and speed before nearing the *Grandeur of the Seas*, as the AIS can display the CPA of other vessels. However, given the proximity of the *Grandeur of the Seas* and the sudden nature of the turn in this occurrence, the AIS would not have had time to calculate effectively. An AIS on the *Summer Bay* may also have benefitted the *Grandeur of the Seas*. AIS identifies other AIS-equipped vessels by name and provides other information while continually tracking them, even when the target is lost on radar.

If bridge teams do not adequately verify their radar data, they may take action based on incorrect information, increasing the risk of an incident or accident.

Company safety management system

Effective safety management requires organizations to recognize the risks involved in their operations and to competently manage those risks. International best practices for SMSs involve a formal, documented, and systemic approach that includes a commitment from senior management, as well as a rigorous risk assessment process and a means of continuously gauging effectiveness so that improvements can be made where necessary. The resulting system helps ensure that individuals at all levels of an organization have the knowledge and tools to manage risk effectively, as well as the necessary information to make sound decisions in any operating condition.

In this occurrence, the investigation determined that Murphy's the Cable Wharf did not have any standard operating procedures or any other documented risk mitigation strategies or procedures to address the safe operation of its vessels in low visibility conditions. Additionally, there was no guidance on operating in Halifax Harbour when vessel traffic is present. As a result, the onus was on the masters to identify risks and implement strategies to mitigate them.

Although the safety of a vessel is ultimately the master's responsibility, an SMS can be a valuable tool in implementing the policies, procedures, and practices developed under that system to assist the master in safely operating the vessel. The SMS is mainly the responsibility of the vessel owner, but the master's input is essential for ensuring that the system is the best fit for the vessel.

If vessel operators do not have standard operating policies, practices, and procedures in place, there is a risk that vessels will not operate safely.

Findings

Findings as to causes and contributing factors

1. After making a port-to-port passing arrangement and continuing as agreed, the master of the *Summer Bay* picked up a false echo on the radar bearing about 45° off the starboard bow at a distance of 0.25 miles.

2. The master of the *Summer Bay* made a last-minute alteration hard to port, crossing the bow of the *Grandeur of the Seas* at a distance of about 25 m from its bulbous bow.

3. The master of the *Summer Bay* had a mental model of the situation that included the inaccurate belief that Pleasant Shoal was still on his starboard side.

4. Based on the inaccurate belief that Pleasant Shoal was still on his starboard side, and having limited experience operating in conditions of poor visibility in Halifax Harbour, the master of the *Summer Bay* decided that turning hard to port was the lowest-risk option to take.

Findings as to risk

1. If bridge teams do not adhere to the *International Regulations for Preventing Collisions at Sea*, particularly when navigating in conditions of restricted visibility, there is a greater risk of collision between 2 vessels.

2. If bridge teams do not adequately verify their radar data, they may take action based on incorrect information, increasing the risk of an incident or accident.

3. If vessel operators do not have standard operating policies, practices, and procedures in place, there is a risk that vessels will not operate safely.

Other findings

1. The *Summer Bay* was not fitted with an automatic identification system.

2. The *Summer Bay* and the *Grandeur of the Seas* made their passing arrangements on a channel that was not being monitored by Marine Communications and Traffic Services.

Safety action

Safety action taken

Murphy's the Cable Wharf

Murphy's the Cable Wharf has made the following changes to its tour vessels:

- It has added automatic identification system units to all vessels except those that are amphibious.[19]
- It has developed standard operating procedures for its vessel masters in reduced-visibility conditions.
- It has commissioned an external audit of its safety management system.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 05 September 2017. It was officially released on 14 September 2017.

Visit the Transportation Safety Board of Canada's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the key safety issues that need to be addressed to make Canada's transportation system even safer. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.

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[19] An amphibious vehicle is a means of transport that can move on land as well as on (or under) water. The amphibious vehicles used by Murphy's the Cable Wharf conduct tours on land and on water.