MARINE INVESTIGATION REPORT

M01C0008

STRIKING OF THE TANKER *HAMILTON ENERGY*

AND

STRIKING AND SINKING

OF THE TANKER *PROVMAR TERMINAL*

BY THE BULK CARGO *UTVIKEN*

NEAR PIER 23, HAMILTON HARBOUR, ONTARIO

01 APRIL 2001

Marine Investigation Report

Striking of the Tanker *Hamilton Energy* and Striking and Sinking of the Tanker *Provmar Terminal*

By the Bulk Cargo *Utviken* near Pier 23, Hamilton Harbour, Ontario 01 April 2001

Report Number M01C0008

Summary

In daylight and clear weather with light winds, while proceeding toward Pier 23, Hamilton Harbour, the deeply laden bulk cargo *Utviken,* with a pilot on board and with tug escort, struck the tanker *Hamilton Energy*, and proceeded to strike and sink the tanker *Provmar Terminal.* Substantial damage was sustained by both tankers, while the *Utviken* suffered damage in way of the bulbous bow, which caused flooding in the forepeak tank. There was minor pollution as a result of this occurrence.

Ce rapport est également disponible en français.

Other Factual Information

	Utviken	*Hamilton Energy*
Official Number	726116	307998
Port of Registry	Nassau	Halifax, Nova Scotia
Flag	Bahamas	Canada
Type	Bulk carrier	Tanker
Gross Tonnage	17 191	982
Length[1]	189.4 m	59.2 m
Draught	Fwd 7.88 m Aft 7.92 m	Fwd 3.05 m Aft 4.27 m (estimated)
Built	1987, Spain	1965, Grangemouth, Scotland
Propulsion	B&W 5 cylinder Diesel 10 900 HP	Polar Atlas, 840 kW diesel
Number of Crew	24	3
Number of Passengers	2	None
Registered Owners	Team Ship Management AS, Norway	Provmar Fuels Inc., Hamilton, Ontario

	Provmar Terminal
Official Number	345867
Port of Registry	Hamilton, Ontario
Flag	Canada
Type	Oil Storage Vessel
Gross Tonnage	4710
Length	122.4 m
Draught	Fwd 6.5 m Aft 6.5 m (summer)
Built	1959
Propulsion	None (engine room - boilers, generators)
Number of Crew	1
Number of Passengers	None
Registered Owners	Provmar Fuels Inc., Hamilton, Ontario

1 See Glossary at Appendix C for all acronyms and abbreviations.

Description of the Vessels

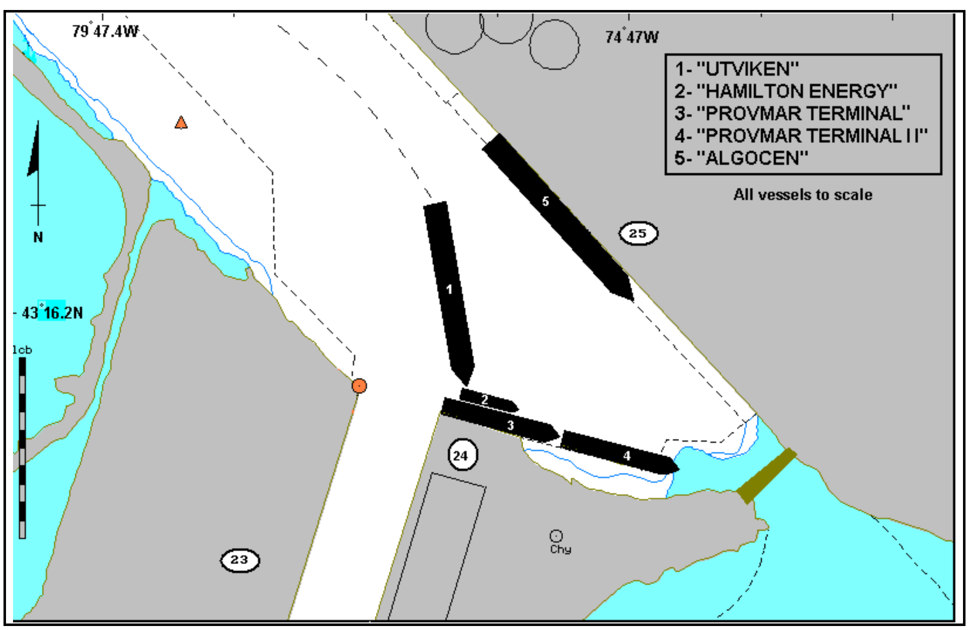
The *Utviken* is a conventional bulk carrier, with bridge, accommodation and engine room located aft of the seven cargo holds. The vessel is fitted with a bulbous bow. On the fore and aft centre line, there are four cranes. The main engine, which requires air start from ahead to astern manoeuvres, drives a single-screw, right-handed propeller.

The *Hamilton Energy* is a small, single-hull tanker used for ship refuelling, primarily in Hamilton Harbour but also in western Lake Ontario. At the time of the occurrence, the vessel was tied up outboard of the *Provmar Terminal*, starboard side to, on the north face of Pier 24.

The *Provmar Terminal* is an oil storage vessel and maintains an engine room which contains boilers and generators. The vessel stores various grades of fuel and supplies the *Hamilton Energy* with fuel cargo. Provmar Fuels Inc. administrative offices are located in the aft accommodation area of the vessel. Located forward of the storage vessel and on the same pier, is the *Provmar Terminal II*. This is an additional oil storage vessel, approximately the same size as the *Provmar Terminal*.

History of the Voyage

The *Utviken* arrived at Hamilton Harbour anchorage at 1100 on 30 March 2001. At 1136 on 01 April 2001, a pilot boarded the *Utviken* in order to conduct the vessel to Pier 23 in Hamilton Harbour. He was handed a pilot card and there was a brief exchange of information between the pilot and master concerning the vessel movement from the anchorage to Pier 23. The pilot had conned this vessel to the same berth the previous year.



At 1254, in clear weather and light winds, the *Utviken* departed the anchorage. On the bridge were the pilot, master, chief officer and helmsman. Two tugs, the *Paul E No. 1* (1200 hp) and *Lac Vancouver* (700 hp) had assisted in the departure of the vessel *Lake Superior* from Pier 23 and were now waiting near section 26 for the arrival of *Utviken*. Arrangements were made to pass the *Lake Superior*, starboard to starboard, near section 27. The manoeuvring room opposite the entrance to Pier 23 was reduced by the presence of the bulk cargo *Algocen* berthed at section 25.

Having passed the *Lake Superior,* and as the *Utviken* approached the tugs, one of the tugs' personnel observed that the vessel's speed was in excess of the typical speed for vessels attempting to berth at Pier 23. At 1328, the tugs were following along on the port side not made fast, with *Paul E No. 1* forward adjacent to cargo hold No. 1 and *Lac Vancouver* aft. Because of the northeasterly wind (astern), the *Utviken* had a tendency to turn to port while proceeding toward Pier 23. Consequently, intermittent starboard wheel was used while coasting ahead. Additionally, the engine control setting was intermittently set at dead slow ahead, slow ahead and stop for the next nine minutes in order to maintain steerage way. There were four successful main engine air starts since the vessel departed the anchorage, two of which were between 1328 and 1337. In retrospect, the master thought the vessel's speed was faster than he was comfortable with under the circumstances, but he did not communicate his concerns to the pilot as he had confidence in the pilot's abilities.

At 1337, the pilot ordered half-astern engine. The rpm indicator momentarily showed astern revolutions, but it quickly returned to the zero position. On his own initiative, the master ordered the starboard anchor to be let go in order to initiate a turning motion to starboard. In quick succession, the pilot then ordered both starboard and port anchors to be let go. Neither the master nor the pilot had specified a length of cable to be let out. The pilot then ordered the forward tug, *Paul E No. 1*, to push with full power on the port side forward. The tug proceeded to push the *Utviken* at an angle of less than 90 degrees to the hull due to the speed of advance. At 1338, the engine control was set to full astern. Again the rpm indicator momentarily showed astern revolutions but it quickly returned to zero.

At 1339, the bridge control for the main engines was switched to engine room control and full-astern power developed some 15 to 20 seconds later. At about this time, a bridge team member observed that the global positioning system unit indicated a forward speed of 4 knots. A crew member on the *Hamilton Energy,* who had just come out on deck aft, could see a bow wave as the *Utviken* approached. Also at about this time, a person ashore, with considerable experience in securing vessels at Pier 23, estimated the vessel's speed to be 5.5 to 6 knots.

At 1340 to 1341, on a heading of approximately 170°(T), the *Utviken's* bulbous bow struck the port quarter of the *Hamilton Energy*, approximately 4 m below the surface of the water in way of the skeg, propeller and rudder. The *Hamilton Energy* was instantly heeled over to port (60 to 70 degrees), submerging the main deck port railing.

The upper bow of the *Utviken* then collided with the aft superstructure of the *Hamilton Energy* and slammed the vessel to starboard against the aft superstructure of the *Provmar Terminal.* The *Hamilton Energy* broke its moorings and drifted at speed, dead-ship, out into the harbour.

While still moving forward and to starboard, the bulbous bow of the *Utviken* then penetrated the engine room spaces of the *Provmar Terminal*, quickly sinking the stern of the vessel in a depth of approximately 10.5 m. The chief engineer, who had been below in the engine room of the *Provmar Terminal*, had just come on deck and was able to safely evacuate the vessel.

Once the *Utviken* had lost all headway, the *Paul E No. 1* quickly proceeded to assist the *Hamilton Energy*, which was drifting ahead in the middle of the southeast portion of the harbour. The *Utviken* was then backed away from the *Provmar Terminal* and manoeuvred to her berth at Pier 23, arriving at 1418. Some minor pollution around the stern of the *Provmar Terminal* was quickly contained.

Additional Information

The vessel's navigation team tested the propulsion machinery and equipment prior to the anchor being weighed. The machinery was tested ahead and astern from both the wheelhouse and the engine room control. No further test was conducted subsequent to the pilot's boarding.

The normal, bridge-controlled, starting sequence is automated and consists of two 18-rpm start attempts followed by one 35-rpm start attempt (at 30 bar air pressure) before switching air tanks. Between 1337 and 1339, the bridge engine control failed to start the main engine at the half and full-astern settings, each with an attempted 18-rpm start. At 1339, the bridge control was switched to manual engine room control (which overrode the automated sequence), and the main engine was started.

After the occurrence, the main engine pneumatic control system was inspected. Many pneumatic valves and O rings were overhauled or replaced within the system. It was discovered that the seal in a three-way starting air valve for the pneumatic main engine control system had deteriorated by some 50 per cent relative to original specifications. This valve is required for the opening of the starting air valve. This degradation of performance reduced the pressure of air delivered to start the engine.

After the surveyed pneumatic control elements were either refurbished or replaced, between April 01 and finishing April 05, test starts were undertaken with a starting air pressure of 28.5 bar. Sixteen bridge control starts were possible (randomly, ahead and astern) from this location before the low air pressure alarm sounded. Control was then passed to the engine room and a further 11 starts were possible, with air pressure at 6 bar for the final start.

At the time of impact, there were three crew members aboard the *Hamilton Energy* and one crew member aboard the *Provmar Terminal*. No warning blast or general alarm was sounded by any of the vessels involved before or after the impact.

Although a formal risk assessment of this area has not been undertaken by the Hamilton Harbour Commission (HHC),[2] the HHC (HPA) recognizes that there are greater inherent risks associated with vessels proceeding to Pier 23 than elsewhere in the harbour.

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[2] On 01 May 2001, the Hamilton Harbour Commission became the Hamilton Port Authority (HPA).

Injuries to Persons

The chief engineer of the *Hamilton Energy* was thrown down a flight of steps at the point of impact. He suffered a sprained wrist and a cut on his hand. The other two crew members were violently tossed about at impact but suffered no personal injury.

After the striking, many crew members on both tankers experienced symptoms similar to that of post-traumatic stress.

Damage to the Vessels

The *Hamilton Energy* sustained heavy damage. The skeg was displaced approximately 1.5 m and the propeller was damaged beyond further use. The rudder and pintle arrangement were significantly damaged and a thrust bearing became misaligned and distorted. The propeller shaft was driven inward, damaging the main engine block. The main engine installation was found to be a total loss. The steering gear flat and equipment sustained significant damage. The poop deck plating was deformed by 0.2 to 0.4 m in several locations. There was superstructure damage to the port and starboard side aft and the flag staff was bent over to at least 70 degrees from the vertical.

The *Provmar Terminal* also suffered heavy damage. Penetration by the bulbous bow of *Utviken* created a 4.0 m by 4.7 m opening into the engine room spaces below the waterline. The subsequent flooding damaged boilers, generators and other electrical equipment.

The *Utviken* suffered damage to the bulbous bow, which flooded the forepeak tank.

Certification of the Vessels

The *Utviken* was certified, equipped and crewed in accordance with existing regulations.
The *Hamilton Energy* and *Provmar Terminal* had current inspection certificates issued by Transport Canada Marine Safety.

Personnel Certification

The pilot was appropriately licensed for the pilotage area of Lake Ontario and Kingston Harbour.

The *Utviken* bridge and engine room personnel held qualifications appropriate for the class of vessel on which they were serving and for the voyage being undertaken.

The tug masters were appropriately certificated.

Personnel History

The pilot had been with the Great Lakes Pilotage Authority since 1993, working primarily on Lake Ontario and Kingston Harbour. He was familiar with Hamilton Harbour, having piloted vessels in and out of the harbour on many occasions. He piloted the *Utviken* to Pier 23 the previous year (i.e. 2000).

The master had been in command of the *Utviken* for the last five years. He had made frequent trips to Hamilton and other Great Lake ports over the last nine years on this and other vessels. He had been master on the *Utviken* the previous year, when the same pilot conned the vessel to Pier 23.

Weather

At 1300, Environment Canada recorded a wind speed and direction of 10 knots at 70 degrees for Hamilton Harbour. At 1400, it was 10 knots at 50 degrees. These readings were taken at the Burlington Bridge. Typically the wind speed at the bridge is slightly higher than at other areas within the Harbour. This would agree with the other observed speeds of 5 to 8 knots.

Navigation Equipment

There was a full range of navigation equipment on board, adequate for the safe operation of the vessel. No equipment malfunction was reported and the appropriate navigation chart was in use at the time of the occurrence.

Main Engine Operation

The vessel is fitted with pneumatic bridge controls for the operation of the main engine. The automated starting sequence consists of two 18-rpm start attempts before an attempt at a 35-rpm start. Reversing the engine requires that the main engine be stopped and reversed via air start control. At the push of a button on the bridge console, control reverts to the engine room.

Starting attempts can also be made from the engine room control room position, either through the automated sequence or by manual means which overrides the 18-18-35 rpm sequence. For engine room manual starting, the duration of the start attempt is then only limited by the amount of starting air available.

On this ship, astern power is 75 per cent of ahead power.

The engine response times are as follows: from stop to either ahead or astern propulsion, approximately 11-15 seconds; and from stop, the propeller takes 15 to 20 seconds to reach the maximum of 100 rpm.

There were four successful main engine air starts since the vessel departed the anchorage, two of which were between 1328 and 1337.

Vessel Manoeuvring Characteristics

A "dead slow ahead" engine control setting gives the vessel a speed of 6.3 knots. Information obtained from the manoeuvring diagram shows that the minimum speed for steerage way in the loaded condition is 4.1 knots. Additionally, these diagrams show that in the loaded condition with the engine at slow ahead (8.2 knots), a crash stop manoeuvre will produce an advance of 3 cables and take 2.24 minutes to come to a stop. At dead slow ahead, the distance and time required to execute a crash stop would be less.

Depth of Water and Vessel Draught

The height of water was 0.43 m above the International Great Lakes Datum 1955, and the depth of water as depicted on Canadian Hydrographic Service (CHS) chart No. 2067 is 8.2 m. The deepest reported draught of the *Utviken* was 7.92 m.

Vessel Speed and Squat

As a vessel moves ahead in a shallow channel, the flow of water under the hull is accelerated and causes a reduction in pressure, such that the vessel settles deeper than her static mean draught. This phenomenon is known as *squat* and depends on the vessel's speed, the ratio of her static draught to the channel depth, and the relationship of the cross sectional areas of the hull and the channel. The amount of squat increases proportionally with the square of the vessel's speed, and loaded vessels with a limited underkeel clearance (UKC), when proceeding at too high a speed, may settle and make bottom contact.

Observation and analysis of several hundred vessels operating at various speeds in relatively shallow water indicate that vessels similar to the *Utviken* with block coefficients of about 0.8, tend to settle bodily and squat more by the bow.

Stopping distances are typically indicated as derived during sea trials conducted in deep water.

The *Utviken* was at maximum seaway draught when it was proceeding to Pier 23 and, as such, had a static UKC of approximately 0.71 m. When the main engine finally developed full-astern power, the propeller's bite of the water was reduced, in part due to the relatively low UKC, causing also a corresponding increase in the stopping distance and time.

Visibility from the Bridge

The disposition of the four cranes did not interfere with the navigational visibility from the bridge.

Deployment of Tugs

Two tugs were used to assist the vessel in manoeuvring/berthing:

Lac Vancouver	18.56 m long	700 hp
Paul E No. 1	22.28 m long	1100 hp

Neither tug was made fast to the *Utviken* because the pilot wanted the freedom to move the tugs along the length of the vessel as required and to avoid the tugs being caught between the *Utviken* and fixed structures in the area.

Communication Between the Pilot and the Tugs

The pilot communicated with the tugs by portable very high frequency (VHF) radiotelephone. There was no communication, however, between the time the tugs followed alongside until the last few minutes prior to the striking.

Exchange of Information Between the Master and the Pilot

The pilot was presented with the "Pilot Card" on boarding, and the exchange of information between the master and the pilot included the following main items:

- the ship was fitted with a fixed-pitch, right-handed propeller;
- astern propulsion would result in the bow going to starboard;
- astern propulsion was 75 per cent of ahead propulsion; and
- from ahead to astern or vice versa, the engine response time was 11-15 seconds.

The pilot/master exchange included the pilot's intended approach to Pier 23. This was to be achieved by turning the vessel directly into the slip under her own power and without securing the tugs to the vessel; referred to as a “running entry” in this report.

Previous Occurrence

In a previous occurrence at the same location, *Hamilton Energy* and *Provmar Terminal* were struck by the bulk carrier *Nirja* as this vessel attempted a turn to starboard while berthing at Pier 23, assisted by three tugs which were not made fast to the vessel.[3]

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3 TSB Report No. M93C0003, 11 December 1993.

Analysis

Main Engine Reverse Failure

The seat for one valve, required for the opening of the starting air valve, was found to have deteriorated by some 50 per cent as compared to original specifications. This degradation of performance reduced the pressure of air delivered to start the engine.

When main engine control was transferred to the engine room, the engineers overrode the automated starting sequence and quickly started the engine astern. The duration of the start attempt in this mode is then limited only to the amount of starting air available. An operator can activate the start sequence for a longer period of time than that of the preset limits.

In manual mode, the engineers were able to extend the time the compressed air was applied to start the engine. It is probable that, by doing this, they were able to compensate for the valve seal which had deteriorated by some 50 per cent.

Information gathered during the investigation points to a deteriorated valve seat as the most probable cause of the main engine reverse failure when ordered in automatic mode from the bridge at 1337. It has not been established why, approximately 2½ hours before leaving anchorage, the reverse start as tested from the bridge was successful.

Failure to start at 1337 could have been due to deterioration of the valve, its seat or its O ring at that time.

Berthing Methods and Speed of Approach

The impact speed was at least 3.5 to 4 knots. At the time of impact, astern power was functioning and both anchors had been deployed. This suggests that the speed of approach just prior to the initial half-astern order was at least 5 or 6 knots. Additionally, due to the speed of advance of the *Utviken*, the force exerted by the tug *Paul E No. 1* (which was not made fast to the vessel) in the last minutes before impact was at an angle of less than perpendicular to the vessel. It follows that the forward component of the resultant pushing force added to the ahead motion of *Utviken,* against the resistance of the deployed anchors and astern power.

Berthing Methods

One accepted procedure for berthing at Pier 23 involves slowing the vessel's headway almost to a stop at the turning point to line up the vessel for movement into the slip. This allows the tugs to do the work in turning the vessel and proceeding slowly to the berth. The alternative is to make a running entry in one continuous motion from the turning point, through approximately 50 degrees, and arrive at the berth with minimal tug assistance. Astern power is put on at a critical point to begin slowing the vessel and initiate the swing to starboard (for right-hand fixed-pitch-propeller-equipped vessels). The latter was apparently the method chosen by the pilot of the *Utviken.* The time saving between the two berthing methods is estimated to be between 15 and 25 minutes, which is negligible.

While a running entry undoubtably saves some time, the minimum speed necessary for a vessel to maintain steerage way (a necessary condition up to the point where astern power is applied) makes this berthing method a higher risk option. Manoeuvring room forward and to each side of the approach channel is restricted. It is even more restricted, as it was in this case, when another vessel is berthed opposite the entranceway to Pier 23. In the event of any mechanical or control failure or a misjudgment by the bridge team, some degree of adverse consequence is almost inevitable.

Speed

Given the adverse effect on stopping distance of a restricted UKC at this location, it is reasonable to assume a crash stop would produce an advance of approximately 3 cables at an initial speed of 4 to 6 knots. The restricted waters of the southeast harbour and the speed of the *Utviken* (a result of the berthing method chosen) left little time or room to respond adequately to any unexpected event. Neither anchors nor tugs were used effectively thereafter to prevent the striking under the circumstances.

The slower speed, tug-controlled berthing method is used more frequently. In the event of mechanical failures or of difficulty/error in manoeuvring, the bridge team has more time to assess and correct the approach. Additionally, the effectiveness of anchors to stop, reduce speed or assist in turning the vessel is relative to the speed of the vessel over the ground.

Effective Use of Tugs

Made Fast or not Made Fast

It remains at the pilot's discretion whether or not to have the assisting tugs made fast or not. If they are not made fast, however, their usefulness is limited to pushing and they have essentially no ability to slow the vessel. If not made fast, the tug assisting aft can proceed around the stern to either the starboard or port quarter and be effective as long as the vessel is moving ahead at a relatively slow speed. Any increase in speed by the assisted vessel significantly diminishes the effectiveness of tugs not made fast to the vessel.

"When deploying tugs ... [the ship handler should] always consider not just the basic berthing manoeuvre ... but whether those tugs are in a position to arrest his forward progress in the event of an emergency."[4] In the 1993 striking of the *Hamilton Energy* and the *Provmar Terminal*, the fact that the tugs were not secured to the assisted vessel was identified as one of the contributing factors in the accident. Having tugs made fast makes them more effective in slowing or stopping the assisted vessel, or applying a pulling force perpendicular to the vessel, if necessary.

[4] Captain P.J.D. Russell, *The Nautical Institute on Pilotage and Shiphandling*, The Nautical Institute, 1990, page 326.

On the other hand, an increased speed, such as that necessary for a running entry, puts tugs which are not made fast at risk. If the tugs are not able to check the vessel's speed, the tugs and their crews may be in danger of being crushed between the assisted vessel and another vessel or wharf. Because of this danger, there is a reluctance amongst pilots to make fast the assisting tugs given the restricted manoeuvring room at Pier 23. However, the risk to the tugs is minimal, whether made fast or not, when the speed of approach is reduced and the tug-controlled berthing method is used. Given a reduced speed of approach, tugs which are made fast can be used to better advantage.

When the running entry method is used, however, the advantages of having tugs make fast appear to be outweighed by the increased risk to the tugs and their crews.

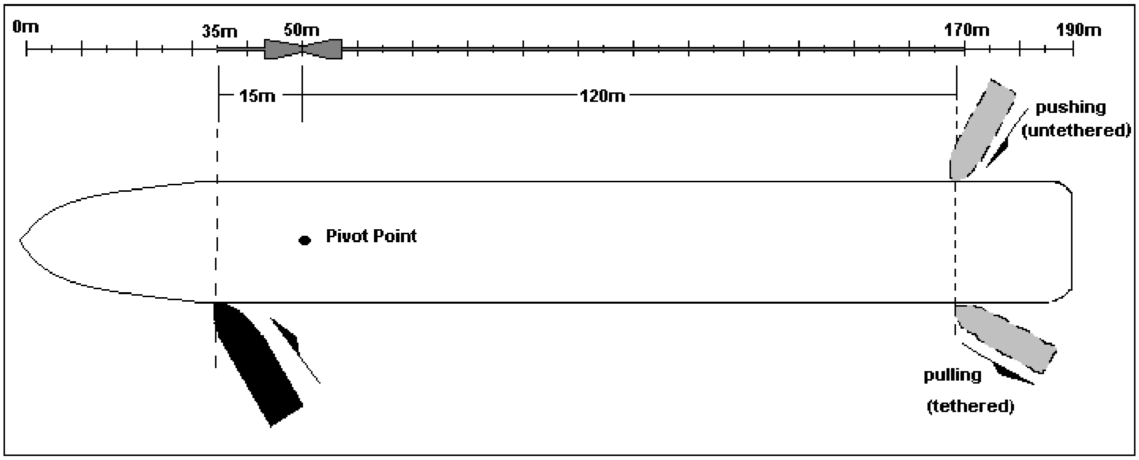
Pivot Point, Turning Levers and Moments

During the final minutes before the striking, the pilot instructed the lead tug, *Paul E No. 1*, to push with full power on the port bow of the *Utviken* in order to move the bow to starboard. The *Paul E No. 1* was the more powerful tug, at 1100 hp, and was already positioned at the fore part of the *Utviken*. The second assisting tug, *Lac Vancouver*, was not used at this time.

The pivot point of a vessel at rest is approximately amidships. When this same vessel is making headway, the pivot point moves to about one quarter of the ship's length from forward.[5] It can thus be appreciated that the turning lever of the forward tug assisting a vessel making headway is reduced and that of the after tug increased.

In this occurrence, the unsecured tug was pushing just aft of the break of the forecastle, or approximately 35 m from forward. Because the *Utviken* was making headway, the pivot point of the vessel would have been approximately 50 m from the bow, giving a turning lever of some 15 m for the forward tug. The aft tug would have had a turning lever in the order of 120 m. Even considering the relative difference in tug power (1100 hp forward versus 700 hp aft), the aft tug pulling on the port side, if made fast or pushing on the starboard side, would have produced about five times the turning moment of the forward tug (see Figure 2). Additionally, once the anchors were let go, the pivot point would have moved even further forward, to a point between the two windlasses. The forward tug's ability to effect a starboard turning moment at this time would have been minimal.

[5] Captain R.W. Rowe, *The Shiphandler's Guide,* The Nautical Institute, 1996, page 12.



In the last minutes before the striking, the aft tug was not used in a manner most effective in turning the vessel to starboard. For the forward tug, the reduced turning lever, the angle of application of the pushing force, and the deployment of the assisted vessel's port anchor all decreased the effectiveness of turning the vessel to starboard. Although the instructions for the forward tug to push full on the port bow were taken in good faith and with the best of intentions, the starboard turning moment applied on the *Utviken* by this action was minimal. Also, contrary to the wishes of all concerned, the assisted vessel's speed reduction was hampered by the forward component of the pushing forces applied by the *Paul E No. 1.*

Deployment of Anchors

Immediately after the bridge team realized the main engine was not responding to the second bridge control command for full-astern power, and since the manoeuvring room was rapidly diminishing, the master ordered the starboard anchor let go. In quick succession to the master's order, the pilot, who was also very concerned about the close proximity of the tankers, ordered both port and starboard anchors dropped.

The anchor cables were checked and veered alternately. This undoubtedly helped slow the vessel, but since both anchors were deployed, the vessel's ability to turn to starboard was severely reduced. The amount of cable veered also increased the risk of underwater damage to the hull by the flukes of the anchors.

A 20 to 25 m movement to starboard would have resulted in the *Utviken's* bow missing the *Hamilton Energy* and the *Provmar Terminal* and possibly clearing the end of Pier 24. The benefit of deploying the starboard anchor on a limited scope of chain, with the port bow tug pushing, would help to create a turning motion to starboard.

Bridge Resource Management

The master had confidence in the pilot's ability, but also thought the vessel was proceeding too rapidly as the vessel was approaching Pier 23.

The essential element of good bridge resource management (BRM) is the challenge and response aspect between the authority of the person conning the vessel (in this case, the pilot) and the assertiveness of the other bridge team members. Although the master did not communicate his concerns to the pilot or challenge him as the vessel rapidly bore down on the moored tankers, he took positive action to increase the vessel's rate of turn and to reduce the vessel's speed.

Location of the Tankers

Pier 24 has been allocated by the Hamilton Port Authority (HPA) to Provmar Fuels Inc. It begins at the northwest end of the pier and extends southeasterly for several hundred metres. It is the location of the permanently moored fuel storage vessels *Provmar Terminal* and *Provmar Terminal II*, as well as the fuelling ship *Hamilton Energy*. There are inherent risks associated with this location; this is the second major striking of these vessels since 1993.

In a report involving the striking of a permanently moored passenger vessel in St. Louis Harbour, the National Transportation Safety Board in the United States (US) recommended that the owners site the vessel in a place that is protected from waterborne risk events.[6] Other authorities, such as the US Coast Guard (CG), cite risk mitigation measures that include location and protective cells for such vessels.[7] Also, the USCG has produced a Permanently Moored Vessel Initial Risk Assessment Form. Finally, a report on site selection and risk mitigation for permanently moored vessels was issued in 1999 by the USCG.

The HPA is aware that the north end of Pier 24 poses higher inherent risks than other locations, although a formal risk assessment has never been carried out. After the occurrence, together with the owners of the fuel oil terminal, an informal risk assessment was conducted. Notwithstanding this approach, there are advantages and further benefits by conducting a formal risk assessment versus intuitive, informal or reactive methods. Some of the advantages include the following:

- traceability of decisions;
- identification of potential hazards;
- identification of potential failure modes;
- quantitative risk statements;
- identification of important contributors to risk; and
- risk reduction solutions.

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[6] NTSB/M-00-32

[7] Draft CG Marine Safety Manual, Volume II, Chapter 10:1.j.1

Emergency Warning

As the *Utviken* approached the moored vessels, unable to turn sufficiently to starboard or slow to avoid impact, neither the general alarm nor the warning signal was sounded to advise the crew of these vessels of the imminent danger. Most of the crew aboard the *Utviken*, *Hamilton Energy* and *Provmar Terminal* were not alerted to any personal danger.

Past TSB occurrence investigations have highlighted the importance of warning crews of an impending danger:

Report Number	Incident Type	Name(s) of Vessel(s)	Location
M93C0003	Striking	*Hamilton Energy* and *Nirja*	Hamilton Harbour, Ontario
M97C0014	Striking and Grounding	*Catherine Desgagnés*	Lorain Harbour, Ohio, USA
M97C0054	Striking	*Thomas Rennie*	Toronto Harbour, Ontario
M98F0039	Collision	*Agawa Canyon* and *Emerald Star*	Sault Ste. Marie, Ontario

It appears that there is either an involuntary lapse or a reluctance to sound the general alarm and/or give warning blasts on the whistle during an emergency.

Findings as to Causes and Contributing Factors

1. The main engine failed to reverse on two attempts from the wheelhouse control. Upon inspection, a faulty pneumatic start system control valve was found and most probably contributed to the failed reverse engine order at 1337.

2. The speed of the *Utviken,* just prior to the turn to Pier 23, left little or no room for error or mechanical failure. Methods employed to avoid the berthed vessels, such as using an unsecured tug pushing forward and the release of both anchors, were ineffective.

3. While it had a limited success in reducing the vessel's speed, the deployment of the port anchor and the length of chain used on both anchors hindered the ability of the vessel to come to starboard.

Findings as to Risk

1. An effective BRM environment was not present on the bridge. As such, the master did not feel comfortable challenging the pilot in respect to the vessel's speed just prior to the turn to Pier 23.

2. Because of prevailing winds, harbour geography and position relative to Pier 23, both the probability and severity of adverse consequences to the permanently berthed vessels at Pier 24 are high.

3. The tugs remained unsecured while assisting the *Utviken.* By remaining unsecured, the tugs could not be used to their full potential in various manoeuvres to assist the berthing vessel.

4. No emergency signal was sounded by the *Utviken*, nor was a warning given aboard the moored vessels, prior to impact.

Safety Action

Action Taken

Vessel Approach to Pier 23, Hamilton Harbour

The Hamilton Port Authority (HPA) has drafted new practices and procedures concerning, *inter alia* " . . . every vessel that is destined for Piers 23 to 26, once they clear the Burlington Canal and make the turn toward Pier 23, is to test the ship's ability to go astern."

Location of the Tankers at Pier 24

As a result of this and a previous occurrence, the owners of Provmar Fuels Inc., together with the HPA, have moved the terminal tanker vessels to the southeast, giving approximately 45 m of clear dock between the vessels and the northeast corner of Pier 24. In addition negotiations are ongoing to remove the two tankers from their present location and to replace their storage capacity with fuel tanks ashore.

Tug Assistance

The Hamilton Port Authority has directed that vessels proceeding to Pier 23 shall use three tugs to assist, until new harbour regulations for vessels proceeding to Pier 23 are in place.

The Great Lakes Pilotage Authority "will take action to ensure proper powered tugs will be available for a better towing assistance in Hamilton Harbour and will also in consultation with the Port Authority and the pilots look at the feasibility and safety of having the tugs tethered versus untethered."

Vessel Management Action

M/V *Utviken* and the sister vessel M/V *Inviken* now carry out all manoeuvring of the main engines from the engine room while on the Great Lakes.

Bridge Resource Management Training

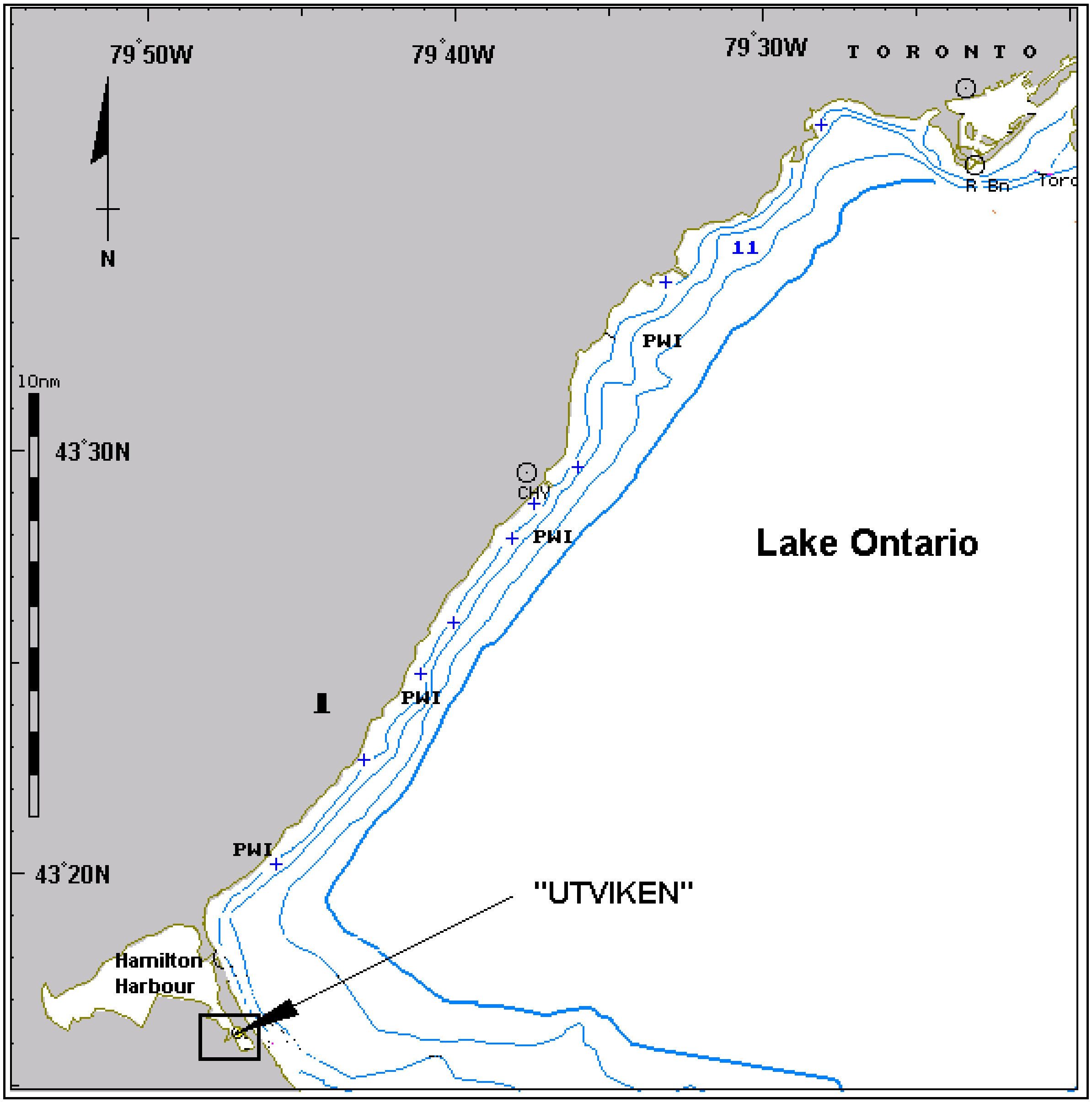
The Great Lakes Pilotage Authority advises that, while the authority requires all its pilots to attend bridge resource management (BRM) training courses, it recognizes the need for supplementary courses to continuously support BRM principles. In its five-year training program, the Authority is reviewing Bridge Team Management courses and Full Mission Simulation programs that would incorporate and reinforce BRM practices and procedures.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 03 April 2003.

Visit the Transportation Safety Board's Web site (www.tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A – Photos

Appendix B – General Area Chart



Appendix C – Glossary

BRM	bridge resource management
HHC	Hamilton Harbour Commission
HPA	Hamilton Port Authority
hp	horsepower
kW	kilowatt(s)
L	litre(s)
m	metre(s)
rpm	revolution(s) per minute
TSB	Transportation Safety Board of Canada
UKC	underkeel clearance
USCG	United States Coast Guard
°	degree(s)