

MARINE INVESTIGATION REPORT

M98F0039

COLLISION

BETWEEN

THE SELF-UNLOADING BULK CARRIER

“AGAWA CANYON”

AND

THE TANKER “EMERALD STAR”

SAULT STE. MARIE, MICHIGAN, UNITED STATES

10 APRIL 1998

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 Investigation Report

Collision

Between
the Self-unloading Bulk Carrier
“AGAWA CANYON”
and
the Tanker “EMERALD STAR”
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Summary

While approaching MacArthur Lock, Sault Ste. Marie, Michigan, the port shoulder of the downbound, fully loaded bulk carrier “AGAWA CANYON” struck the port side of the upbound tanker “EMERALD STAR”, which had just departed the adjacent Poe Lock. At the time of the collision, both vessels were in the confines of the approach walls to the locks and had increased their speeds: the “AGAWA CANYON” to increase manoeuvrability and the “EMERALD STAR” to avert collision. There was no pollution and both vessels retained their watertight integrity. However, a significant risk was generated because the “EMERALD STAR” had been gas-freeing two of the vessel’s starboard tanks.

Ce rapport est également disponible en français.

Other Factual Information

	"AGAWA CANYON"	"EMERALD STAR"
Port of Registry	Sault Ste. Marie, Ontario	Halifax, Nova Scotia
Flag	Canada	Canada
Registry Number	331081	814361
Type	Self-unloading Bulk Carrier	Tanker
Gross Tonnage ¹	16,290	6,262
Length	193 m	118 m
Draught	Forward: 7.84 m Aft: 7.89 m	Forward: 3.25 m Aft: 5.6 m
Built	1970, Collingwood, Ontario	1992, Wismar, Germany
Propulsion	Fairbanks Morse diesel engine, 8503 kW, driving a single controllable-pitch propeller	B&W diesel engine, 3700 kW, driving a single controllable-pitch propeller
Bow Thruster	Yes	Yes
Number of Crew	26	16, and 1 supernumerary
Registered Owner	Algoma Central Corporation, Sault Ste. Marie	Rigel Shipping Canada Inc., Halifax

Circumstances Leading to the Occurrence

"AGAWA CANYON"

The "AGAWA CANYON" is a self-unloading bulk carrier with the bridge forward providing an unobstructed view. Fully loaded with 22 000 tonnes of potash, the vessel was at the maximum permissible Seaway draught. Stopping distance (head reach) in the fully loaded condition, at a speed of 6.5 knots, is 1.2 miles and, at 4.0 knots, 0.8 mile.

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

On 10 April 1998, the vessel was en route to Burns Harbour, Indiana, and was approaching MacArthur Lock at Sault Ste. Marie, Michigan. Winds were from the northwest at 10 to 12 knots and visibility was clear. The initial speed of approach to the western edge of the canal zone appeared, to the lockmaster, to be faster than normal; to the master it appeared normal. After slowing the vessel, the estimated speed of approach was reportedly about 3.0 to 3.5 knots. At approximately 1627 eastern daylight time,² the vessel was approaching the lock wall to starboard and was positioned some 550 m west of the International Bridge. The master and helmsman were on the bridge and two linesmen were landed ashore to carry heaving lines that were attached to the vessel's mooring cables. The linesmen help manoeuvre the vessel by placing the ship's mooring cables on bollards ashore; the ship's winches are used to heave up, check or slacken the cables as the ship moves forward using engines and thruster.

The closest point to the approach wall was estimated at 3.5 m forward and 3.0 m aft. The bow thruster was used intermittently as the vessel moved forward and the speed was progressively increased. Unable to run along at this speed, the linesmen let go of the lines. The speed was progressively increased to over 6 knots as efforts were made to bring in the bow, which had swung out to port as the stern was sucked to the dock wall.³ The bow thruster was now in constant use, but at this speed it had little effect. The vessel, now having lost the ability to remain close to the dock wall, moved further out to port, setting up a bow cushion at the starboard bow. Efforts to bring the bow back to the wall by increasing the speed to 7 knots were unsuccessful. Reportedly, astern movement was not used because of the master's concern for stern suction and the possibility that the vessel would sheer to port and cut off the channel. The vessel continued to move further to port, away from the dock wall and into the path of the upbound tanker "EMERALD STAR".

At 1634:12, the "EMERALD STAR", which had just departed the adjacent Poe Lock and was moving along the West Center Pier dock wall, was advised by the "AGAWA CANYON" on VHF channel 14, that the "AGAWA CANYON" was experiencing manoeuvring difficulties and that the stern was sucking the wall. A request was also made that the "EMERALD STAR" move to starboard as far as possible to give the "AGAWA CANYON" more sea room. At 1635:11, the two vessels collided when the port bow of the "AGAWA CANYON" struck the port side of the "EMERALD STAR" a glancing blow between Nos. 1 and 2 ballast tanks.

The angle of impact was 25 to 30 degrees to the fore-and-aft line of the "EMERALD STAR" at an estimated speed of 5.5 to 6.0 knots; the closing speed of the two vessels was about 11 to 12 knots. As the port shoulder scraped along the length of the "EMERALD STAR", the starboard bow anchor of the "AGAWA CANYON" was deliberately dropped, with one shackle (approximately 28 m) of chain into the water. The collision occurred in position latitude 46°30'09" N, longitude 084°21'28" W, some 240 m east of the International Bridge.

² All times are eastern daylight time (coordinated universal time minus four hours).

³ VHS video cameras, positioned at the western-most point of the West Center Pier, were switched on around 1633 and movements of the "AGAWA CANYON" were monitored. Information obtained from the video recording and other sources has been used to calculate the speed of the vessel. Given the very short time-frame and the error of parallax, the calculated speeds of the vessels are approximate only.

To prevent the stern of the "AGAWA CANYON" from striking the "EMERALD STAR", the "AGAWA CANYON" engine controls were set briefly to full ahead with port helm. After clearing the stern of the "EMERALD STAR", the "AGAWA CANYON" then struck the north wall at 1636:02 with some force, 137 m from the Poe Lock entrance. The collision between vessels resulted in indentation of shell plating and associated internals in way of the forecastle deck over a length of 6 m, and collision with the lock wall resulted in corresponding heavier damage at and below the waterline.

The vessel was then made fast on the West Center Pier wall to await inspection by the appropriate authorities. There was no delay to other traffic.

"EMERALD STAR"

The "EMERALD STAR" is a tanker with the bridge and accommodation aft and a clear view forward. As per the *International Convention for the Prevention of Pollution from Ships* (MARPOL) and the United States *Oil Pollution Act* of 1990 (OPA 90) regulations, the "EMERALD STAR" is fitted with side and bottom ballast tanks and void spaces. Stopping distance (head reach) for the ballast condition is 457 m at a speed of 6.7 knots and 117 m at 3.5 knots.

After discharging some 2800 tonnes of gasoline and some 4400 tonnes of diesel No. 2, the vessel departed Sault Ste. Marie, Ontario, bound for Thunder Bay, Ontario. The voyage was uneventful until the departure from Poe Lock. The lock and dam operating supervisor (locally referred to as the lockmaster) gave permission to the "EMERALD STAR" to exit the lock at 1628. The "EMERALD STAR" was under the conduct of the master with the helmsman (and intermittently the watchman) on the bridge.

The normal time to exit the lock for a 222 m to 304 m long vessel is about 10 minutes. The "EMERALD STAR" is a smaller vessel, was in ballast, and in about 6 minutes had cleared the lock (at about 1634) at a speed estimated to have been about 6 mph. As the vessel was departing from Poe Lock, gas-freeing and tank-cleaning operations of Nos. 2 and 4 starboard (cargo) tanks were reportedly underway. The master indicated that gas-freeing began only when the vessel was clear of the dock. Other witnesses indicated that gas-freeing had begun before departure from the lock. In either instance, gas-freeing was taking place close to the lock.

Reportedly, the lockmaster indicated that he had called the underway "EMERALD STAR" by VHF radio, as that vessel was departing the lock, to alert it to perceived concerns with the movements of the "AGAWA CANYON". Due to a technical problem, this communication was not tape-recorded and its receipt was not confirmed. The lockmaster also indicated that as the "EMERALD STAR" cleared the lock upbound, the "AGAWA CANYON" was just making her landing, west of the International Bridge.

At 1634, St. Marys Falls Lock Operations was informed that the "EMERALD STAR" was clear of the Poe Lock. Some 14 seconds later, the master of the "EMERALD STAR", upon receiving a VHF call from the "AGAWA CANYON", learned for the first time that the "AGAWA CANYON" was experiencing manoeuvring difficulty. He had noted earlier that the "AGAWA CANYON" had initially made what he interpreted to be an unusual landing at the approach wall, but he was concentrating on manoeuvring his own vessel. No clarification was sought, nor was the "AGAWA CANYON" contacted to confirm if all was well. Instead, it was decided that collision avoidance would be attempted by increasing the speed and manoeuvring through the diminishing

space between the bow of the “AGAWA CANYON” and the wall of the West Center Pier. The bow thruster was not used.

The “EMERALD STAR” first altered course to starboard and then, some 30 seconds later, altered course rapidly to port to reduce the angle of impact. No warning signal on the whistle was sounded to warn the ship’s complement and the lock personnel of the impending danger, nor was the general alarm sounded in the internal spaces of the vessel. At 1635:11 the vessels collided. The speed of the “EMERALD STAR” was estimated to have been about 6.0 to 6.5 knots. The impact of the collision set the “EMERALD STAR” some 10 m bodily to starboard. The vessel, however, managed to move rapidly ahead and in so doing did not become pinched between the bow of the “AGAWA CANYON” and the West Center Pier.

Damage to the “EMERALD STAR” comprised indentation to the side shell plating and lifting of the main deck plating in way of a fairlead. The side ballast tanks and void spaces acted as a buffer zone and prevented more serious consequences. There was no pollution.

Effectiveness of Bow Thruster

Each vessel was fitted with a bow thruster, the performance of which varies with the vessel’s speed. While its effectiveness is 100 per cent when the vessel has no headway, it diminishes to 50 per cent at 3 knots, and is nil at 5 knots.

Canal Wall Fender

Once the “AGAWA CANYON” port shoulder cleared the “EMERALD STAR” stern, the “AGAWA CANYON” collided with the opposite wall with such frictional force that the heavy wooden fenders were briefly set on fire until the wash from the vessel coming alongside extinguished the flames. The damage was substantial. The recently installed fendering was intermittently crushed and ripped for a length of approximately 40 m, with intermittent minor damage to the concrete.

Certification

The master of the “AGAWA CANYON” held a Canadian Master Inland Waters certificate since 1981. He had sailed intermittently as master and third, second and first mate spanning a period of approximately 30 years. He had been master of this vessel for one year. He was well rested and a recent company medical examination indicated that he was medically fit.

The master of the “EMERALD STAR” has held a Canadian Master Home Trade certificate since 1968. Since 1968 he has served as master on various vessels. He has been sailing on tankers for approximately 20 years. He had been master of this vessel since 13 February 1998 and had been employed as master with the same company since 31 January 1997. He was well rested and a company medical examination had determined him fit for duty.

St. Marys Falls Lock Operations and Waterway

The southwest pier canal services the entry/exit for both the Poe Lock and the MacArthur Lock. It is 92.65 m wide and has a limiting depth of 8.53 m. The locks are administered and operated by the United States Army Corps of Engineers (USACOE). They are not part of the Canada–United States Seaway system and, thus, St. Lawrence Seaway Regulations do not apply. Neither vessel was required to have a pilot aboard.

Poe Lock and MacArthur Lock were at “high pool” (slack water) and there was no current at the time of the occurrence.

The regulatory speed limit is 2.5 mph entering the locks and 6.0 mph departing the locks.

Vessels were not prohibited from tank cleaning or gas-freeing while traversing the lock system, nor were they required to report to the lock operations if such operations were taking place. St. Lawrence Seaway Regulations, in contrast, prohibit such activity, and there is a requirement to report such activity to the authorities.

As a result of a near-collision in 1996, an internal USACOE memorandum comprised of instructions had been issued by the lock administration to lockmasters stating that tankers are not to exit a lock upbound when a vessel is downbound in the approaches unless the downbound vessel is made fast alongside. This also applies in the opposite direction. This information was not promulgated to vessels through notices to shipping, nor was it required to be. In this instance, the lockmaster had permitted the tanker to exit Poe Lock while the bulk carrier was still manoeuvring underway and was not secured to the approach wall. It was indicated that since the 1996 memorandum there had been hundreds of occasions where tankers were released from a lock to meet vessel traffic in the canal zone. According to the lockmaster, given this fact, the release of the “EMERALD STAR” on this occasion was not unusual.

There is no real-time speed information on vessels moving along the approach wall available to the St. Marys Falls Lock Operations personnel.

Analysis

Method of Approach to the Locks

Instructions to masters for the St. Marys Falls Canal require that, before entering a lock, a vessel shall put out heaving lines, attached to forward and after mooring cables, onto the approach pier. Either the line or the cable shall be continuously carried by the vessel’s deckhands or canal linesmen until the vessel is moored in the lock chamber.⁴ The reason for this is that vessels can be controlled and quickly secured, if necessary. The movement of a vessel along the approach wall is similar to other lock approaches in the Seaway; the bow is angled in towards the dock at approximately 8 to 10 degrees and slides slowly along the fendering. The “AGAWA CANYON” was allowed to proceed bodily alongside the approach wall and the bow began to move away from the wall while moving ahead. The deployment of the mooring cables at this point—to check the bow in or secure the vessel until the other vessel had passed—could have been carried out, but this was not done.

⁴ *United States Coast Pilot Volume 6 - Great Lakes: Lakes Ontario, Erie, Huron, Michigan, and Superior and St. Lawrence River*, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Oceans Service.

Instead, the main engine was used in an attempt to bring the bow back to the approach wall. This resulted in increased speed and gave rise to further problems associated with hydrodynamic interaction, squat and generated currents.

Under-Keel Clearance

The fully laden "AGAWA CANYON" was operating at maximum Seaway draught with an under-keel clearance of 0.65 m. As the speed of the vessel increased, her mean draught was increased by an amount which varied with the speed of the ship (squat effect). Shallow water restricts the flow of water to a vessel's propeller and results in cavitation which, in turn, reduces steerability. It is most likely that the "AGAWA CANYON" was affected by these forces, while proceeding at a speed greater than 6.5 knots.

Stern Suction

The stern remained close to the approach wall. As the revolutions per minute (rpm) increased on the controllable-pitch propeller in the ahead mode, the propeller pulled the water from between the wall and the stern of the ship. This resulted in greater hydrodynamic suction than the force of water thrusting against the rudder (which would tend to move the stern away from the wall). This suction force prevented the vessel's stern from moving away from the wall despite the helm being hard-to-starboard. The master believed that he could get the stern away from the wall by giving the vessel a "kick" ahead; i.e., putting the engine controls to full ahead for a brief period. The vessel's speed was increased in an attempt to overcome stern suction, but the bow moved further to port. In contrast to this, with an earlier setting of the engine controls to "full astern," while there might have been some initial stern suction, with the slowing of the vessel and the subsequent increase in bow thruster effect, there would have been a greater chance of moving the vessel's bow to starboard.

Intership Hydrodynamic Interaction

As the bow of the rapidly moving "EMERALD STAR" passed the bow of the approaching "AGAWA CANYON", intership suction was created just aft of the port shoulder and thus the "AGAWA CANYON" was drawn toward the "EMERALD STAR" that much faster.

Bow Thruster

The bow thruster of the "AGAWA CANYON" was in varying use throughout the manoeuvres, up to the point of collision and striking of the West Center Pier. As the speeds of both vessels increased to beyond 4 knots, the effectiveness of the bow thruster diminished rapidly to nothing. The speeds of both vessels, just before the collision, would have rendered the bow thrusters ineffective and the bow thruster of the "AGAWA CANYON" was no longer of use in keeping the vessel's bow close to the wall.

The bow thruster of the "EMERALD STAR" was not used.

Mooring Cables

Two crew members were swung ashore to act as linesmen, one forward and the other aft, each carrying a heaving line to pull out a mooring cable if needed for tying up or checking the bow in. As the vessel's speed and the distance from the bow to the approach wall increased, this possibility was nullified since the linesmen had to run with lines in hand until they had to let them go. Maintaining the vessel's speed within the lock operating speed of 2.5 mph would have permitted the forward mooring cable to be used to nip the bow in. The speed of the "AGAWA CANYON" now posed a danger to the safety of the linesmen ashore. Apparently, their vulnerability was not fully appreciated by the master, even though he was frequently out on the starboard bridge wing and had a good view of the approach wall.

Generated Current Effect

The "AGAWA CANYON" was pushing significant amounts of water ahead of her due to the forward and lateral (crabbing) motion within the narrow confines of the canal leading to the locks. Unusual currents would be created by the additional speed of the vessel in conjunction with the movement of the "EMERALD STAR" coming out of the Poe Lock. This "bath tub" effect was further aggravated by both vessels' rapid increase in speed.⁵

Risk Assessment

"AGAWA CANYON"

The master of the "AGAWA CANYON" indicated that it appeared to him that the vessel made a normal landing at the approach wall. The weather and waterway conditions were almost ideal. The navigation and mechanical operations of the vessel were problem free. There was no urgency for the vessel to arrive at the next port of call and there was no other nearby downbound traffic. The MacArthur Lock gates were open and ready to take the "AGAWA CANYON".

In considering the under-keel clearance, the effects of "squat" and stern suction, the lack of bow thruster control and lack of utilization of the mooring cables, diminishing sea-room ahead while approaching a lock, intership suction and generated currents, *speed* was the critical factor. There was also the possibility of a collision with a tanker. The master did not know that the tanker was gas-freeing highly explosive gasoline vapours from the No. 2 and No. 4 starboard tanks. As the "AGAWA CANYON" was scraping along the "EMERALD STAR", the master of the "AGAWA CANYON" placed the engine controls to full ahead with full port helm and successfully averted having the stern of his vessel collide with the "EMERALD STAR"; however, at the completion of this action, the speed of the vessel had increased. Given the immediate need to reduce speed and to minimize the angle and velocity of impact with the north wall, the master elected to drop the starboard bow anchor. However, this decision was not without risk, as there was the potential that the vessel could run over the anchor (with low under-keel clearance) and possibly sustain bottom damage.

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The term "bath tub" effect is a colloquial expression used in the Seaway. It describes the surging and oscillation of vessels in locks and approaches due to the movement of the mass of water within these confines. It is mostly created by the movement of the vessels themselves.

Early avoidance action such as the use of the engine astern together with the use of the bow thruster and/or the use of the mooring cable to control the vessel's swing may have better enabled the vessel to extricate herself from the developing situation.

"EMERALD STAR"

Reportedly, the master of the "EMERALD STAR" was concentrating on exiting Poe Lock and was surprised when he received the VHF radio call from the "AGAWA CANYON" indicating that the latter was experiencing manoeuvring difficulty. However, he had noted that the "AGAWA CANYON" had initially made what he interpreted to be an unusual landing at the approach wall. Despite this, he did not consider the incident significant enough to cause him concern until he received the VHF call, nor did he seek information or clarification from the "AGAWA CANYON" with respect to his observations. Consequently, an opportunity to take early action, such as remaining in the lock and/or slowing or stopping the vessel (which would have given the "AGAWA CANYON" more time to be extricated from the developing situation), was lost.

Having decided to proceed ahead, the master of the "EMERALD STAR" was faced with a sudden compelling set of circumstances that offered little avenue for escape. A bow-on collision would have posed less of a threat to the tanks but would have placed the lock structures at risk. The master elected to move ahead at full speed, keeping at least 10 m off the West Center Pier wall to allow the vessel some manoeuvring room.

Both masters opted to increase speed in order to extricate their vessels from the dangerous situation. This despite the fact that increased speed would lead to greater intership hydrodynamic action and would further exacerbate the situation. As events show, they were quickly confronted with an increasingly dangerous situation, the urgency of which did not allow further assessment, and reactions to the events became spontaneous.

Lock Operations

Despite USACOE Lockmaster instructions to the contrary, the "EMERALD STAR" was cleared to leave the lock. The lock operations control centre was not equipped with a means to provide real-time speed of a vessel approaching the approach wall. The lockmaster estimated at an early stage that the "AGAWA CANYON" was proceeding at an unsafe speed. However, the "AGAWA CANYON" thereafter had slowed to put linesmen ashore and her movements would not have looked unusual at that time. On the other hand, a close monitoring of the "AGAWA CANYON" by the lock operations control centre would have indicated that the vessel was experiencing manoeuvring difficulty. A means of alerting and/or a reaction by the lockmaster based on his perception of the approach speed at this early stage would have given him more time to respond. By the time the lockmaster became aware of the manoeuvring difficulty experienced by the "AGAWA CANYON", the "EMERALD STAR" had exited the lock. Once the bow came off the approach wall after landing the two linesmen ashore, there was very little that the lockmaster could do except to watch events unfold.

Since the instructions to hold a tanker in lock until the downbound vessel has been made fast at the approach wall were not published in the notices to shipping, the masters were not aware of these instructions. Given the intership hydrodynamics at play, both masters ought to have been aware of the dangers of both vessels passing underway at relatively high speed in the narrow approach to the lock. Because the "EMERALD STAR" was a tanker, the danger and the risk posed by the vessel was all the greater.

Regulatory Requirement

St. Lawrence Seaway Regulations apply to all areas of the Seaway, including locks that are part of the Canada–United States Seaway system, except the St. Mary’s Falls Locks and Canals. Section 73 of the St. Lawrence Seaway Regulations prohibits cleaning and gas-freeing of tanks while: (a) in a canal or lock, or (b) in an area that is not clear of other vessels or structures, or (c) before gas-freeing and tank cleaning has been reported to the nearest Seaway station. The regulations reflect the risk associated with tank-cleaning and gas-freeing operations when vessels are operating at close range. However, at the time of the occurrence there were no such requirements in this lock system, which is administered by the United States Army Corps of Engineers.

Findings as to Causes and Contributing Factors

1. The method used to prevent the bow of the “AGAWA CANYON” from moving away from the lock wall was limited to an increase in speed and the application of helm. Other means, such as reduction in speed combined with the application of bow thrust, and the use of a head line to nip the bow of the vessel, were not used.
2. Despite instructions to the contrary, the tanker “EMERALD STAR” was given permission by the lockmaster to exit the lock before the downbound self-unloading bulk carrier “AGAWA CANYON” was made fast to the approach wall.
3. Although the master of the “EMERALD STAR” gave information that the “AGAWA CANYON” had made an unusual landing at the approach wall, he neither sought clarification from the latter vessel or lock control nor instituted additional safeguards to permit the safe transit of the vessels.
4. The speed of the “EMERALD STAR” was increased to pass between the “AGAWA CANYON” and the dock wall, instead of being reduced or stopped to give the latter more time to be extricated from the difficult situation.
5. The depth of water, proximity to the locks, other traffic in the area and intership hydrodynamic interaction were not fully taken into account in determining a safe speed for the “AGAWA CANYON”.

Findings Related to Risk

1. The master of the “AGAWA CANYON” did not fully appreciate the dangers to the linesmen associated with increasing the vessel’s speed.

2. The bow thrusters on board both vessels were rendered ineffective due to the increased speed of both vessels.
3. No warning blasts on the whistle or sounding of the general alarms by either vessel took place to warn the ship and the lock personnel of the impending danger.
4. The increased danger associated with tank-cleaning/gas-freeing operations while in the canal was not fully appreciated by the master of the "EMERALD STAR", nor by the lockmaster, and there was no requirement for vessels to cease such activity near the lock area.
5. The side ballast tanks and void spaces of the "EMERALD STAR" acted as a buffer and prevented more serious consequences.
6. There is no means to accurately measure, in real time, the speed of approaching or departing vessels at St. Marys Falls Canal Lock Operations.

Safety Action

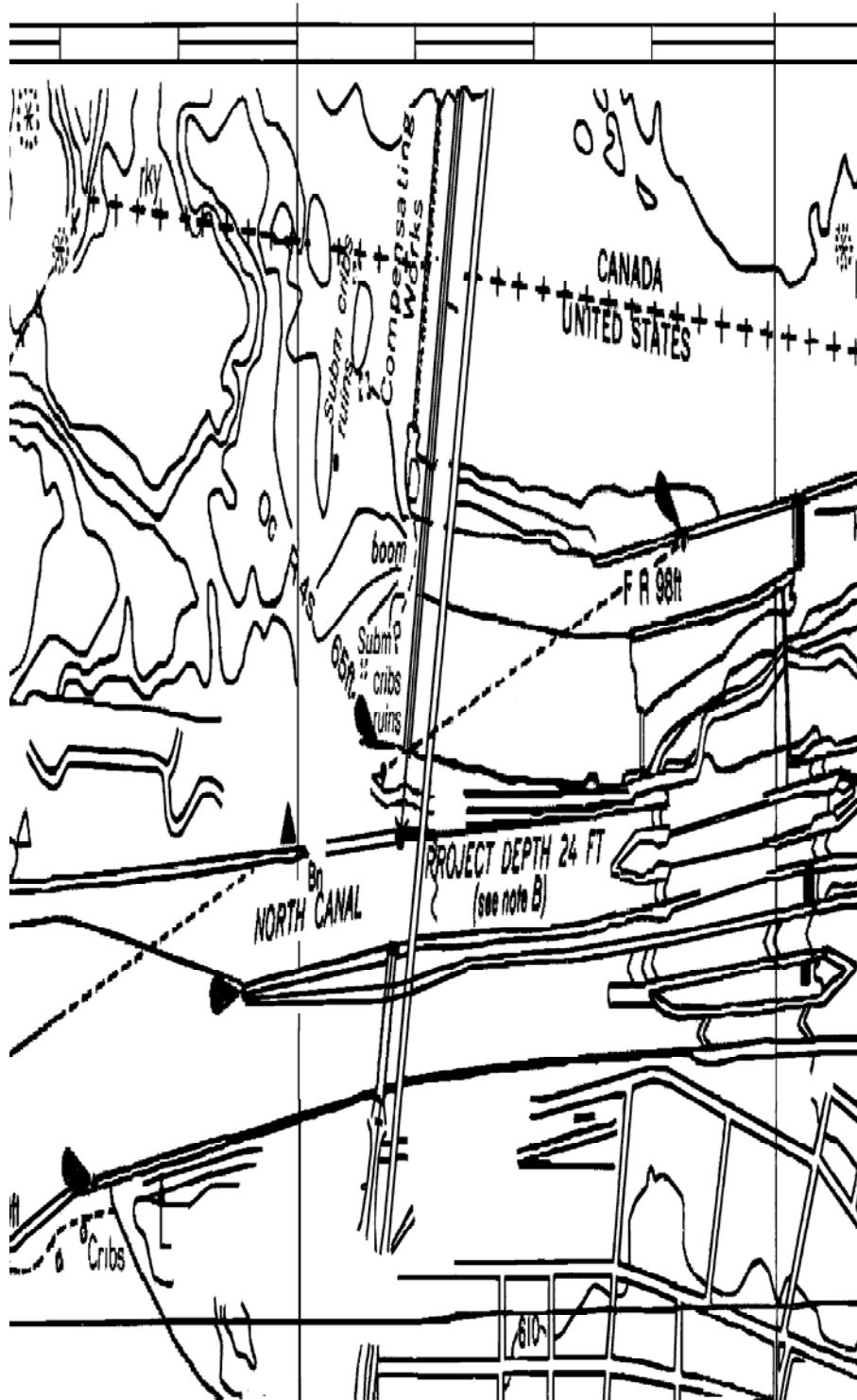
The USACOE has initiated changes to the U.S. Regulations 33CFR204.7 and issued *Notice to Navigation Interests L99-08*, which indicates that cleaning and gas-freeing of tanks on all hazardous material cargo vessels shall not take place in a lock or any part of the lock's approach canals.

The USACOE also issued *Notice to Navigation Interests L99-09*, which requires, *inter alia*, that whenever a tank vessel is within a Sault Ste. Marie lock chamber, the tank vessel will not be released from the lock until the channel in the direction of the tank vessel is clear of vessels or vessels therein are securely moored to the approach pier. This limits movement to a single vessel whenever a tank vessel is within the limits of the lock piers either above or below the locks. A "note" indicates that a tank vessel includes a vessel that is not gas-free.

The owners of the "AGAWA CANYON" advise that they have a training program in place for new masters which includes computer simulator training courses. This has been augmented by including a Manned Model Shiphandling course, which the master had attended, as well as other shipboard training requirements. All Algoma masters have been given additional information on shallow water and hydrodynamic effects on vessel manoeuvrability.

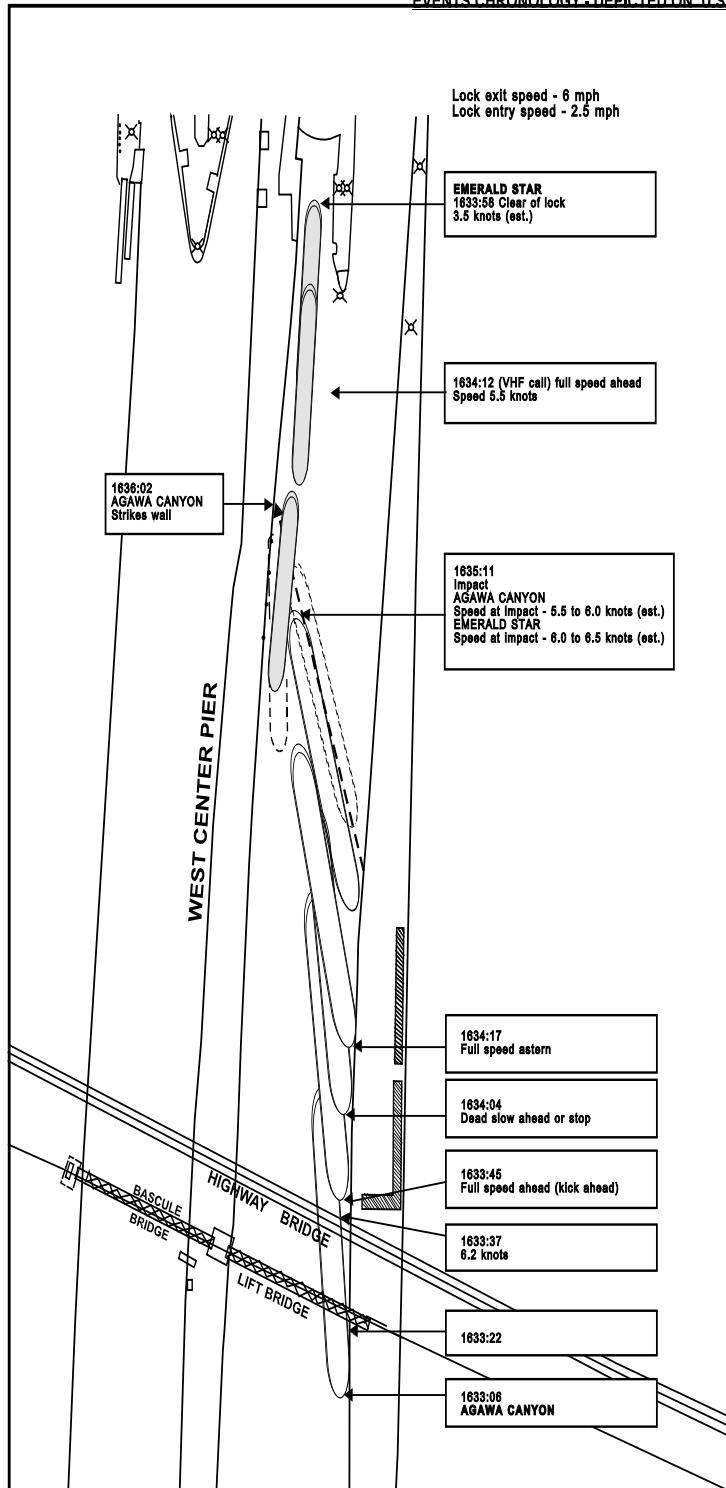
This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 28 November 2000.

Appendix A - Sketch of the Occurrence Area



Appendix B - Chronology

EVENTS CHRONOLOGY - DEPICTED ON U.S. ARMY CORPS OF ENGINEERS CHART



Appendix C - Photographs



ST. MARYS FALLS CANAL LOCKS -LOOKING WEST



EXIT VIEW FROM POE LOCK