MARINE INVESTIGATION REPORT
M00W0303

STRIKING OF A BRIDGE

TUGBOAT *MILLER RICHMOND* AND
BARGES *MILLER 201* AND *MILLER 206*
PITT RIVER HIGHWAY BRIDGE, BRITISH COLUMBIA
18 DECEMBER 2000

Transportation Safety Board of Canada

Bureau de la scurit des transports du Canada

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

Marine Investigation Report

Striking of a Bridge

Tugboat *Miller Richmond* and Barges *Miller 201* and *Miller 206* Pitt River Highway Bridge, British Columbia 18 December 2000

Report Number M00W0303

Synopsis

On 18 December 2000 in darkness, while under tow of the tug *Miller Richmond*, the second of two loaded barges, the *Miller 201*, struck the Pitt River Highway Bridge which spans the Pitt River between Douglas Island and Chatham Reach in British Columbia. The couplers between the two barges broke after the barge struck the protection pier causing the *Miller 201* to break free from the tow.

The striking caused extensive damage to the protection pier. There was no major disruption to either highway bridge traffic, or to marine traffic. No one was injured and there was no pollution as a result of this occurrence.

Ce rapport est également disponible en français.

1.0 Factual Information

1.1 Particulars of the Vessels

	Miller Richmond	*Miller 201*	*Miller 206*
Official No.	348856	802722	346587
Port of Registry	Vancouver	Vancouver	Vancouver
Flag	Canada	Canada	Canada
Type	Tugboat	General cargo barge	General cargo barge
Gross Tonnage	131	849	774
Length	19.7 m[1]	61 m	58.5 m
Draught	F: 1.52 m A: 1.52 m	F: 2.13 m A: 2.13m	F: 2.13 m A: 2.13 m
Built	1974	1982	1972
Propulsion	Twin Diesel/1 406 bhp Twin screw props	non self-propelled	non self-propelled
Cargo	N/A	1,400 tons rock	1,400 tons rock
Crew	3	unmanned	unmanned
Owner(s)	JJM Construction Delta, British Columbia	Miller Contracting	Miller Contracting

1.1.1 Description of the Vessels

The *Miller Richmond* (See Photo 1) is a shallow draft steel tug with the superstructure located forward. The vessel is equipped with a hydraulically operated towing winch on the after deck with 670 metres (m) of 28 millimetre (mm) diameter steel wire towing cable, and a 25 mm diameter steel wire towing bridle approximately 17 m in length. Two 100 mm diameter polypropylene couplers, each approximately 10 m in length and fitted with eyes at both ends, are used to connect barges.

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

The tug is powered by two diesel engines driving twin fixed-pitch propellers, with twin rudders for each propeller. The wheel-house is well laid out, with propulsion controls arranged on the main console amidships. A second control console is located at the after end of the boat deck abaft the funnels. Both control stations are fitted with pneumatic abort systems to allow the cable to run freely off the towing winch drum in the event of an emergency.

Barges *Miller 201* & *Miller 206*

Both barges of steel construction, are flat decked, non-self-propelled and unmanned. The *Miller 201* (See Photo 2) is fitted with a hydraulically-operated stern ramp. In the stowed position, the ramp has a vertical height of 12 m, and requires the Pitt River Highway Bridge to be swung open to enable transit.

1.2 Description of Pitt River Bridges

There are three bridges spanning the Pitt River at Chatham Reach, British Columbia. The Pitt River Railroad Bridge is operated and controlled by the Canadian Pacific Railway Company (CP). Approximately 305 m to the north is the Pitt River Highway Bridge which is operated by the provincial Ministry of Transportation.[2] The highway bridge consists of two bridge spans
76 m apart. They form a part of the Lougheed Highway connecting the City of Port Coquitlam to the Municipality of Pitt Meadows, British Columbia (See Appendix A).

The Highway Bridge spans are fitted atop elliptically shaped concrete piers which have protection piers extending approximately 53 m both up and down stream. The protection piers are constructed of wood pilings, with cross and diagonal timber bracing bolted to the pilings. Each protection pier has a protective abutment, constructed of wooden pilings and fir timber sheathing.

The approximate vertical clearance under the highway bridges is 8.5 metres.

A downbound vessel encounters the north section of the road bridge first, followed by the south section and then the railroad bridge.

1.3 History of the Voyage

On 15 December 2000, the master of the tug *Miller Richmond* contacted the Pitt River Highway and Rail Bridges and arranged to transit the bridges upbound on 18 December 2000 at 0430 Pacific standard time[3].

At 1730, 17 December 2000, the *Miller Richmond* departed Delta, British Columbia towing the two empty barges *Miller 206* and *Miller 201* to load rocks at the Columbia Bithulic Quarry, some 21 miles away and four miles north of the Pitt River Bridges (See Appendix B). The tug and tow arrived at the Pitt River Rail Bridge at 0330, 18 December 2000, and awaited the arrival of the assist tug *Nellie Irene*. The master confirmed his transit time of 0430 to the bridge tenders.

On schedule, the tug and tow passed through the rail bridge at 0430. Soon after, and when the tug and tow were about mid-way between the rail and road bridges, the tug's master was informed that the bridge tender was unable to open the south road bridge. The tow was stopped and *Miller 206* was coupled to the *Nellie Irene*. Since this barge did not have a ramp to hamper its passage under the bridge, it was towed to the stone quarry. The *Miller Richmond* and the barge *Miller 201* were secured in the area between the rail and road bridges until repairs to the bridge were effected at 0900. The south bridge opened to marine traffic at 0915, after which the tug and its tow were able to continue on passage to the stone quarry.

---

2 At the date of the occurrence, the Ministry of Transportation and Highways.

3 All times are Pacific daylight time (Coordinated Universal Time minus six hours) unless otherwise noted.

Loading was completed at 1700 that same day and the master contacted the highway bridge tender to make arrangements to transit the bridges downbound at 1900. He made contact by cellular telephone as he was unable to contact the bridge tender on very high frequency radio (VHF) channel 74, the designated working frequency. The bridge tender was on the lower level of the control tower (where there is no VHF) when the VHF call was made.

The *Miller Richmond*, with the loaded barges in tow, departed the berth at 1730 on 18 December 2000 bound for the Fraser River. To transit the bridge spans, the *Miller 206* was made fast to the tug on a short tow followed in tandem by the *Miller 201.*

At Harken 3 Grounds, approximately one mile upstream of the north bridge, the transit time of 1900 was confirmed with the tenders of both the rail and the road bridges. The tug *Nellie Irene* was standing by upstream of the north bridge to assist as required. In the *Miller Richmond*'s wheel-house were the master and the two crew members. Speeds were varied in order to arrive at the desired time.

At 1840, the bridge tender informed the master of the tug by VHF radio that the south span of the bridge would not open. The tug was 3/8 of a mile (700 m) upstream of the north bridge and proceeding at an estimated 5.5 knots over the ground.

The master chose to abort the transit while he still had the opportunity to do so. Speed was reduced and a turn to port commenced although the master knew that the width of the river did not offer him enough room to execute a 180° turn and that he would almost certainly run aground. Approximately three minutes later, and half way into the turn, he was informed by the bridge tender that the span was now opening. The master then decided to abort the turn to port and attempted to realign the tug and tow for the transit. However, he found it difficult as the tow was now over towards the south (port) side of the river while the bridge span was to starboard. The assisting tug *Nellie Irene* was standing by his port side.

As the *Miller Richmond* proceeded slowly into the draw, the tug and the first barge passed clear. However, the starboard forward corner of the *Miller 201* came into contact with the cement protection pier, resulting in the couplers between the barges breaking and the *Miller 201* being separated from the rest of the tow.

The *Miller Richmond* with the *Miller 206* in tow continued on, passing through both the road bridges, while the *Nellie Irene* pushed the *Miller 201*, which was still on the upstream side of the north bridge, away from the contact point.

The *Miller 206* was secured to a log boom below the rail bridge and the *Miller Richmond* returned to tow the *Miller 201* through the two road bridges assisted by the *Nellie Irene*. The *Miller Richmond*'s master then made arrangements for a damage inspection of the bridge.

Later both barges were re-coupled and taken down to Miller's Delta yard where they were secured at 0500, 19 December 2000, in readiness for discharging.

1.4 Damage

1.4.1 Damage to Bridge

The bridge pier protection was damaged extensively. The concrete front of the bridge pier was damaged, and the stringers on top of the pier protection were broken/cracked. Some stringer anchoring bolts required replacing.

The sheathing planks of the protection piers are damaged frequently. This damage is rarely reported.

1.4.2 Damage to Vessels

The *Miller 201* suffered extensive damage to the shell on the starboard forward corner in way of the collision bulkhead.

1.5 Certification

The *Miller Richmond* had a Steamship Inspection Certificate valid until 14 October 2001.

The barges *Miller 201* and *Miller 206*, being non-propelled barges and not carrying pollutants, were not required to undergo inspection by the Marine Safety Branch of Transport Canada.

1.5.1 Personnel

The master of the *Miller Richmond* holds a Master Home Trade 350 Ton Certificate of Competency issued by Transport Canada in 1975 and re-issued with a STCW 95[4] endorsement in 1997. He has 33 years of experience on the Fraser and Pitt Rivers, and has sailed as master of the *Miller Richmond* since 1988.

The deckhands held no certificates, nor were they required to.

---

[4] Standards of Training, Certification and Watchkeeping for Seafarers 95

The road bridge tender on duty at the time of the occurrence underwent a seven-day training program in the operation of the Highway Bridge after new software was installed in December 1997. This training was conducted by a representative of the software developers.

1.6 Weather, Tide and Current Information

Weather conditions were fine and clear, with no wind and calm seas in the sheltered waters of Pitt River.

Tide and current information for the area is referenced on Point Atkinson, English Bay, British Columbia. At the time of the occurrence the combined effect of the ebb tide and the current was 3.3 knots.

1.7 Highway and Marine Traffic Density

Some 80 000 vehicles pass over the Pitt River Bridge every week day, approximately 40 000 on Saturdays and somewhat fewer on Sundays. Ambulances use the bridge during medical emergencies at least once a day.

A delay caused by an extended road closure results in a major build up of highway traffic on both sides of the bridge.

The majority of marine traffic traversing the Pitt River Bridges does not require the bridge spans to be opened as most tugs, tows and pleasure craft do not have height restrictions.

The Pitt River Bridges are opened about once a week for commercial traffic bound for the quarry and other destinations upstream. During the summer season, the bridges are also opened for large pleasure craft.

1.8 Bridge Control Tower

The Control Tower is a two-level structure located between the north and south road bridges, the upper level of which offers an all-round 360° view. It is manned round the clock by a bridge tender.

The upper level of the tower houses 17 monitors that are connected to cameras scanning different sections of the highway. The cameras can be controlled from the tower to swing through 360° and also zoom in for close-ups. This enables the bridge tender to locate any traffic buildups and divert emergency vehicles as and when needed. In addition, they allow the bridge tender to safely implement and remove highway counter-flow operations as required.

Two Video Display Units (VDU), located in the control station on the upper level, serve to both monitor and control the opening and closing of the bridge spans. One of these is the ‘Fault Monitoring Screen’, while the other ‘Control Screen’ covers the entire ‘swing’ operation. It offers a continuous graphic representation of the position of the bridge span during an opening or closing operation. The ‘Fault Monitoring’ VDU does not provide audio indication of a fault and, in order to catch errors as soon as they occur, it is essential that the bridge tender monitor the two screens during the opening/closing process.

The lower level of the tower houses two sets of two Programmable Logic Control units (PLCs), one of which serves as an emergency backup to the main unit. These PLCs interface with the VDU screens on the floor above and via an analog/digital interface, control the sequence of operation of the electric motors, ‘wedges’, ‘end lifts’, ‘centering pin’ etc. in order to make the bridge span ‘open’ or ‘close’. The PLCs also manage the ‘Lane Control’ process, which takes care of the road traffic gates, the counter-flow systems, the audio and visual advance warnings for road and visual warnings for marine traffic. Washrooms for the bridge tenders are also located at this level.

The public can access the control tower by easily bypassing security arrangements. Bridge tenders have been threatened by irate motorists who have accessed the tower when delays, caused by malfunctions, occur.

1.9 Communications

1.9.1 Fraser River

The Pitt River Bridges are located outside the Fraser River Vessel Traffic reporting zone of Vancouver Marine Communications and Traffic Services (MCTS).

1.9.2 Control Tower

The upper level of the control tower is equipped with a VHF radiotelephone and a land line telephone. The lower section is equipped only with a land line telephone.

1.9.3 Miller Richmond

The tug is equipped with both VHF and cellular telephones.

1.10 Operation of Bridge Spans

Prior to 1998, a bridge tender operated electrical switches to control the north and south swing spans. The switches controlled the direction of movement of various crown and pinion gears, which caused the swing portion of the bridge span to open or close. The two spans differ from each other in the machinery that is used to accomplish the ‘turning’. The north span, which is the newer of the two, has electro-hydraulic components, while the south span has electro-mechanical components.

The control of the open/close operation of the Pitt River highway bridge spans, traffic signals and gates was computerized in 1998. It was part of a plan to control all the bridges in the Fraser River electronically, from one central command station. The Pitt River bridge is the first to be so converted and a number of independent contractors were hired by the provincial Ministry of Transportation to carry out the project.

To 'open' or 'close' a swing span, the bridge tender has to initiate the operation on the 'control' VDU, using his 'mouse'. The PLCs then automatically execute the operation, while a continuous status display of the process is provided on the VDUs. The bridge tender monitors the process and in the event of a malfunction, can immediately switch over to a 'manual' mode of control. In this mode the programme in the PLCs is bypassed, and the bridge tender follows appropriate prompts on his VDU screen, to 'open' or 'close' the span.

Electricity for the operation of the bridges is supplied from both Port Coquitlam and Pitt Meadows. To ensure a continuous supply of power in the event of a breakdown of either source, a 'Transfer Switch' automatically changes over to the other one.

The basic components directly related to the bridge openings are the 'end lifts', the 'wedges' and the 'centering pin'.

In the case of the south span, which is electro-mechanical, signals are sent to an electric motor which starts the process of the 'end lifts' raising the span. There are no hydraulic components involved, the 'end lifts' lower the span onto the main bearings, and the centering pin retracts allowing the span to swing.

The north span is different in that it is electro-hydraulic and has 'wedges' that need to be removed. The 'end lifts' raise the span allowing the removal of the 'wedges'. The span is then lowered onto the main bearings and the 'centering pin' retracts allowing the span to swing.

1.11 Failures of the Highway Bridge Swing Spans

In 1998 there were some 127 reported swing span openings. In 1999, there were approximately 142 openings and in 2000 there were approximately 115 openings.

Between the years 1999 and 2000, there have been some 90 swing span failures recorded, the majority of them on the south span. In the year 2000, over 40 % of the total number of attempts failed. Further, during the period 17 November 1998 to 21 December 2000, there were 27 failures which resulted in the bridge remaining 'closed' to marine traffic for periods of one to eleven days.
It has been reported that there are problems of compatibility between the newly-installed digital components of the process control loop and the older analog and mechanical components. Reportedly also, the automatic transfer of electric power from one source to the other is often not 'smooth' and frequently results in false information being transmitted to the PLCs and thence to the Fault Monitoring Screen.

1.12 Erroneous Status Bar Readouts during Malfunctions

The "Status Read" on the bridge tender's computer monitor often gives an incorrect indication on the status of the south span swing process. On occasions it has been known to indicate that the bridge is open before the swing is complete, or that the centring pin is out when it is not. This leads to confusion as the object of the 'status bar' is to signal any faults in the system to the operator, allowing him to change over to the manual mode to continue the swing.

1.13 Testing of Bridge Swings

Some test runs were done after the installation of the new equipment was connected with the PLCs and the computerisation of the opening and closing process of the Pitt River Road bridge. The testing was not exhaustive and did not identify all the deficiencies in the system or the effect of seasonal and climatic change.

1.14 Protocol for Bridge Openings

Regulations concerning the railroad and highway bridges in the Pitt River, previously under Rules 59 and 60 of the *Fraser River Harbour Commission (*now the *Fraser River Port Authority) By-Laws*, became obsolete with the introduction of section 56 of the *Canada Marine Act*. A copy of the relevant section of the By-Laws, however, can still be found for the guidance of mariners, in the *Sailing Directions, British Columbia Coast (South Portion)*. Accordingly, the swing spans of the bridges are opened only for vessels that cannot otherwise pass under any part of the bridges.

Except for emergencies, there are stipulated times when the bridge cannot be opened. To arrange an opening, mariners have to follow the 'calling in ' protocol required by the By-Laws. Openings have to be requested 30 minutes in advance of the estimated time of arrival (ETA) at the bridge and then reconfirmed not later than 10 minutes prior to arrival. Communication with the bridge tender can be via VHF radio on Channel 74 or by telephone. Additionally, the vessel has to signal its approach by sounding two short and two long blasts on its whistle. Both the rail and road bridges are equipped with sirens to signal an imminent opening or closing.

It is further required that a vessel, having signalled for the swing span of the bridge to be opened, shall remain at a safe distance from the bridge until clearance has been given to transit.

In practice, most vessels call in at 60, 30 and 10 minutes prior to their ETA at the bridges. In addition, the master of the *Miller Richmond* gave advance notice two days prior to his intended passage and once again before departing his berth in Delta.

1.15 Evolution of Bridge Operating Practice

The *Navigable Waters Bridge Regulations* (NWBR) made pursuant to the *Navigable Waters Protection Act* (NWPA) require that bridge spans be opened "immediately, or as soon thereafter as is reasonably possible, to permit the passage of the vessel". Further, the regulations emphasize the requirement for efficient, reliable service to the marine community to be provided by organizations operating the bridges.

Marine traffic users of the Pitt River Highway bridges have indicated that the span opening process is not commenced while the tug is still a safe distance away, even though repeated ETAs are given. The practice used by the bridge tenders is as follows:

- for upbound vessels, the highway bridge opening procedure is commenced only after the rail bridge has been opened, and

- for downbound vessels, the bridge opening procedure is commenced when the traffic is approximately half a mile away.

1.16 Navigation Light Signals for Marine Traffic

All the bridges have a system of red and green lights to indicate the 'closed' or 'open' position of the swing spans. On the rail bridge, these are mounted on the side of the bridge facing the vessel and on the highway bridges, these are mounted at the extreme ends of the protection piers.

To marine traffic, a red light indicates the swing span is closed and a green light indicates the span is open. There is no light to indicate an intermediate status of the bridge.

The *Navigable Waters Bridge Regulations* have provisions for bridge owners to exhibit, maintain and operate lights as necessary. They do not, however, prescribe the minimum luminous intensity for bridge lights. In the Fraser River, the colour, characteristics and location of bridge lights are noted but not the range or intensity.

1.17 Operation and Maintenance of the Highway Bridge

The Pitt River Highway bridge falls under the jurisdiction of the provincial Ministry of Transportation. The Ministry has in turn contracted out the operation and maintenance of the swing spans to a private company. It has however, retained the supervision and maintenance of the electrical and electronic components of the machinery.
To this end the Ministry has constituted a team whose job it is to oversee the maintenance of this, and all the bridges in the Province and to ensure compliance with contractual obligations. Similarly, the private contractor has a team looking after its contractual commitments with regard to the bridges.

The Ministry's team is made up of bridge engineers, electrical engineers and systems technologists. The contractor's team includes a bridge manager of operations and a manager for traffic claims. The latter is directly involved in the day-to-day operation and maintenance of the bridges.

When a failure occurs during a bridge opening, according to Ministry protocol, the Electrical Department is first called out, irrespective of the actual nature of the fault which could be mechanical, electrical or electronic. The electrician then advises the bridge tender to call out technicians from the other departments, if required.

1.18 Highway Bridge Operational Statistics

Statistical data since 1995 was obtained to compare failure to success ratio immediately prior to and after the upgrade. The data show that the failure to success ratio of the span swings had increased considerably post-control system upgrade.

1.19 Quality System

The quality assurance system of the Ministry of Transportation and the private contractor for bridge operation and maintenance was incomplete in that:

- no common database was set up to record bridge repair/ maintenance such as faults identified and steps taken to rectify them;

- there were no written operating procedures for normal or emergency opening/ closing of the bridges.

2.0 Analysis

2.1 Frequency of Pitt River Bridge openings

Although the Pitt River Highway Bridge spans are not frequently required to open, their correct operation is extremely important to maintain both highway and marine traffic flow.

With some 80 000 vehicles passing over the bridge every week day, there is considerable pressure on the bridge tenders to keep the highway closure periods down to a minimum. This is reflected in the irate motorists making threats to the bridge tenders.

To avoid large traffic build-ups, bridge openings are left to the last possible minute in spite of the fact that some 90 swing span failures were recorded in the two-year period between 1999 and 2000.

2.2 Testing of Bridge Swings

Because of traffic and budgetary constraints, the testing done after the installation of the new equipment was not exhaustive. As a result the testing did not identify all the deficiencies in the system. The hardware and software installed to operate the Programmable Logic Control Units were also not exhaustively tested before the operation of the Pitt River Road bridge (the processes of opening and closing) was computerized. Given these restraints, it was further not possible to optimise the interaction of all the components to deal with the effects of seasonal and climatic change.

2.3 Operating Procedures for Opening and Closing Swing Spans

The manual procedure for opening and closing the swing span is straightforward and accomplished by the bridge tender following 'on screen' prompts. There are however, no established comprehensive standard operating procedures to follow in the event of a malfunction.

Often, upon encountering a failure of the automatic opening process, the tender switches over to manual and re-tries the last operation in the sequence. While this is frequently successful and the bridge can then be opened, it has the detrimental effect of erasing the record of the previous defect, making it extremely difficult for maintenance staff to later identify the cause of the breakdown. This in turn makes identification of systemic deficiencies difficult and time consuming.

2.4 Visibility from Bridge Tower

When problems are encountered with the opening or closing of the spans, or with vessels approaching the span, the bridge tender has to follow the sequence of operations and the prompts as they appear on the two monitors in front of him.

Because the operator cannot leave his station in front of the monitors, he is unable to physically view the position of the swing span or to visually assess the unfolding situation vis-à-vis marine traffic.

Since the washroom is located on a different level from the bridge tender's control station, he may be absent from his control station at critical times. After the loading of the barges at the quarry was completed, the master attempted to contact the bridge tender on VHF channel 74. The bridge tender was not at the control station at this time.

The layout of the control tower is not conducive to 'one-man operation' during bridge swing span operations.

2.5 Protocol for Marine Traffic during Bridge Transits

With the introduction of the *Canada Marine Act*, the Fraser River Harbour Commission was conferred the status of a Canadian Port Authority. On 01 July 1999, the Fraser River Harbour Commission became recognized as the Fraser River Port Authority. Under the *Port Authority Operations Regulations* which are made pursuant to the *Canada Marine Act*, new *Practices and Procedures for the Fraser Port* were introduced on 1 July 2002. The *Sailing Directions, British Columbia Coast (South Portion)* will be updated accordingly.

In the interim, other than the regulations contained in the *Fraser River Harbour Commission By-Laws*, there is no established protocol to help marine traffic safely transit the bridge spans.

The Port Authority, as an agency responsible for the safety of Fraser River waterways (within their jurisdiction) and the bridge operating company, under a contract from the British Columbia Ministry of Transportation to operate the bridge, provide the tools for vessels to safely transit the bridge span. The mariner has to rely on the prompt and efficient opening of the bridge span to safely transit the bridge area. This is consistent with the requirements contained in the *Navigable Waters Bridge Regulations* that bridge spans be opened "immediately, or as soon thereafter as is reasonably possible, to permit the passage of the vessel". Further, regulations emphasize the requirement for efficient, reliable service to the marine community.

As the management has no established written procedures for the opening/closing of bridges, the practices used by the bridge tenders of delaying the opening of the bridge has become the accepted norm. This practice effectively diminished/eradicated the significance of the signal lights, breaching the primary defence barrier.

2.6 VHF Communication and Signal Lights During Transit

There are no set procedures for communication using VHF radios between the vessels and the bridge tender. This contributes to the risk involved, should it be necessary to slow down a tug's progress to allow a bridge span to fully open, or even abort the transit altogether, in the event of a failure in the bridge system.

The tug master is also unable to get a clear indication of the situation from the signal lights mounted on the ends of the protection pier which indicate only if the bridge spans are open or closed to marine traffic.

Therefore, the crew of a tug has neither an established means of radio communication with the bridge tender, nor a visual means of determining an intermediate status of the position of the bridge's swing span. Despite this, the tug master continued to approach the bridge and was faced with a reduced number of options to abort the transit.

Similar concerns arose in a recent Transportation Safety Board of Canada (TSB) investigation (TSB Report Number M99W0078) concerning the Fraser River Mission Bridge.

2.7 Bridge Transit Safety

Scheduled span opening/closing times for marine traffic are stipulated in the Sailing Directions. The master requested the bridge opening within this stipulated time frame. He informed the bridge tender prior to the vessel's departure from berth some two hours prior to arrival at the bridge and subsequently when the vessel was 10 minutes steaming time away from the bridge. The purpose of these calls is to provide sufficient notice to bridge tenders to open the bridge in a safe and efficient manner. Furthermore, it also helps the master to plan the vessel's departures and/or adjust the passage speed(s) so as to ensure a safe and efficient transit with minimum disruption to the road traffic. In the event that the timing is inappropriate for the vessel's transit through the bridge cutting—be it due to an emergency or due to unforseen circumstances—earlier and timely information from the bridge tender to the vessel would permit the master to take appropriate measures—be it delaying the vessel's departure from the berth and/or make an adjustment in speed—for the safety of the tug and tow operations. Such an approach would further the safety of marine traffic, especially during difficult operations such as a tug hauling a tow on a short line under ebb tidal and current conditions where the practice of commencing the opening of the bridge as the vessel approaches a ½ mile off may not always be appropriate. The establishment of Call-in-points (CIPs) and abort points have been used effectively in the marine environment for transits through bridge/lock openings. Such an approach, together with well-established bridge operating practices and procedures, will help ensure that vessel masters, as well as bridge tenders, fully understand their roles and responsibilities and respond in a well coordinated manner. Further, it would help ensure an efficient and safe transit of vessels to the benefit of the safety of road and marine traffic.

Prompt notification of bridge operating equipment failure to the vessel is essential for the master to determine risk and initiate additional measures. In emergency situations such as this, the bridge tender may become preoccupied with remedying the situation. This may result in a delay in notifying the vessel. A warning system that automatically displays the status of the bridge operating machinery could help ensure timely notification to the approaching vessel and would be an additional safeguard against human error.

2.8 Bridge Maintenance and Repairs

2.8.1 Computer readouts

The "Status Read" on the bridge tender's computer monitor often gives an incorrect indication and therefore cannot be used as a reliable means of fault-finding and trouble-shooting. Faulty execution of a 'swing' command could be as a result of defective software (programming) or hardware (electrical, mechanical or hydraulic).

However, because of operational exigencies, bridge tenders have to resort to every available means at their disposal to complete the 'swing'. They do this by switching over the PLC controlled process from 'auto' to 'manual'. This has the effect of clearing the computer record of the fault which caused the cessation of the automatic process. Maintenance staff is hence, unable to determine the cause of the malfunction, and effective repair is rendered difficult.

2.8.2 Procedures to Identify the Causes of Malfunctions

According to Ministry protocol, after a malfunction of the 'swing' operation, an electrician from the Electrical Department is first called in. This electrician inspects the bridge and its machinery to determine if the fault is electrical or if it necessitates the calling out of mechanical or electronics technicians. This protocol leads to delays in rectifying the problem and often results in lengthy periods when the bridge cannot be opened to marine traffic.

Because the various departments involved in the repair and maintenance of the highway bridges have not set up a database where faults and the steps taken to rectify them are documented, there is no record of the causes of these failures. The establishment of a suitable database would allow pooling of inter-departmental information, essential for the timely identification and repair of defects.

Although the bridges have a history of malfunctions (especially post computerisation), there has been no effort on the part of the relevant departmental heads to meet regularly to discuss these problems.

Reportedly, many problems are software related, are of a recurrent nature and date back to the initial installation and programming of the PLCs. However, effort has not been made in a timely manner to contact the designer of the software to attempt to identify and remove these problems.

2.9 Marine Traffic

2.9.1 The Transit

After loading at the quarry, the master of the *Miller Richmond* requested clearance to transit the Pitt River bridges, two hours in advance of his ETA. Later, about one mile upstream of the bridges, he reconfirmed this ETA. The bridge tender however delayed the opening of the spans until the last minute to minimise the disruption to highway traffic. When the bridge failed to open, the tug and its tow were too close and the master had to take immediate and drastic action to avoid hitting the bridge. He turned hard to port knowing that the width of the river did not offer him enough room to execute a 180° turn and that he would almost certainly run aground.

This influenced his decision to abort the turn and re-attempt the transit when, a few minutes later, the bridge tender called him back to inform him that the span was now opening. In the short distance remaining, he was unable to realign his tow which was instrumental in causing the second barge to strike the protection pier.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. The south span of the Pitt River Highway Bridge failed to open as the *Miller Richmond* and her tow were making their final approach to the draw.

2. To minimise the disruption to highway traffic, the bridge tender had delayed the opening of the spans. Consequently, when the swing span failed to open there was an insufficient margin of safety for the tug to take early avoiding action.

3. Attempting to avoid or minimize damage to the unopened span, the master of the *Miller Richmond* started to abort the transit.

4. Shortly afterwards, when the bridge tender succeeded in opening the bridge span, the master of the tug could not sufficiently re-align the tow to navigate safely through the draw and the barge *Miller 201* collided with the protection pier.

5. The master continued to approach the bridge and pass limits where alternative action could be taken despite a lack of visual indication that the bridge was opening.

3.2 Findings as to Risk

1. The number of bridge span opening failures (some 90 were recorded in the two-year period between 1999 and 2000) has increased since the computerisation of the Pitt River Road Bridge.

2. Although the bridges have a history of malfunctions (especially post computerisation), there has been no effort on the part of the relevant departmental heads to meet regularly to discuss these problems.

3. The hardware and software installed to operate the Programmable Logic Control Units were not exhaustively tested before the operation of the Pitt River Road Bridge was computerized.

4. The several entities involved in the operation, repair and maintenance of the highway bridges do not have a common database where the information on the causes of the frequent malfunctions since computerization can be recorded or stored - or where the corrective measures taken can be documented.

5. There are no established Calling In / Abort Points in the vicinity of the Pitt River swing bridges to indicate the proximity of vessels to bridge tenders and where vessels may safely abort transits in the event of a failure of the swing bridge mechanism.

6. In the event that a bridge span fails to open, bridge tenders switch from the PLC-controlled process (auto) to manual control which clears the computer-stored record of the cause of the malfunction. Maintenance staff is thus unable to access the computer-stored diagnostic of the cause of the malfunction and repairs are delayed until a comprehensive inspection is made.

3.3 Other Findings

1. Other than the regulations contained in the *Fraser River Harbour Commission By-Laws*, there is no specific protocol established to help marine traffic safely transit the bridge spans.

2. The system of bridge opening lights indicates to shipping that the span(s) are either open or shut. The lights do not indicate an intermediate status of the process to vessels using the Pitt River bridges.

3. The nominal range (intensity) of lights installed on bridges for the purpose of marine navigation is not consistent within the same geographic area.

4. The layout of the bridge tender's control tower is not ergonomic and is not conducive to 'one-man operation' when operating the swing bridge.

4.0 Safety Action

4.1 Action Taken

Since the operation of the bridge spans was computerized, the more commonly occurring faults with limit switches, sensors and relays have been addressed.

Following the accident, a gate secured by wire ties is in place to prevent public from gaining easy access to the bridge tenders.

'*Practices and Procedures for the Fraser River Port Authority*', which replaced the '*Fraser River Harbour Commission By-Laws'* were published and came into effect on 1 July 2002.

In March, 2002 the TSB issued two Marine Safety Information (MSI) letters dealing with shortcomings identified during the investigation. MSI 02/2002, issued 6 March 2002 was addressed to the Navigable Waters Protection Division (NWPD) of the Canadian Coast Guard. The MSI letter dealt with inconsistencies in the application of standards for Marine Navigation Signal Lights on Bridges and Structures. The NWPD was requested to review their procedures regarding lighting development at bridges in order to mitigate risks to bridge and vessel users. The TSB has yet to receive a response to this communication. However, a response to a copy of the letter, sent to the British Columbia Council of Marine Carriers, indicates the Council's willingness to work with all parties concerned to encourage a consistent application of the process to achieve consensus on such matters.

MSI 04/2002, issued 28 February 2002, was addressed to the British Columbia Ministry of Transportation, District Highways Branch. This letter dealt with the implementation of standard operating procedures for bridge openings and communications, an effective maintenance system to rectify frequent swing span failures, and the ergonomics of the control tower. The Ministry of Transportation discussed the issues raised in the MSI but the TSB is not aware of any action taken to address them.

4.2 Action Required

4.2.1 Coordination and Procedures for Bridge Transits by Vessels

Procedures necessary to ensure safe operations concerning bridge transits by vessels involve the close coordination of the Fraser River Port Authority, the provincial Ministry of Transportation, bridge tenders and vessel operators. Since this occurrence, there has been no information received by the Board to indicate that the parties have met with one another to conduct an overall review of operations and procedures for bridge transits by vessels. Also, there has been no indication of a coordinated review by the parties concerning the dissemination of transit procedures to the marine community.

Any successful bridge transit by a vessel also involves close interaction between the bridge tender and vessel operator. This requires clear and established communication, approach and transit procedures that take into account both routine and non-routine situations, such as the failure of the span to open. Regulations about operations and signal lights concerning the Pitt River Railway Bridge and the Pitt River Highway Bridge were stipulated in sections 59 and 60, respectively, of the *Fraser River Harbour Commission By-Laws* and published in *Sailing Directions, British Columbia Coast (South Portion)*[5]. Furthermore, a vessel that had signalled for the swing span of the Pitt River Highway Bridge to be opened was required to remain at a safe distance from the bridge until the green signal light at the end of the swing span was given to indicate that the span was open. However, the practice of delaying the opening of the bridge, which evolved over the years, effectively diminished/eradicated the significance of the green signal light breaching the primary defence barrier. Further, the By-Laws were repealed upon the coming into force of the *Port Authorities Operations Regulations* on 1 March 2000. The *Port Authorities Operations Regulations* do not deal with bridge transits by vessels.

Information concerning the transiting of the Pitt River Railway Bridge and other railway bridges by vessels within the jurisdiction of the Fraser River Port Authority is now contained in the Authority's *Practices and Procedures*, established pursuant to section 56 of the *Canada Marine Act*. The purpose of the document is to promote the safe and efficient navigation in the waters of Fraser Port. The document, however, does not contain information about signal lights for the various railway bridges nor does it contain any information about the Pitt River Highway Bridge that was in the previous regulations.

Given that the above-mentioned safeguards are no longer in place, and that there is lack of coordination among parties responsible for ensuring efficient and safe operation of bridges, vessels, bridge structures and bridge users may continue to be placed at undue risk during vessel transits. The Board, therefore, recommends that:

> The Fraser River Port Authority and the provincial Ministry of Transportation, in collaboration with the bridge tenders and vessel operators, review and, if necessary amend, their current policies, practices and procedures, and ensure implementation so that the safety of vessels, bridges and bridge traffic is not compromised.

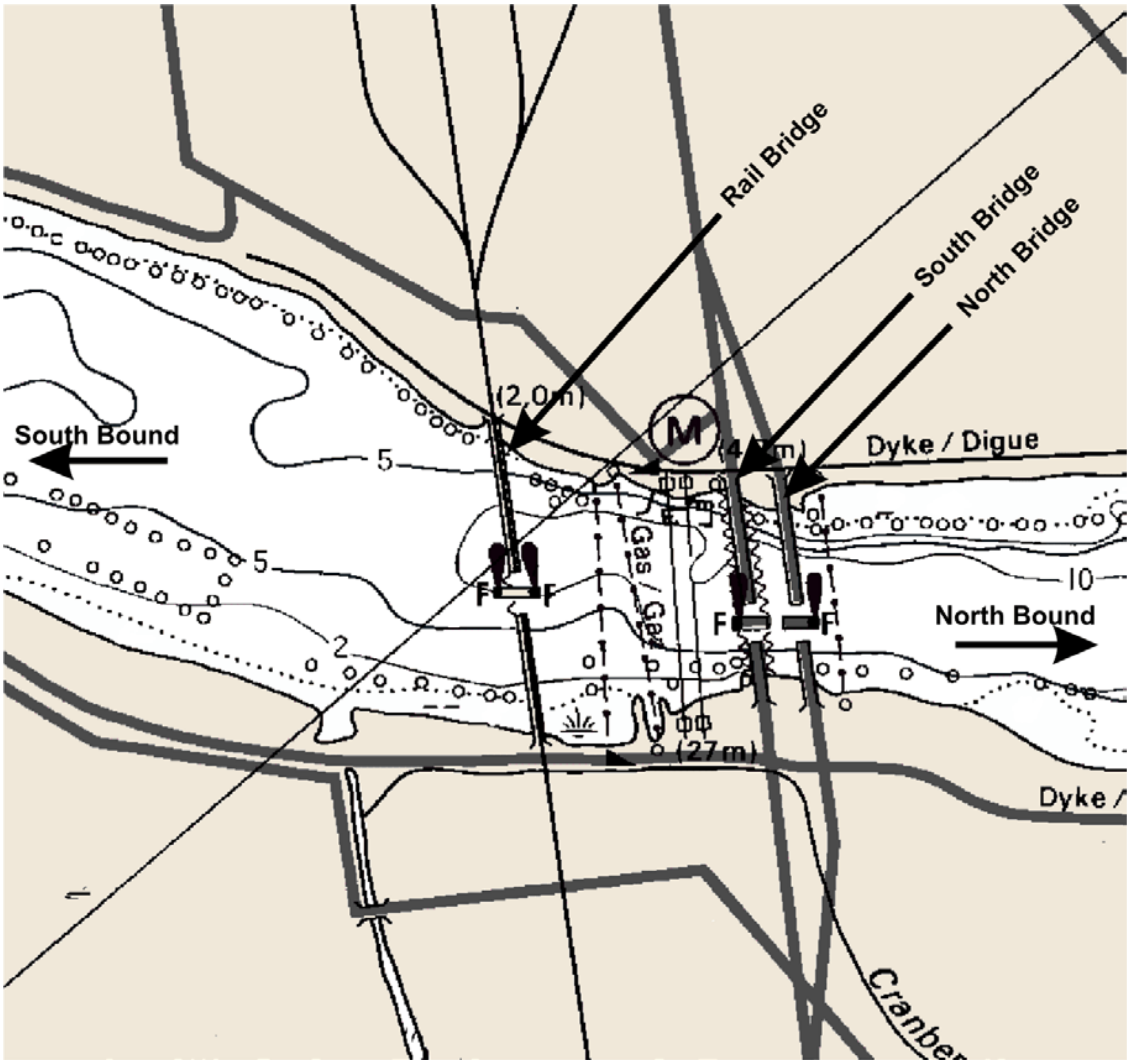
M 03-04

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 May 2003.

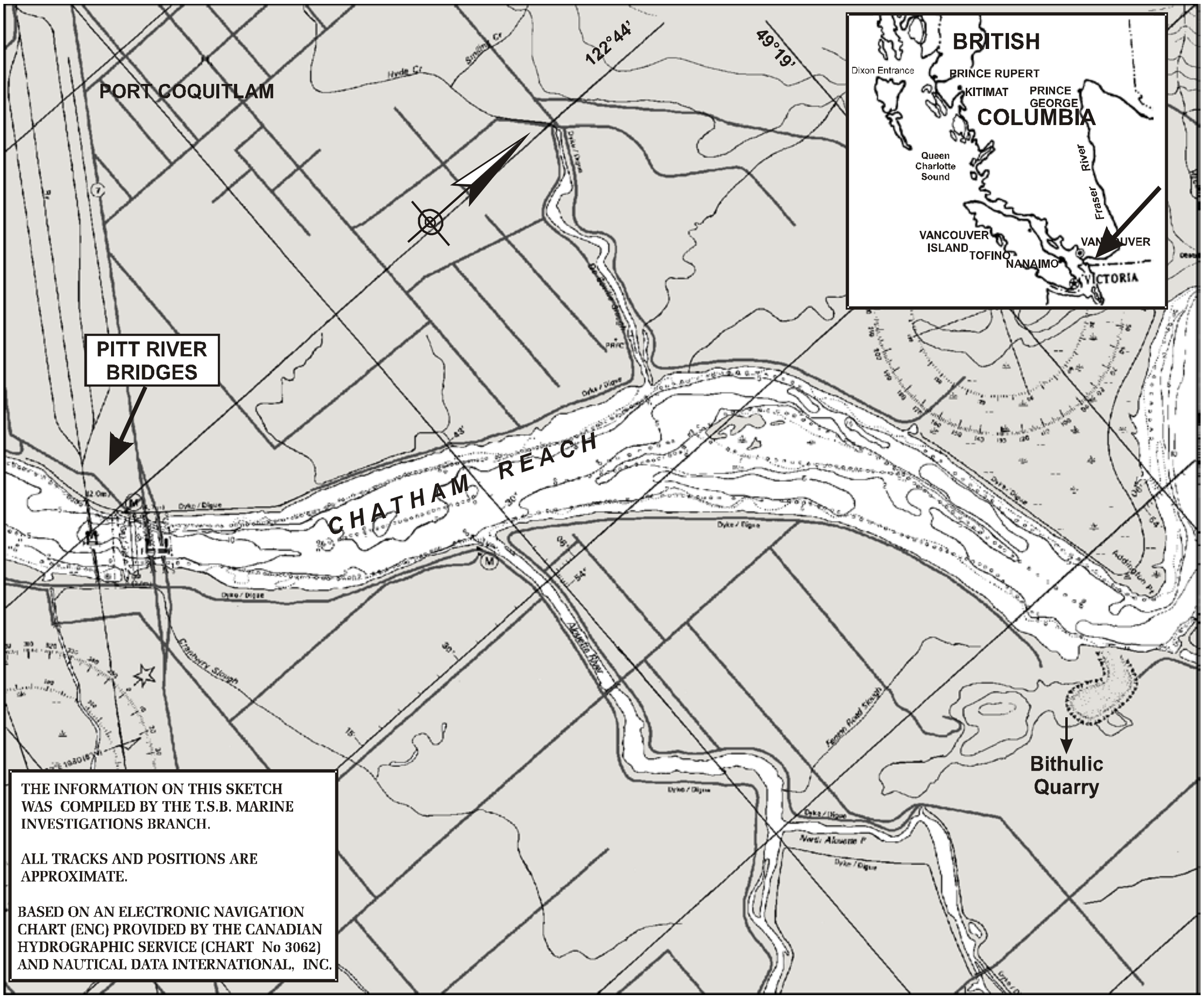
Visit the Transportation Safety Board of Canada web site, www.tsb.gc.ca, for information about the TSB and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A - Sketch of Pitt River Rail and Highway Bridges

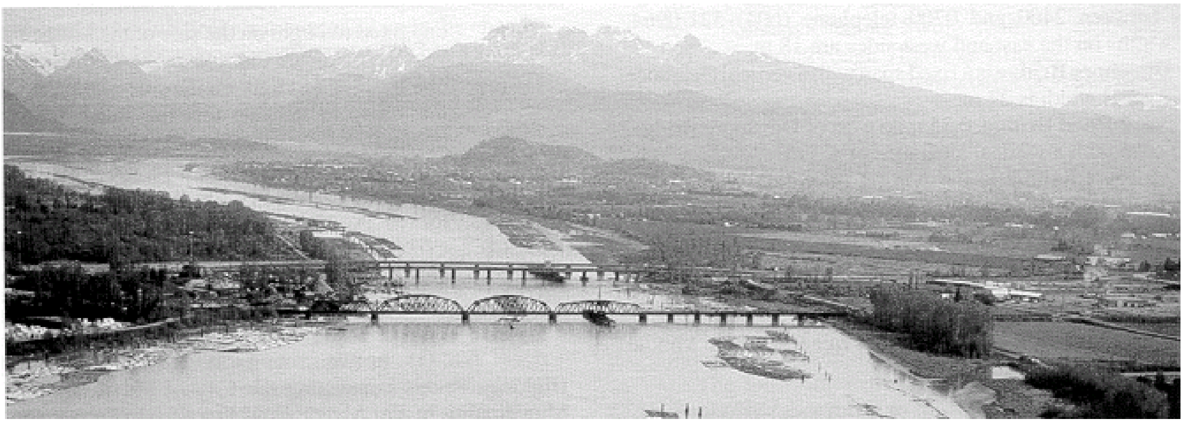
[5] Vol.1, Sixteenth Edition, 1999, Department of Fisheries and Oceans.

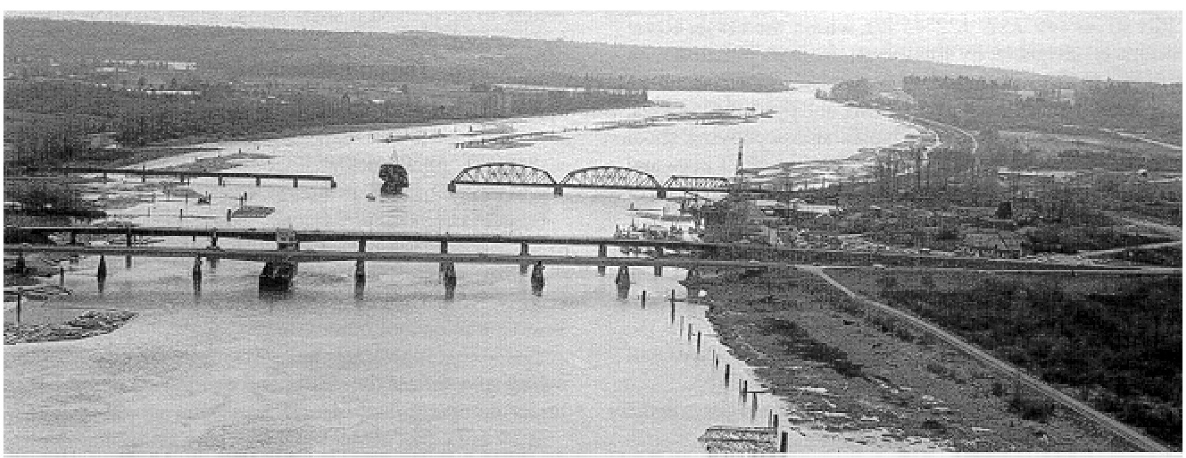

Rail Bridge
South Bridge
North Bridge
(2.0m)
South Bound
Dyke / Digue
Gas / Gaz
North Bound
(27m)
Dyke /
10
5
2

Appendix B - Sketch showing section of river between Pitt River Road Bridge and Columbia Bithulic Quarry



Appendix C - Photographs





Appendix D - Glossary

CIP	Call-in-point
CP	Canadian Pacific (Railway)
ETA	Estimated time of arrival
IMO	International Maritime Organization
m	metre(s)
MCTS	Marine Communications and Traffic Services
mm	millimetre(s)
MSI	Marine Safety Information
NWBR	Navigable Waters Bridge Regulations
NWPA	Navigable Waters Protection Act
NWPD	Navigable Waters Protection Division
PLC	Programmable Logic Control
SI	International System of Units
TSB	Transportation Safety Board of Canada
VDU	Video Display Unit
VHF	very high frequency (radio)