Report 98-201

general cargo vessel *T.A. Explorer*

grounding

Nelson

19 January 1998

Abstract

At about 2145 on Monday, 19 January 1998, the general cargo vessel *T.A. Explorer* was outbound from Nelson under pilotage when the vessel failed to make the turn near the entrance to the harbour and ran aground on Haulashore Island. The vessel was re-floated after about 20 minutes and, as damage was minimal, continued its voyage to Timaru.

The grounding occurred because the speed of the ship was too high for the tugs to assist in the manner intended by the pilot. Safety issues identified included:

- incomplete assessment of new piloting techniques,
- the standard of communication within the pilot and tug services for the port,
- the need for a common minimum standard of on-going training for pilots, and
- the need for some form of quality control among pilots.

Safety recommendations were made to the harbourmaster for Port Nelson to address the safety issues.

T.A. Explorer aground on Haulashore Island with the tugs *Huria Matenga* and *W.H. Parr* in attendance
(Photograph courtesy of Nelson Mail)

Transport Accident Investigation Commission

Marine Accident Report 98-201

Vessel particulars:

Name:	*T.A. Explorer*
Type:	General cargo carrier
Class:	VII, foreign-going cargo vessel (SOLAS)
Construction:	Steel
Built:	1987 in England
Owner:	Rosewater Maritime Incorporated
Operator:	Tasman Asia Shipping
Registered:	Monrovia, Liberia
Tonnage (gross):	17 101 t
Tonnage (dead-weight):	22 800 t
Length:	
over all:	187.4 m
From Bridge to stem:	152.4 m
From Bridge to stern:	35.0 m
Breadth (extreme):	23.14 m
Draught (actual):	Forward: 3.8 m Aft: 6.8 m
Speed (service):	17 knots
Propulsion:	One MAN-B&W[1] 7278 kW reversible diesel engine driving a single, four-bladed, right-hand-turning, fixed-pitch propeller

Location:	Nelson Harbour entrance
Date and time:	Monday, 19 January 1998 at 2145[2]
Persons on board:	Crew: 22 Other: 1 (pilot)
Injuries:	Nil
Nature of damage:	Minimal
Inspector-in-Charge:	Captain Tim Burfoot

[1] Mafchinenfabrick Augsburg Nuernberg A.G. - Burmeister and Wain
[2] All times are NZDT (UTC + 13 hours) and are expressed in the 24 hour mode.

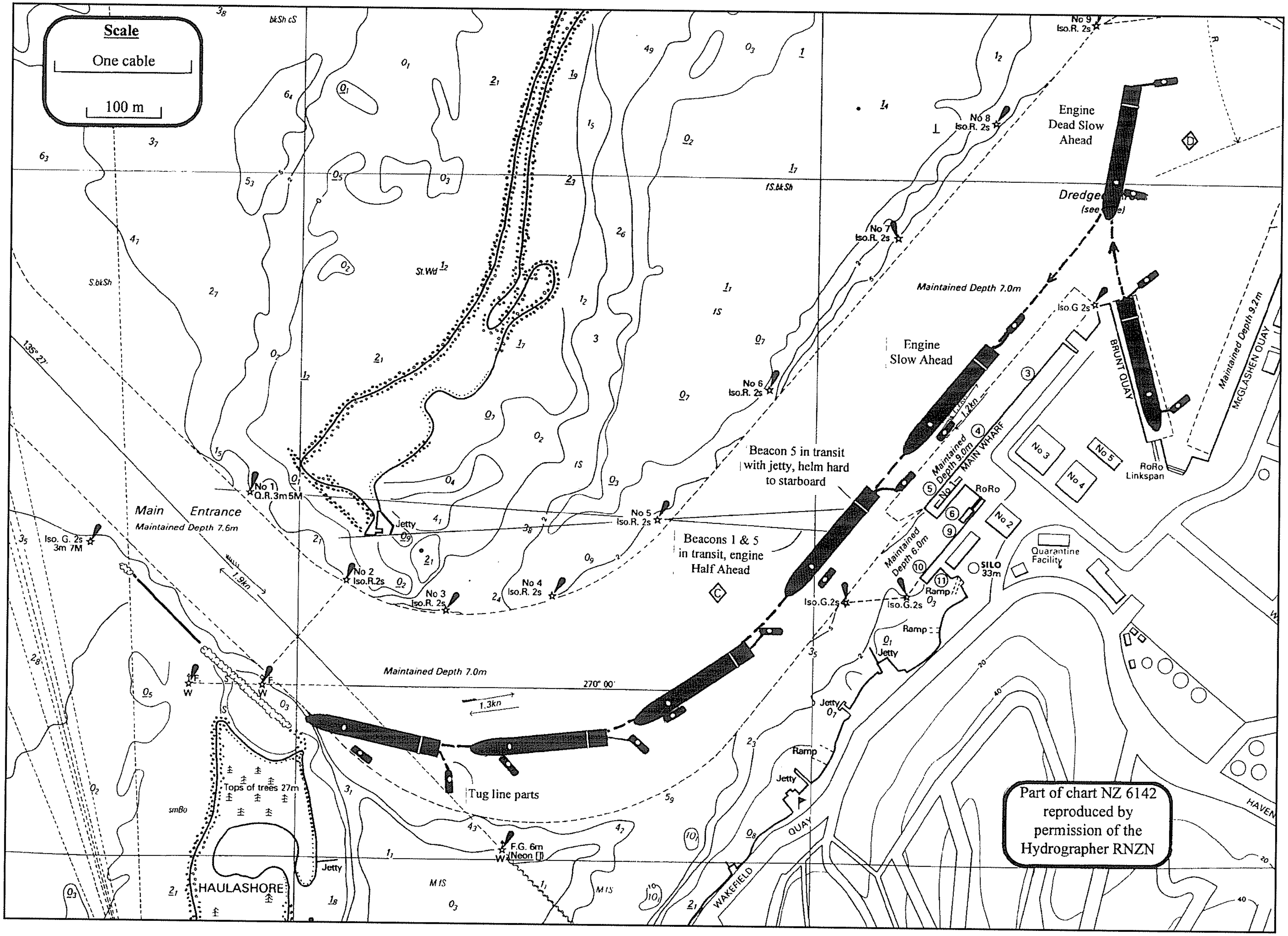

Figure 1
Part of chart NZ 6142 showing key information. The ship and tug overlays are broadly to scale.

1. Factual Information

1.1 History of the voyage

1.1.1 The *T.A. Explorer*, a regular caller to Port Nelson, arrived off the port at about 2000 on Sunday, 18 January 1998, and embarked a Port Nelson pilot, who was the harbourmaster.

1.1.2 The entry into port went without incident; however, the pilot used the tug *Huria Matenga* to push the bow of the *T.A. Explorer* to port to ensure the vessel made the turn safely.

1.1.3 As the *T.A. Explorer* was ahead of its schedule, the vessel remained idle over-night. Between 0700 and 1330 on 19 January, break bulk cargo and containers were exchanged, and sailing was posted for 2115 that night to coincide with the predicted time for slack low water in the channel, of 2122.

1.1.4 The main entrance channel for the port (see Figure 1) was dredged to maintain a minimum depth of 7.0 m at chart datum. The predicted height of tide at low water was 1.1 m above chart datum, which gave a predicted minimum available depth in the channel of 8.1 m at the time of sailing. The sailing draught of the *T.A. Explorer* was 3.8 m forward and 6.8 m aft, giving a predicted minimum under-keel clearance of 1.3 m.

1.1.5 At 2045 the third mate tested the bridge equipment and steering gear, and prepared the bridge for departure in accordance with a departure checklist, which formed part of the International Safety Management (ISM) procedures manual. No deficiencies were recorded for the equipment or steering gear.

1.1.6 Before boarding the *T.A. Explorer* at 2108, the Port Nelson duty pilot checked the height of tide visually against a tide gauge located under McGlashen Quay. The tide gauge confirmed that the height of tide was 1.1 m, as predicted.

1.1.7 Once on board, the pilot handed his passage plan to the master. The passage plan consisted of a photocopy of part of the Port Nelson chart with a table on the reverse side in which the pilot had entered tide, depth and vessel information. The chartlet showed the intended track from the berth to the pilot station, the approximate wheel-over position (outwards) and various other information related to vessel size and berthing restrictions.

1.1.8 The master had not prepared a plan for the passage from the berth to the pilot station.

1.1.9 The pilot discussed with the master the passage plan, which included the following points:

- because of the size of the *T.A. Explorer*, the wheel-over point on the intended track was usually when numbers one and five beacons were in line, which was earlier than that shown on the chartlet,
- because of the 3 m trim, and small under-keel clearance of the *T.A. Explorer*, the pilot intended making the wheel-over position even earlier, when number five beacon was in transit with the jetty off the end of Boulder Bank,
- once clear of the berth, both tugs would remain with the vessel; one attached through the centre lead aft, the other standing by near the port bow, to assist the *T.A. Explorer* in making the turn if required, and
- the effect of the tide and wind on the vessel was going to be negligible.

1.1.10 The master acknowledged each of the points and agreed with the pilot on all of them.

1.1.11 By 2117 two tugs were made fast to the *T.A. Explorer,* each using its own towline: the *W.H. Parr* to the port shoulder of the ship, and the *Huria Matenga* through the centre lead aft. At 2224 the *T.A. Explorer* was cast off and moved astern out of the berth with the assistance of the two tugs.

1.1.12 On the bridge, the helmsman was steering manually using the main centrally located wheel, the first officer was operating the main engine by bridge control, the pilot was giving engine and helm orders directly to the helmsman and first mate, and the master was moving around the bridge deck with the pilot, occasionally repeating the pilot's orders from the bridge wings. The third mate and the second mate were the officers-in-charge of the forward and aft mooring parties respectively. Both anchors were cleared in readiness for letting go, if required.

1.1.13 By 2129 the *T.A. Explorer* was clear of the berth, turned and proceeding down the channel. The *W.H. Parr* was let go and instructed to run with the ship on the port shoulder. The *Huria Matenga* was left secured through the centre lead aft and instructed by the pilot to "... just run with the ship. I'll let you go when we are outside". The *Huria Matenga* kept about 35 m astern of the ship with minimal weight on the towline. The *W.H. Parr* ran with the ship about 3 m off the port shoulder, aft of where the flare of the bow ended.

1.1.14 The bridge deck of the *T.A. Explorer* extended some 15 m aft of the bridge wings and, unless one walked to its aft extremity, the stern of the vessel and the aft tug were obscured from view.

1.1.15 At 2129:22 the engine was put on Dead Slow Ahead and the helmsman ordered to steer a course of 220°. The vessel began moving down the channel on a track about 60 m off two fishing vessels that were moored at Main Wharf.

1.1.16 At 2135:38, when the bridge of the *T.A. Explorer* was level with a point about half way along Main Wharf, the pilot:

- estimated that the speed of the vessel was about three knots,
- ordered the engine increased to Slow Ahead to attain a speed of about five knots for the turn in the main channel, and
- told the *Huria Matenga* "As I approach the corner, just be ready to pull the stern to port".

1.1.17 The skipper of the *Huria Matenga* acknowledged the request and moved his tug across to port, out of the propeller wash of the *T.A. Explorer*, maintaining sufficient forward thrust on his tug to keep the towline between the two vessels slack at about 45° to the centreline of the ship.

1.1.18 As the stern of the ship neared the southern end of Main Wharf, the pilot ordered the helm amidships, followed by hard to starboard as the stern cleared the end of the wharf. The rudder was moved across hard to starboard, as requested.

1.1.19 At 2138:31, as the vessel started swinging to starboard, the pilot ordered Half Ahead on the engine to increase the rate-of-turn and to try and bring the *T.A. Explorer* through the turn without the assistance of the tugs.

1.1.20 The pilot monitored the turn by observing the inner leading lights and the rate-of-turn indicator in the wheelhouse. He soon became aware that the *T.A. Explorer* was not turning as quickly as he required.

1.1.21 The following very high frequency (VHF) radio exchange ensued:

Pilot	"*Matenga*, stand by to pull"
Huria Matenga	"Stand by to pull"
Pilot	"When you are there, give me 500"
Huria Matenga	"500 astern"

1.1.22 The pilot thought that by his reply "500 astern" the skipper of the *Huria Matenga* meant that he was going to give a pull directly astern. Although this was not what the pilot had intended, he reasoned that, if the *Huria Matenga* was pulling directly astern, then such a pull would increase the rate-of-turn of the ship, so he did not correct the skipper.

1.1.23 The tug skipper was, however, aware that the pilot wanted him to pull the stern of the ship to port. By replying "500 astern" he was implying that he would rotate his Z-peller[3] propulsion units to an angle that would apply astern propulsion, but would also keep his tug pulling the stern of the ship across to port.

1.1.24 As the skipper of the *Huria Matenga* made the adjustments to the Z-pellers, the tug was swept back into the propeller wash behind the ship. He angled the Z-pellers to pull the stern of the tug back out to port, which was partially achieved; however, the hydrodynamic forces on the tug created by the speed of the *T.A. Explorer* through the water, and by its propeller wash, kept the tug pinned in a position where the towline was slightly to starboard of the ship centreline (see Figure 2 below).

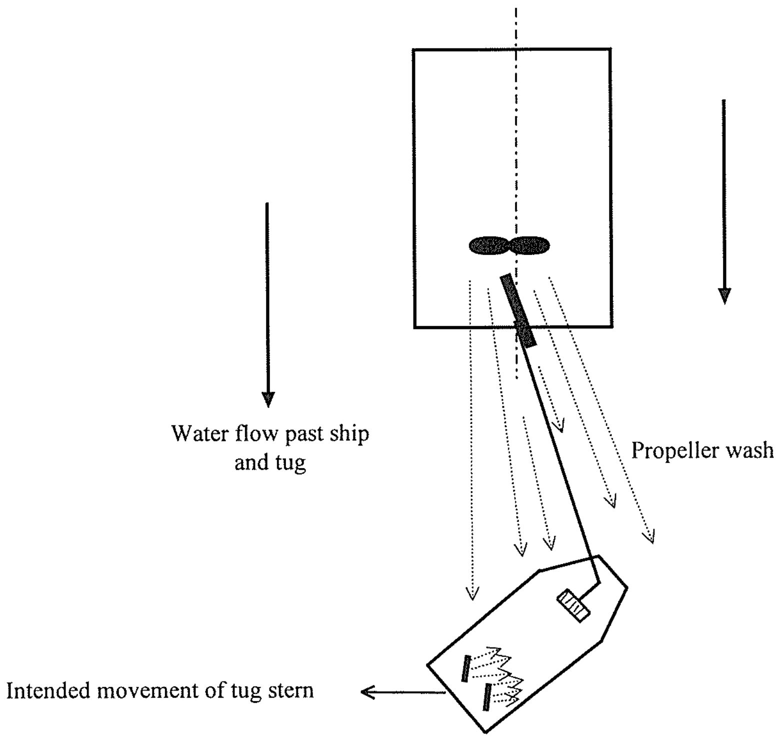

Figure 2
Diagram showing towing relationship between tug *Huria Matenga* and *T.A. Explorer* (Diagram not to scale)

[3] See section 1.3 for description of propulsion units.

1.1.25 The skipper of the *Huria Matenga* began to adjust the angle and power setting of the Z-pellers in an attempt to drag the tug across to the port side of the ship; however, the propeller wash from the ship was sending aerated water into the Z-pellers causing them to cavitate. Additionally, the *Huria Matenga* was heeling over to port to the point where water was starting to wash over the deck on that side. In this situation, the skipper was not prepared to put full engine power into the manoeuvre.

1.1.26 Meanwhile, the pilot, unaware of the tug skipper's difficulties, observed that the rate-of-turn had not improved.

1.1.27 The master of the *T.A. Explorer* was concerned at the slow rate-of-turn and asked the third mate on the forecastle to start reporting the distance between the bow and the shore. The first distance the third mate reported was 40 m and decreasing.

1.1.28 The skipper of the *W.H. Parr* had heard the order for the *Huria Matenga* to pull the stern to port and, suspecting that he was about to be asked to push on the bow, he moved the *W.H. Parr* against the side of the ship between numbers one and two holds in anticipation of such an instruction.

1.1.29 The following VHF radio exchange ensued:

Pilot	"*W.H. Parr*, can you come in"
W.H Parr	"Yes, come in"
Pilot	"When you get there *Parr*, give me 800"
W.H. Parr	"Eight in, I'm on nine now to keep up with you"
Pilot	"Okay, give me full power in"
W.H Parr	"Roger"
Pilot	"*Matenga*, increase to full"
Huria Matenga	"Increase full"
Pilot	"As much as you can out on the quarter"
Huria Matenga	"I can't get across through the wash"
Pilot	"Fair enough" - "*W.H Parr*, give me everything you have got"
W.H Parr	"Yes, you've got it all"
Pilot	"... *Matenga*, give me everything you have got"
Huria Matenga	"Everything you got"

1.1.30 Both the pilot and the master observed that the rate-of-turn of the *T.A. Explorer* had increased, but realised that it was not sufficient for the ship to make the turn, so at 2140:58 the engine was stopped and the telegraph set to Half Astern.

1.1.31 The pilot then called the *Huria Matenga* and instructed the skipper to "... give me absolutely everything you can out on the port beam". The skipper of the *Huria Matenga* replied "Yeah, we're coming across now; that's it, the lot now".

1.1.32 Over the ensuing 30 seconds or so, the following sequence of events took place:

- the third mate continued reporting the decreasing distance between the bow and the shore,
- the skipper of the *W.H. Parr* informed the pilot that he was running out of room forward,
- the pilot instructed the *W.H. Parr* to move out, back as far as it could, and push in again,
- the engine of the *T.A. Explorer* started turning astern,
- after the pilot and master agreed, the master ordered the third mate to let go the port anchor,
- the *W.H. Parr* reversed out of the decreasing wedge between the ship and shore,
- the port anchor was let go,
- the towline from the *Huria Matenga* to the ship parted, and
- at about 2142:30, the *T.A. Explorer* grounded on Haulashore Island.

1.1.33 The force of the grounding was so gentle that, initially the pilot and the master were unsure if the vessel was aground. The heading of the vessel when it grounded was about 285° by the ships gyro compass (negligible gyro error).

1.1.34 Over the ensuing 20 minutes, the crew of the *T.A. Explorer* carried out a damage assessment, pumped out ballast water from the forepeak tank and, aided by the two tugs and the rising tide, the vessel was re-floated and taken to anchor off the port for further damage assessment.

1.1.35 No obvious damage was found, so the *T.A. Explorer* continued its voyage to Timaru.

1.2 Damage

1.2.1 The only damage sustained by the *T.A. Explorer* was minor scraping of the paint under the bow.

1.2.2 An assessment of the parted towline from the *Huria Matenga* by an independent expert concluded that only 26% of the strands of the towline actually failed in overload. The remaining 74% of the strands were either chaffed or fused.

1.2.3 The failed, fused and worn strands parted over a one metre section of the rope, from where the rope passed through the Panama lead, towards the mooring bitts around which the eye of the line was secured.

1.2.4 There was no one person designated to conduct inspections of the tow lines on either tug. Any one of the pilots, tug skippers or deck hands who noticed that a line was worn, would inform the duty pilot, who would arrange to have the line, cut and re-spliced, end-for-ended, or replaced as required.

1.3 Vessel information (*T.A. Explorer*)

1.3.1 The *T.A. Explorer* was a 187.4 m, 1000 TEU[4] general cargo vessel which provided a liner service between Australia/New Zealand and South-East Asia. The vessel was fitted with tween-decks in each of its five cargo holds, and six cranes for self-loading/discharging capability.

1.3.2 Propulsion was by one 7278 kW MAN-B&W, reversible diesel engine driving one fixed-pitch, four-bladed, right-hand-turning propeller. The following table shows propeller revolutions per minute (RPM) and corresponding speeds and bridge telegraph positions, as recorded on the manoeuvring tables for the vessel.

Bridge telegraph setting	RPM	Speed when loaded (Knots)	Speed in ballast (Knots)	Theoretical speed (Knots)
Dead Slow Ahead	33	1.7	2.9	6.66
Slow Ahead	48	5	7.2	8.41
Half Ahead	64	10.3	12.4	11.39
Full Ahead (Harbour)	79	14.1	15.9	13.85
Full Ahead (Sea)	92	16.4	17.8	15.77

Astern power was 75% of ahead power.

1.3.3 During sea trials the *T.A. Explorer* took 6 minutes and 10 seconds and 0.93 nautical miles to stop from a speed of 16.5 knots when the crash stop manoeuvre (Ahead Full to Astern Full) was performed in deep water. During the crash stop manoeuvre, the vessel took 2 minutes to stop from a speed of 6.64 knots. In shallow water, such as in Nelson Harbour, the stopping distance, and turning circle dimensions, would increase significantly.

1.3.4 The *T.A. Explorer* was fitted with a semi-balanced Spade rudder. With two steering motors in operation, as was the case at the time of the grounding, the rudder was capable of moving from hard port to hard starboard (35° each side) in 14 seconds.

1.3.5 During sea trials, the turning circle tests yielded the following results for the vessel at speed Half Ahead. The shaded boxes refer to the condition closest to that of the *T.A. Explorer* at the time of the grounding:

	Turn	Advance (Cables)	Transfer (Cables)
Loaded	Port	3.7	4.7
	Starboard	4.0	5.3
Ballast	Port	3.5	4.6
	Starboard	2.9	3.4

(Refer to Figure 3 below)

[4] Twenty foot container or Equivalent Unit

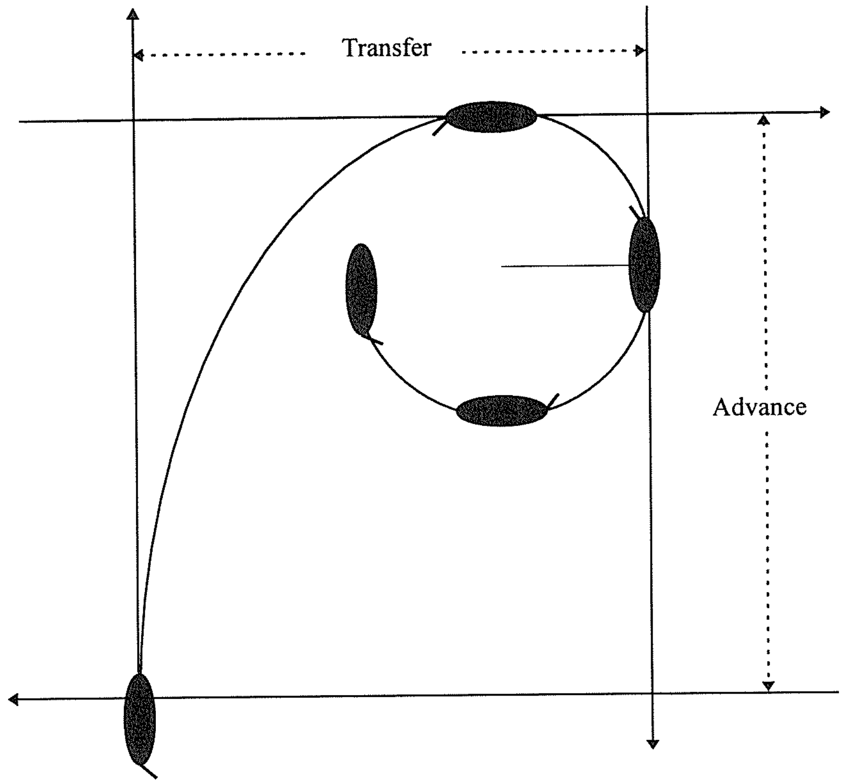

Figure 3
Example of a turning circle diagram
(Diagram not to scale)

1.3.6 The sea trials were conducted with the *T.A. Explorer* in deep water. No turning circle data was provided for the ship in shallow water. Shallow water effect generally increases the advance, the transfer and thus, the diameter of the turn. The manoeuvring chart for the *T.A. Explorer* contained the following warning:

> The response of the *T.A. Explorer* may be different from that listed above if any of the following conditions, upon which the manoeuvring information is based, are varied:
>
> - calm weather - wind 10 knots or less, calm sea,
> - no current,
> - water depth twice the vessels draft or greater,
> - clean hull, and
> - intermediate drafts or unusual trim.

1.3.7 Navigation aids on board the *T.A. Explorer* included the following:

- dual global positioning system (GPS) receivers,
- one Loran/Satellite navigator,
- two radar,
- one magnetic compass,
- one gyro compass (negligible gyro error),
- automatic pilot,
- one depth sounder,
- one Doppler speed log,
- one rate-of-turn indicator (with four repeaters: two in the wheelhouse and one on each bridge wing), and
- several fixed and portable VHF radios.

1.3.8 The *T.A. Explorer* was fitted with an engine movement logger and a course recorder. The engine movement logger was 10 seconds slow on UTC. The course recorder was switched on, but the pen marker was not set up correctly and did not record a trace of the rudder movements and courses steered during the departure.

1.3.9 The propeller of the *T.A. Explorer* became totally immersed when the aft draught reached 6.64 m. The vessel was in a light condition when it sailed from Nelson. With about 1800 t of cargo on board, and most ballast tanks full, the corresponding draughts (as read) were 3.8 m forward and 6.8 m aft, giving a 3 m trim by the stern. The draught for the *T.A. Explorer* in ballast condition (referred to in the manoeuvring tables) was 3.76 m forward, and 5.743 m aft. Comparing the two sets of draughts; forward they were similar, but aft, the *T.A. Explorer* was about one metre deeper when it sailed from Nelson. At this aft draught, the propeller would have been more efficient, but the large trim would have affected turning performance.

1.3.10 Port company records, and those kept by the pilot, established that he had piloted the *T.A. Explorer*, or its sister vessel, the *T.A. Voyager*, on 18 occasions. On six of those occasions, the vessel had an under-keel clearance of less than 1.5 m, and on four of those occasions, the vessel had a trim greater than 2.8 m; but the accident trip was the only occasion when both these parameters were exceeded, when the under-keel clearance was 1.3 m and the trim 3.0 m.

1.3.11 On 9 of the 18 pilotages, the pilot needed tug assistance to make the turn through the main entrance.

1.3.12 The vessels had a reputation among the Nelson pilots, and pilots from other New Zealand ports, for being slow to turn. Most thought that their relatively narrow beam in relation to their length, coupled with a relatively small rudder, may have affected their turning performance.

1.4 Tug information (*Huria Matenga*)

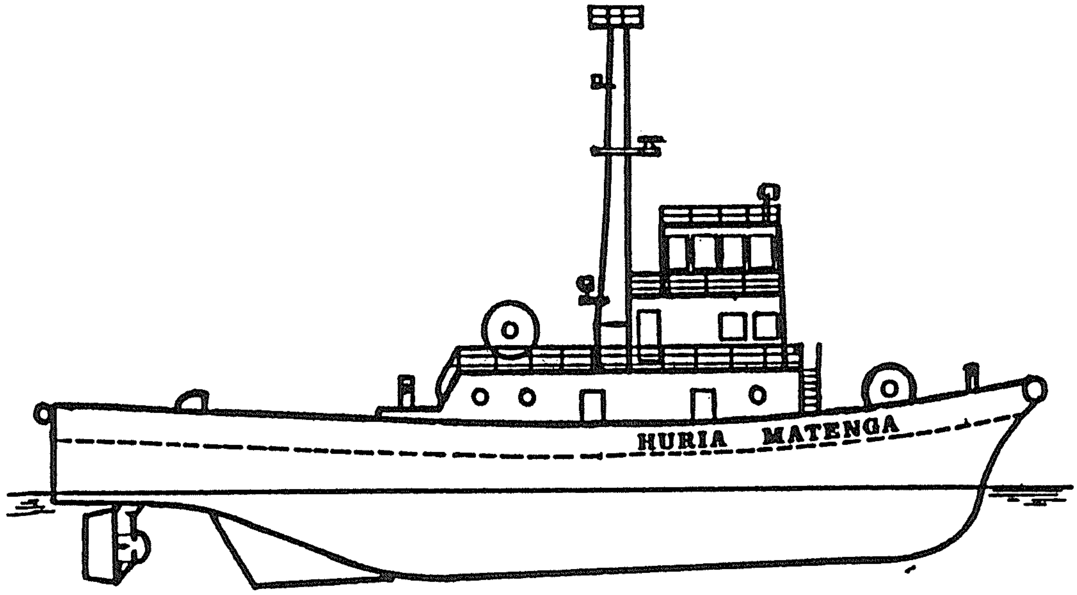

Figure 4
Tug *Huria Matenga*

1.4.1 The *Huria Matenga* was a 30.5 m azimuth stern drive (ASD) harbour tug (sometimes referred to as a reverse tractor tug). Propulsion was by two 1120 kW Niigata diesel engines, each driving an omnidirectional, fixed-pitch propeller shrouded by a Kort nozzle. The design name for these drive units is "Z-pellers". The two Z-pellers were located near the stern of the tug.

1.4.2 Each Z-peller could be rotated 360°, either independently, using separate ahead/astern controls, or in parallel with the other unit, by using an azimuth wheel. The RPM of the propellers could be adjusted from zero (unclutched) to a maximum of 750, using separate speed control levers. The configuration of the Z-pellers made the *Huria Matenga* a highly manoeuvrable tug, being able to turn within its own length, steer astern and move sideways. The tug had a rated maximum bollard pull[5] of 36 t ahead, and 33 t astern, and a maximum speed of about 13.5 knots.

1.4.3 The *Huria Matenga* was fitted with a hydraulic towing winch located on the foredeck for towing over the bow in the reverse tractor mode.

1.4.4 The winch was loaded with a 72 mm, Karat multi-plait towline, which had a breaking strain of 93 t when new. The towline fed off the winch and through a towing lead near the bow. The winch was operated from the wheelhouse, allowing for safe and easy adjustment of the towline length without the crew having to occupy the working deck. The winch had an automatic tension override device which eased the towline out when tension at the winch exceeded 43 t. The normal length of towline used for larger vessels was about 35 m.

1.4.5 Navigation aids included a radar, a magnetic compass and a fixed VHF radio with a recording facility. The recorder was voice activated and recorded the radio transmissions between the pilot and tug skipper. The recording was not time referenced.

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[5] Force that a tug can exert on a towline, or against the side of a ship, using its propulsion units only.

1.4.6 The *Huria Matenga* was fitted with a retractable Pitot Speed Log; however, it was never used due to the shallow conditions in which the tug operated, and due to the unreliability of the log in the often turbulent waters associated with ship manoeuvring, which meant that the tug skipper could only estimate the speed of the tow.

1.5 Tug information (*W.H. Parr*)

1.5.1 The *W.H. Parr* was a smaller (20 m long), older and less powerful version of the *Huria Matenga*. Propulsion was by two 520 kW Paxman diesel engines, each driving a Schottel omnidirectional, fixed-pitch propeller shrouded by a Kort nozzle. Although the operating controls were different, each nozzle could be operated in much the same way the as the Z-pellers on the *Huria Matenga* (for clarity, they are referred to as Z-pellers on both tugs). The Z-pellers were located near the stern.

1.5.2 The rated bollard pull of the *W.H. Parr* was about 20 t ahead, and 18 t astern, and the maximum speed when new, was about 10.5 knots at 1250 RPM.

1.5.3 The *W.H. Parr* was not fitted with a towing winch, but instead the towline was handled by the crew using a capstan. Like the *Huria Matenga*, the *W.H. Parr* was used in the reverse tractor mode, towing over the bow.

1.5.4 The *W.H. Parr* was fitted with a horizontal rotating bow fender to assist the tug in moving along the hull of the assisted vessel when in the pushing mode. The fender could be locked by a pneumatic brake controlled from the wheelhouse.

1.5.5 Navigation aids included a radar, magnetic compass and a fixed VHF radio. The VHF radio had a voice-activated recording facility.

1.6 Relevant personnel information

1.6.1 The pilot of the *T.A. Explorer* held the following maritime qualifications:

- United Kingdom Certificate of Competency Class 1 (Master Mariner)
- United Kingdom Certificate of Competency as Foreign Master Square Rig (Unlimited)
- British Technical Education Certificate of Achievement in Nautical Science (UK)
- Higher National Diploma in Nautical Science (UK)
- Authorisation of Pilot: Port of London
- Maritime Pilot Licence: Port Nelson

1.6.2 His sea-going time spanned some 13 years, beginning as deck officer cadet, and finishing with five voyages as master, having sailed in various ranks on a variety of vessel types.

1.6.3 In 1992, the pilot moved into a shore based job with the Port of London, assisting the harbourmaster in a number of duties including vessel traffic management, before commencing his pilot training with the Port of London Authority in 1994.

1.6.4 After training with authorised pilots for six months, and attending numerous ship handling and pilot training schemes, the pilot became an Authorised London Pilot and conducted some 320 pilotage acts, eventually handling vessels up to 280 000 t dead-weight and 340 m in length.

1.6.5 In 1996, the pilot was employed by Port Nelson. His first eight weeks consisted of training with Port Nelson pilots to become familiar with local geography, conditions and port practices.

1.6.6 The pilot's tug handling experience commenced while piloting for the London Port Authority, where pilots had to become familiar with the handling characteristics and limitations of the various types of tugs in use. During this period, the pilot made several observation trips on Z-peller tugs similar to the *Huria Matenga* and the *W.H. Parr*.

1.6.7 When the pilot started with Port Nelson, he began training as a relief tug skipper on the *Huria Matenga*, in addition to his port familiarisation. All of this training was conducted as an understudy to the full time tug skippers.

1.6.8 The master of the *T.A. Explorer* started his maritime career with two years in the Egyptian Maritime Academy, followed by 13 years sea-going experience, reaching the position of master in January 1997. He joined the *T.A. Explorer* in October 1997, and was on his second round voyage, and second time into Nelson when the grounding occurred.

1.6.9 The crew comprised a variety of nationalities: German, Polish, Ukrainian, Filipino, Portuguese and Cabo Verde. Of the crew interviewed during the investigation, all spoke good English and appeared to be able to communicate effectively with each other.

1.6.10 The skipper of the *Huria Matenga* started his maritime career in 1979 as deck hand on the Port Nelson tugs and pilot launch. In 1980, he obtained his Local Launchman Licence and skippered the port pilot launch until 1983, when he obtained his Master of Rivership Licence and became skipper of the then new, *Huria Matenga*. Although the skipper alternated between the two tugs, the majority of his ensuing 14½ years was spent operating the *Huria Matenga*.

1.6.11 The skipper of the *W.H. Parr* held a Commercial Launch Master Certificate. He had some 25 years in the maritime industry and had spent a number of those years as skipper of the port suction dredge, deckhand on the tugs, skipper of the pilot launch, and for the last seven years, skipper of the tugs.

1.6.12 Both tug skippers had passed the Nelson City Council pilot exemption examination, as part of the port company's training regime for tug skippers.

1.7 Port Nelson, information and history of pilotage

1.7.1 Port Nelson is contained between a boulder bank and the mainland at the head of Tasman Bay. The only entrance in use by commercial traffic lies between the end of the boulder bank and Haulashore Island. Tidal flows generally follow the main channel, although some set can be experienced in the main channel from the tide passing through the old entrance, and from the shallows on the northern side of the channel (see Figure 1).

1.7.2 Vessels entering or departing Nelson have to negotiate a tight 94° turn in the channel which has an approximate radius of 2.6 cables. On an outward passage, when a turn is commenced near the southern end of Main Wharf, the available advance (see Figure 3) for a vessel to make the turn and end up close on the main leads, is about 3.65 cables.

1.7.3 The main channel is maintained at a minimum depth of 7 m at chart datum, although a hydrographic survey of the main channel, made in January 1998 (shortly before the grounding), showed that the depth along the track the *T.A. Explorer* made leading up to the grounding, varied between 6.9 m (over one location) to about 14 m.

1.7.4 In 1988, with the abolition of Harbour Boards in New Zealand, the Nelson Harbourboard made the transition to Port Nelson Limited. During this period, the incumbent pilots formed a pilotage company, Tasman Bay Pilots, and were awarded a two year contract, the first year of which was to the old Nelson Harbour Board; the second year, to Port Nelson Limited.

1.7.5 Towards the end of 1989, negotiations for renewal of the contract between Port Nelson Limited and the Tasman Bay Pilots broke down, resulting in Tasman Bay Pilots offering a pilot service for the port, outside the auspices of Port Nelson Limited.

1.7.6 The marine services manager/harbourmaster for Port Nelson Limited took on the role of Port Company Pilot until new pilots could be trained. The result was two competing pilot services for the same port.

1.7.7 Use of the two port company's tugs, the *W.H. Parr* and the *Huria Matenga*, was restricted to Port Nelson Pilots. Tasman Bay Pilots were forced to acquire the use of two other tugs, which had substantially less bollard pull (10 t and 3 t). Because of the limited bollard pull of their tugs, Tasman Bay Pilots were only able to offer a pilot service for smaller vessels. This situation existed until 1995, when Tasman Bay Pilots obtained a High Court ruling over Port Nelson Limited, allowing Tasman Bay Pilots to use the Port Nelson tugs.

1.7.8 At the time of the grounding of the *T.A. Explorer*, Port Nelson Limited employed two full time pilots, with the harbourmaster relieving when required. Tasman Bay Pilots employed two full time and one part time pilots.

1.8 Pilot training and pilotage methods

1.8.1 Broadly speaking, the purpose of training maritime pilots is twofold:

- to acquire skills for handling vessels in confined waters, including the use of tugs and other port assets, and
- to gain local knowledge of the areas in which they are piloting.

1.8.2 Ship handling techniques are mostly acquired by, observing experienced pilots in their work, attending simulator and/or manned model training courses, and piloting under supervision. The amount of each type of training varies depending on the trainee's previous experience, and the policy of the port authority.

1.8.3 Each pilot will inevitably adopt his/her own style of piloting. As an understudy, a trainee pilot will often adopt what he/she perceives to be the better of several ways of performing each manoeuvre. After initial training, pilots build on their knowledge through experience and, if available, on-going training and peer review.

1.8.4 In most ports, methods of performing manoeuvres are developed over time, and as new pilots are trained by old, those methods are passed on. As new technology results in changes to ship and tug design, and research fosters new ideas for more efficient use of tugs, port authorities are adopting this new technology to pilot bigger ships into smaller ports, while maintaining existing safety parameters.

1.8.5 Over the years, pilots in Nelson had developed a standard method of using tugs to assist large vessels, or those with poor turning performance, to make the turn into and out of the port. For outbound vessels, the *Huria Matenga* was often made fast to the starboard shoulder of a vessel, where it could be used to pull back, thus retarding the vessels speed and increasing the efficiency of the ship's propeller. The *W.H. Parr* would stand by either on the port shoulder or starboard quarter, to push if required. With minor variations, this method had been used successfully for many years.

1.8.6 When Port Nelson Limited employed the pilot, he came to them already trained in ship handling techniques. The purpose of his training for the Port Nelson was, therefore, to gain local knowledge of the port.

1.8.7 Once the pilot had completed his training, he was allowed to pilot vessels using his own style. The pilots were free to seek advice or consult on various matters with the harbourmaster and/or tug skippers. Pilots and tug skippers relied on informal random discussions among themselves to share information on any problems encountered. Problems were few, because each of the pilots, including the Tasman Bay Pilots, broadly followed the same procedures.

1.8.8 In 1997, Port Nelson Limited began a study to see if they could accept larger vessels into the port. The study involved modelling Port Nelson into a ship simulator in Launceston, Australia. By November 1997, a provisional model had been installed in the simulator. First the harbourmaster, and then the two Port Nelson pilots spent two days in the simulator experimenting with different ways to get bigger ships around the corner, including experimenting with using the tugs in different configurations.

1.8.9 The *T.A. Explorer* pilot returned to Nelson with the theory that the most efficient way to use the *Huria Matenga* to escort and assist a vessel in a turn was to make the tug fast aft through the centre lead, from where it could pull the stern either way, or retard the vessel should it be required. He had successfully piloted vessels in and out of the port in the simulator, using the tug in the described way. The simulator did not allow for the manoeuvrability of the tugs authentically, instead it automatically applied the requested direction and amount of pull.

1.8.10 The pilot discussed with the two tug skippers, the use of a tug working from the centre lead aft to assist vessels in the turn. The indirect mode[6] of tug assistance was mentioned, but as neither tug skipper was familiar with the manoeuvre, the matter was not pursued. The pilot and tug skippers agreed to start using the new method, with the aft tug using the direct pull method.

1.8.11 For the ensuing two months, the pilot used the tugs in this manner. Occasionally the aft tug was asked to assist by pulling back, or pulling the stern across at relatively slow speeds, but until the grounding, neither tug skipper had been asked to tow the stern of a vessel across to port in the turn with the vessel at a speed comparable to that of the *T.A. Explorer* on the accident trip. Because the pilot was the only one to use the tugs made fast through the centre lead aft, he had not had the opportunity to try the manoeuvre during his own tug familiarisation.

1.8.12 The harbourmaster and the other pilot, although aware of the new method being used by the *T.A. Explorer* pilot, continued to use the *Huria Matenga* in the traditional way, as did the Tasman Bay pilots. The harbourmaster did, however, start having the *W.H. Parr* standing by on the starboard side aft (for outbound vessels) instead of on the port shoulder.

1.8.13 The Port Nelson harbourmaster attended a bridge resource management course in March 1998 and it was intended to send the remaining Port Nelson pilots at the earliest opportunity.

[6] See Figure 8

1.9 Relevant ship handling information (turning)

1.9.1 The forces affecting a ship in a turn are numerous and complex. Some will assist a vessel to turn, while others will resist it. The following information is an overview of the forces that are considered to have contributed to the grounding of the *T.A. Explorer*.

1.9.2 The pivot point is an imaginary moving point, situated somewhere in the vertical plane through the stem and stern, around which a vessel turns when forced into a directional change. The form of the submerged hull, rudder size and type, trim, under-keel clearance and direction and speed of movement all affect the position of the pivot point of a vessel. When stopped in the water, the pivot point sits near the centre of gravity of the vessel, usually around amidships. If a vessel is trimmed by the stern, its centre of gravity sits further aft, and so too does the pivot point.

1.9.3 Referring to Figure 5 below, when a ship begins making headway, forward movement is initially resisted due to inertia. The pivot point (P) moves forward to a position about one eighth of the length of the vessel from the bow (P1). As speed increases, the forward momentum of the ship is balanced by the longitudinal water resistance to that momentum, and the pivot point moves back and settles at a point about a quarter of the length of the ship from the bow (P2).

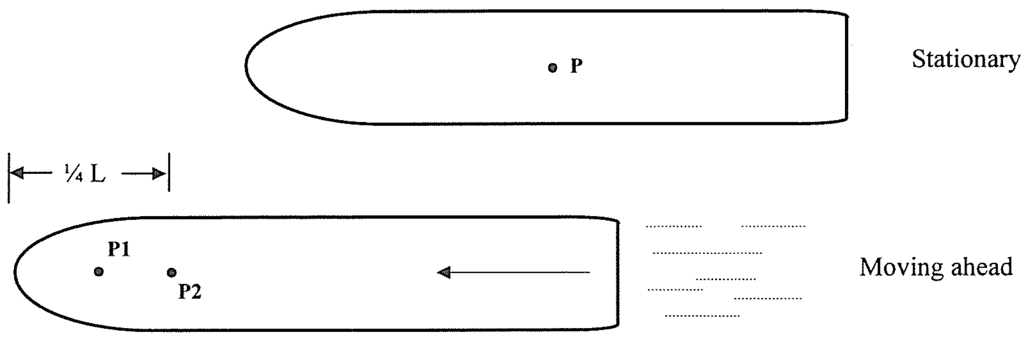


Figure 5
Pivot point

1.9.4 The position of the pivot point is never constant. Many of the forces that affect the speed or direction of a ship, will also affect the position of the pivot point.

1.9.5 When rudder is applied to a ship, a turning moment is created about the pivot point, and the vessel begins to turn. The greater the distance between the rudder and the pivot point, and the higher the rudder force, the greater the turning moment will be. As the vessel enters the turn, it experiences a certain amount of sideslip in the water, which results in a build up of water resistance along the side of the ship. This resistance (lateral resistance) opposes the rudder force. When the rudder force and lateral resistance find a balance, the vessel will settle at a relatively constant drift angle (D) and a relatively constant rate-of-turn (see Figure 6).

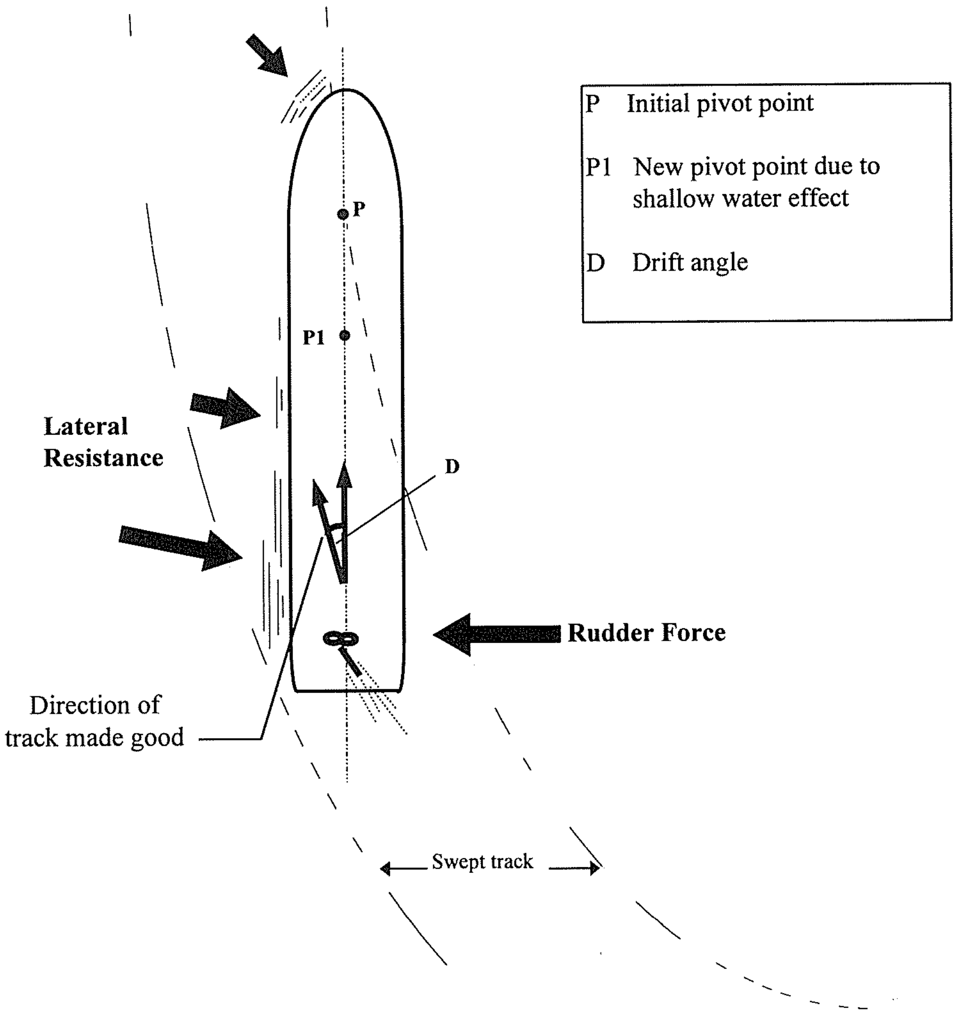


Figure 6
Lateral forces in the turn

1.9.6 The drift angle in a turn creates a considerable braking force on the ship, which, for the *T.A. Explorer* in deep water, causes up to 50% reduction in the speed of the ship. However, in shallow water (water depth less than twice the draught of the ship), the lateral resistance on the hull increases because the water flow under the vessel is restricted, requiring the rudder force to overcome higher lateral resistance forces. Additionally, the longitudinal resistance mentioned in paragraph 1.9.3 increases, pushing the pivot point back to P1 (in Figure 6), thereby reducing the lever arm between it and the rudder. The combination of these two effects: reduces the drift angle, reduces the loss of speed in the turn, and results in a deterioration in turning performance.

1.9.7 The smaller the under-keel clearance, the greater the deterioration in turning performance. Under-keel clearance in shallow water is often reduced further by squat, which is the term for the bodily sinkage which a ship can experience due to its movement through the water. The velocity of the water increases as it is forced under the hull of the ship, causing a pressure drop and resultant loss of buoyancy. Loaded ships at even keel usually squat by the head; however, fine lined ships trimmed significantly by the stern, such as the *T.A. Explorer* on departing Nelson, will often squat further by the stern. In shallow water, the effect can be cumulative, as this further restricts the water flow, resulting in more sinkage. The propeller, when operating ahead, accelerates the water flow under the stern, thus amplifying the effect.

1.9.8 The magnitude of the forces involved when a ship interacts with the sea bed varies with the square of the speed of the ship or water flow; therefore, excessive speed in shallow water should be avoided.

1.9.9 To increase the rate-of-turn of a vessel, a ship handler may increase the rudder force, or use tug assistance. The rudder force may be increased by increasing the propeller RPM (a kick), which increases water flow past the rudder, thereby increasing its lift; however, this will eventually result in an increase in speed of the ship. In shallow water, the increase in speed of the ship will cause a rapid increase in opposing lateral force, which may overcome any benefit gained from increased rudder force if the kick is applied for too long.

1.9.10 Tide and wind can also affect a vessel in a turn; however, on the night of the accident, both were negligible.

1.10 Relevant tug handling information

1.10.1 Referring to Figure 7 below, the effectiveness of a tug in each position is as follows:

Position 1 A high sideways steering force is applied, but its effect is limited due to the short lever around the pivot point and resultant lateral forces that have to be overcome. There is also a vector which will increase the speed of the ship.

Position 2 The tug has to overcome the same lateral forces as tug 1, but has virtually no turning leverage around the pivot point. The tugs underwater resistance opposes the turn, and in some test cases, tugs pushing in this area have resulted in the vessel turning to port instead.

Position 3 A turning couple is created by the ship and tug propulsion opposing each other. The speed of the ship slows and this improves the effect of the propeller wash past the rudder. The underwater resistance of the tug contributes to the starboard swing. This position is the most effective of the three forward positions in assisting a starboard turn when making headway. The tug is in a good position to retard the ship in case of steering or engine failure, although this will result in the ship swinging to starboard.

Position 4 Because of the long lever about the pivot point, the tug is in an effective position to assist the starboard turn by pushing. The underwater resistance of the tug assists the starboard turn.

Position 5 The tug is in a very effective position. The longest possible lever about the pivot point is obtained, and the tug provides retarding forces while providing good steering assistance. The tug can easily give steering assistance on both sides, or be an effective brake by “digging in” astern.

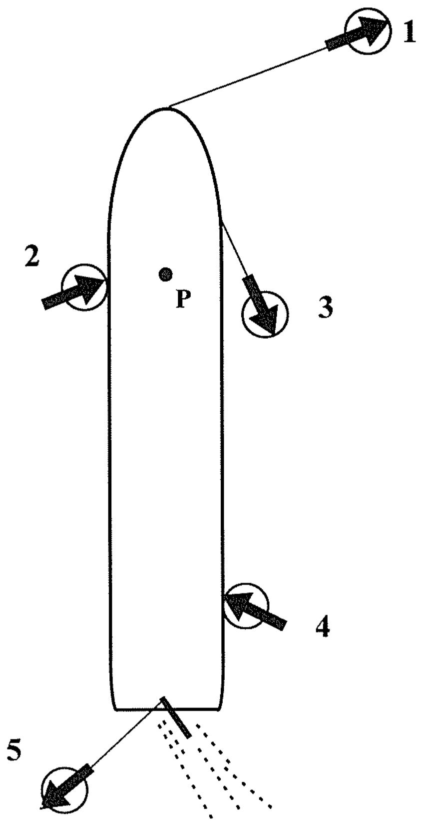
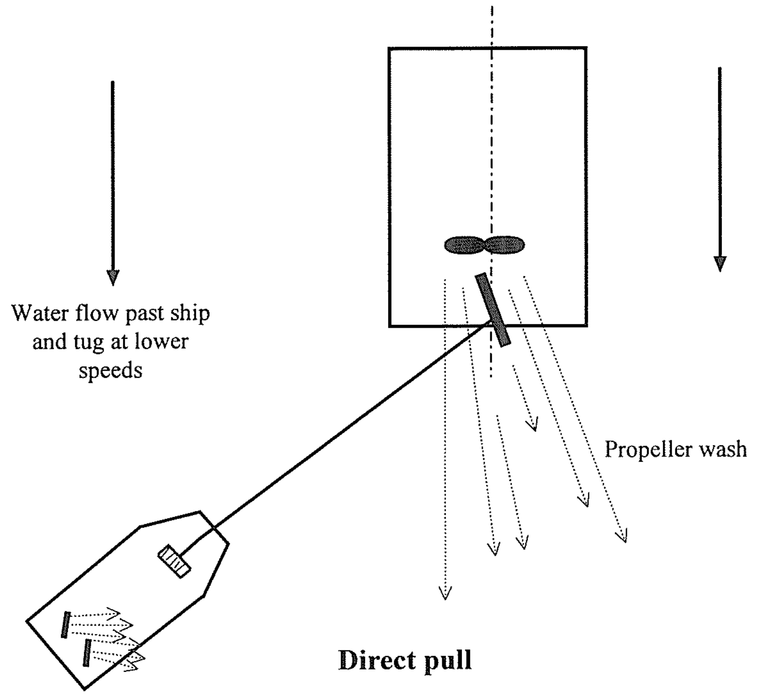


Figure 7
Diagram showing different positions for tugs to assist a ship making a starboard turn when making headway. Arrows indicate direction of push or pull.

1.10.2 The summary of the effectiveness at each tug position is based on the assumption that a tug skipper is able to position his tug and apply the required force in the direction indicated by the arrows in Figure 7. The effectiveness of the tug will be largely dependent on the speed of the ship through the water. The higher the speed; the more tug power will be required to keep up with the ship; the less power will remain to assist the ship.

1.10.3 An exception to the rule is when a tug assists using an indirect pull, when hydrodynamic forces acting on the underwater profile of the tug are used to increase the pull on the tow line. A tug assisting using this method can apply forces on the tow line in excess of its bollard pull (see Figure 8).

1.10.4 The tug has become more recognised as a valuable asset for protecting the port environment and infrastructure. The majority of publications and articles on tug design, use and handling, are based mainly on theoretical data, results of tank testing programs, and claims made by tug and tug propulsion system manufacturers. Few, to date, are based on real life testing.



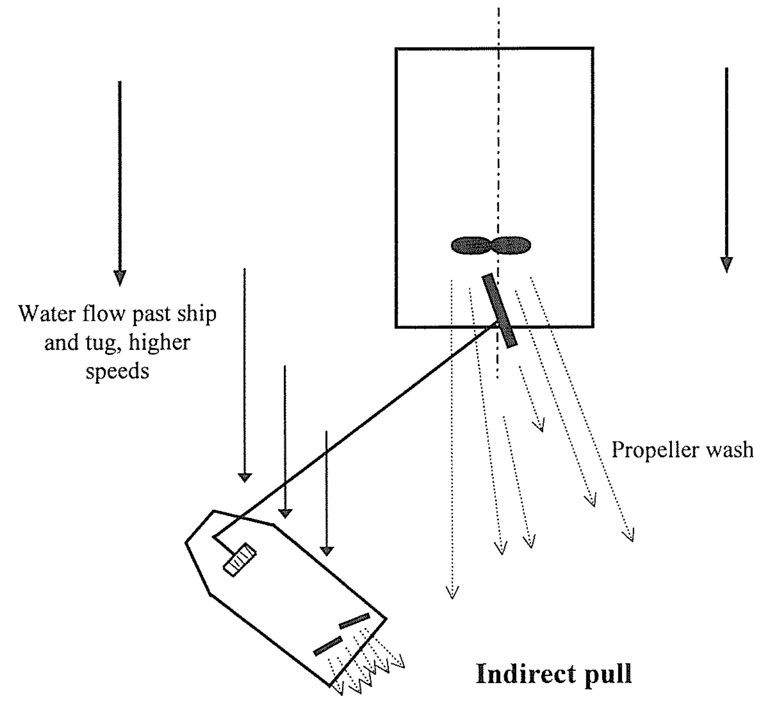


Figure 8
Diagrams illustrating the direct and indirect pull for a tug escorting on a line aft and assisting a starboard turn.

1.10.5 The subject of hydrodynamic and other forces involved in tug performance and ship/tug interaction, is complex. Some experienced tug skippers are sceptical of claims made as to the capability of certain tugs, as the claims do not appear to take into account all factors affecting tug performance, and do not always work when applied in a real environment.

1.10.6 As an example, the *Huria Matenga* trying to direct pull the stern of the *T.A. Explorer* to port, as requested by the pilot shortly before the grounding; some text books and manufacturers claim that this can be achieved by Azimuth Stern Drive tugs at speeds up to six knots. The consensus among a number of experienced tug skippers was that, at a speed of 4 knots, a tug skipper should be thinking about switching to the indirect pull method. Some tug skippers, when trying a direct pull at a water speed of 5 knots, have experienced the same effect as the skipper of the *Huria Matenga* encountered; while turning the Z-pellers, the tug has been swept back into the propeller wash and remained there pulling back on the tow line, but slightly off on the wrong side. The relevant tug speeds will obviously vary depending on tug power and design.

1.10.7 As the effectiveness of a tug using an indirect pull depends on the size of its underwater profile, the *Huria Matenga*, with its relatively shallow draft and relatively small underwater profile, may require higher speeds through the water for it to provide an effective indirect pull.

2. Analysis

2.1 *T.A. Explorer* without tug assistance

2.1.1 On half of the passages into and out of Nelson, the *T.A. Explorer* had required tug assistance to make the turn in the main channel.

2.1.2 Comparing the deep water turning circle data for the *T.A. Explorer* with the details of the turn, it appeared that the ship could have made the turn, unassisted. However, the relatively small under-keel clearance of the *T.A. Explorer* increased the dimensions of its turning circle significantly. Additionally, the large trim of the ship placed the pivot point further aft than normal, reducing its rudder effectiveness.

2.1.3 When the *T.A. Explorer* grounded, the wind and tide were negligible and had no influence on the occurrence.

2.1.4 There was no malfunction of the engine and steering gear on the *T.A. Explorer*, or any suggestion that they were not controlled as requested by the pilot and master.

2.1.5 With its small under-keel clearance, the *T.A. Explorer* would have been struggling to attain a drift angle in the turn. The pilot's action of increasing the engine to Half Ahead to increase rudder effectiveness (kick), would have had limited effect, as it would result in the vessel speeding up in the turn, with little reduction in the diameter of the turning circle. If a kick was to be used, it would have been more effective to reduce the initial speed of the ship first (engine Dead Slow, or even Stopped).

2.1.6 The *T.A. Explorer* would have been affected by squat. With such a large trim, the squat was likely to have been by the stern, reducing the under-keel clearance. The kick at Half Ahead would have caused an accelerated water flow under the stern, causing the ship to squat further, exacerbating any shallow water effect on turning.

2.1.7 The above factors, and past records of turning performance for the *T.A. Explorer* at Port Nelson, indicated the ship would require tug assistance to make the turn safely.

2.2 The grounding

2.2.1 The pilot recognised the *T.A. Explorer* might require tug assistance, as evidenced by his exchange of information with the master before the ship departed Brunt Quay, and by his instructions to the skipper of the *Huria Matenga* as the ship was passing Main Wharf.

2.2.2 Having realised the assistance of the tugs may be required, the pilot should have positioned the tugs where they would best aid the turn, and manoeuvred the ship at a speed appropriate for the chosen tug positions, and for the type of assistance required from them.

2.2.3 The position the pilot chose for the *Huria Matenga* was that which is widely accepted as being the most effective position for such a tug; however, with the tug using the agreed direct pull method from the stern, the pilot should have kept the ship speed down, to enable the tug to assist as instructed.

2.2.4 Estimates of the actual speed of the *T.A. Explorer* as it entered the turn differed. The master sighted the Doppler log displaying 7 knots, and the GPS displaying 7.2 knots. The pilot estimated the speed to be "4 to 5 knots". The *W.H. Parr* was ". . . at 900 rpm to keep up". Correlating the times of the engine movements with the pilot's recollections of when each engine movement was made, it was estimated that the *T.A. Explorer* travelled 3.5 cables in about four minutes before coming to rest on Haulashore Island, which equates to an average speed of 5.25 knots. As the average speed includes the slowing down prior to grounding, the speed must have been higher than 5.25 knots during some stage of the turn.

2.2.5 Trim and shallow water can effect Doppler logs. GPS indicated speeds can be erratic if frequent position updating has been selected, due to the variable accuracy of the system. The *W.H. Parr* was on the outside of the turn and would have been affected by interaction with the hull of the ship, requiring more rpm to maintain its station. Considering all of these factors, it is likely that the speed of the *T.A. Explorer* was at least 5 knots as the vessel entered the turn. With the kick at Half Ahead, the speed would have increased until the *Huria Matenga* began to retard the ship.

2.2.6 The pilot was under the impression that the *Huria Matenga* should have been able to assist as instructed, using a direct pull at speeds up to 6 knots. His impression was based on information from several publications, and simulator trials, none of which took into account all the practical difficulties that faced the skipper of the *Huria Matenga*, such as:

- the higher speed through the water required of the tug as it swung outside the track of the ship in the turn,
- the time taken to reverse the Z-pellers when changing from escort to assist mode,
- the increased relative water speed caused by the ship propeller wash,
- Z-peller cavitation caused by the propeller wash from the ship and the forward tug,
- the angle of heel the tug assumed when trying to drag its underwater profile sideways through the water.

2.2.7 The pilot had not tried such a manoeuvre himself during his tug training, neither had the skipper of the *Huria Matenga* in his 14½ years driving the Port Nelson tugs. Therefore, the pilot had not tried the manoeuvre before it was needed.

2.2.8 At a speed in excess of 5 knots, and taking the above factors into consideration, it was unlikely the *Huria Matenga* could assist in the turn in the manner envisaged by the pilot. With the tug pinned in the propeller wash, and its stern canted to the centreline of the ship, the *Huria Matenga* would have been applying a significant retarding force to the ship through the towline; however, the retarding force also pulled the stern to starboard, which **decreased** the rate-of-turn of the ship, **instead of increasing it**.

2.2.9 With the retarding effect of the tug astern, the speed of the ship decreased, and the skipper of the *Huria Matenga* was able to work his tug slowly across the propeller wash of the ship, but by then the *T.A. Explorer* was too far to the port side of the channel to complete the turn. When the engine of the ship was stopped and then started astern, the speed of the ship would have reduced rapidly. As a result, the *Huria Matenga* was operating in clean water, and moved rapidly across to port. The momentum of the tug swinging to port caused its tow line to part at about the time the ship grounded.

2.2.10 Two minutes and 27 seconds elapsed from the time the engine of the *T.A. Explorer* was increased to Half Ahead, after passing the main wharf, to the time it was stopped and then started astern, 1 minute and 32 seconds before the grounding. Some of that time elapsed while the pilot made his assessment of the rate-of-turn of the ship before making his request to the *Huria Matenga* for assistance. The skipper of the *Huria Matenga* appears to have made a good attempt to reposition his tug to pull the stern of the *T.A. Explorer* to port, which took some time. By the time it became apparent to the tug skipper that he was not going to be successful, the pilot had initiated the string of VHF orders to both tugs, during which the skipper informed the pilot that, "I can't get across through the wash".

2.2.11 In hindsight, if the skipper of the *Huria Matenga* had informed the pilot of his difficulties as soon as his tug was swept in behind the ship, the pilot may have aborted the turn sooner, and the grounding may have been avoided; however, as the manoeuvre had not previously been tried at the speed at which the *T.A. Explorer* was moving, the tug skipper was left in an unenviable position. When the *Huria Matenga* was swept in behind the *T.A. Explorer*, the tug skipper acted appropriately in attempting to regain position on the port quarter of the ship, as instructed by the pilot. The concentration required by the tug skipper to attempt this task without jeopardising the safety of his tug, and the short time span between events, precluded earlier radio contact with the pilot.

2.2.12 The *W.H. Parr* was used in the least effective position for assisting the *T.A. Explorer* to make the starboard turn at the pilot's target speed of 5 knots. With the ship making a speed in excess of five knots, the tug would have been pushing close to the pivot point, with most of its available power being used to keep up with the ship. With the underwater resistance of the tug opposing the turn, it is unlikely that the *W.H. Parr* would have been effective in increasing the rate-of-turn; it may even have decreased it.

2.2.13 Regardless of whether or not the *T.A. Explorer* could have made the turn in the main channel, unassisted, the overriding cause of the grounding was that neither tug, as used, could effectively assist the ship to make the turn. Instead, both tugs probably hindered it.

2.3 Options

2.3.1 With about 100 m of channel available on either side of the vessel, the turn in the entrance to Port Nelson leaves little margin for error.

2.3.2 The variations between any two acts of pilotage are many, but broadly speaking, there were two options available to the pilot using his chosen tug configuration:

- to keep the speed of the ship down to a minimum, and allow the aft tug full use of the direct pull method, or
- take the corner at a higher speed, and allow the aft tug to use the indirect pull method effectively.

2.3.3 The second option had the disadvantage of increasing the effect of interaction due to shallow water and, in the event of an emergency, requiring more sea room to stop the ship. The pilot also needed to assess the suitability of the *Huria Matenga* for indirect towing, with regard to the ship speed required, and the limited sea room that left little margin for error.

2.3.4 Although the option chosen by a pilot is a matter of personal preference, and to a certain degree, the opinion of the master, the harbourmaster also had a degree of responsibility in relation to overseeing the safe navigation of vessels within port limits. The harbourmaster, in his submission, expressed some reservations about using tugs in the indirect mode, because of the factors mentioned above.

2.3.5 The pilot had opted for a combination of the two methods. He piloted the ship with the intention of trying to make the turn at about five knots, without tug assistance, but having them there just in case. When tug assistance was called for, the speed of the ship was too high for the tugs to be effective using the agreed direct pull method.

2.3.6 If the speed of the ship and the method of tug use were compatible, the *Huria Matenga* alone, should have been able to give the required assistance for the *T.A. Explorer* to negotiate the turn. The role of the *W.H. Parr*, therefore, should have been merely as a stand-by tug, in accordance with Port Nelson policy.

2.3.7 However, as the *W.H Parr* was an additional safety margin supplied by the port, the pilot should have placed it in a position where it would be of maximum use if required.

2.3.8 The port shoulder was not the best place for the pilot to have positioned the *W.H. Parr*. At the speed the *T.A. Explorer* was moving, it may even have hindered the ship in its turn. Because of its limited speed, the *W.H. Parr* was rarely used on a line when in the escort mode, but instead was used as a stand-by pusher tug. As a stand-by pusher tug, a more appropriate position to have had the *W.H. Parr* would have been on the starboard side aft, where in the event of the *Huria Matenga* encountering difficulties, it could aid the turn by pushing against the flat side of the ship with a good turning lever about the pivot point, and where the underwater resistance on its hull would have provided an additional turning moment to assist the turn.

2.4 Pilot/master/tug skipper relationship

2.4.1 The terminology a pilot uses when giving instructions to the tug skippers, not only varies from port to port, but can vary from pilot to pilot within a port. In Port Nelson, pilots normally gave instructions to the tug skippers in the form of engine RPM, "pull", "push", "a little out on the quarter" for example. While this method of instruction has merit for some applications, such as pushing and pulling a vessel on or off a berth, it has limited application when tugs are in the escort mode. If a tug skipper decides to apply an indirect pull to the tow line, an order from the pilot such as "give me 500 pull" is meaningless; therefore, if the indirect pull was going to be used in Port Nelson, an alternative style of orders would have to be developed.

2.4.2 If a pilot requests a tug to pull the stern to port, for example, the tug skipper is in a good position to assess the local factors, such as strain on the tow line, speed of the tug through the water, propeller wash, cavitation of the tug propulsion units and heel angle of the tug. The pilot may not be able to see the tug, as was the case with the *T.A. Explorer*, but he does have a good appreciation of the speed of the ship, and knows what he intends to do next with the speed. It is vital therefore, that the pilot and tug skipper share the same concept of the plan, which requires a good two-way communication system.

2.4.3 The shared plan concept and system of communication between pilots and tug skippers usually evolves over time. If a new method is introduced, it is important that it be: carefully assessed, discussed so that all relevant parties share the same concept, and tested in a safe situation before being implemented.

2.4.4 The method of using the tug through the centre lead aft was new to Port Nelson. The concept had been discussed between the pilot and the tug skippers, but not fully. The tug skippers had previously expressed concern to the pilots about the speeds at which they were being asked to assist. The indirect method of pulling was mentioned, but not followed up. If the pilot intended to use the *Huria Matenga* to assist in a turn, at speed, the indirect pull should have been an option that was assessed, discussed and practised. It was not, neither was the direct pull method tested at speed. The result was that for two months, the pilot conducted ships in and out of the port employing a flawed approach to tug use, until the outbound *T.A. Explorer* required assistance to make the turn, could not get that assistance, and grounded.

2.4.5 Although neither the pilot, nor the crew of the ship had attended a Bridge Resource Management (BRM) course, the standard of BRM was reasonable. Both the master and the first mate were monitoring the progress of the vessel, and both recognised that the vessel was not making the turn. Information was coming from the third mate forward as to the closing distance between the bow and the shore. The actions of the master and pilot were virtually simultaneous; going astern with the main engine and letting go the port anchor.

2.4.6 What the master and the first mate did not know, was what the pilot was instructing the tugs to do. Pilots who use portable radios to talk to tug skippers can be a problem for masters, who should know what the tugs are doing. Unless the pilot informs the master of each order he has given the tug, or the master follows the pilot closely, the master can lose situational awareness, particularly on large ships where the tugs are obscured from view.

2.4.7 Most ship masters' knowledge on the intricacies of tug performance and positioning is limited. That is one reason why pilots are employed to use their specialist skills to co-ordinate the tugs and other port services to ensure safe passage for the ship.

2.4.8 The master of the *T.A. Explorer* accepted the pilot's passage plan. In doing so, it was reasonable for him to assume that the pilot had arranged his tugs in an appropriate manner. The pilot did not discuss with the master how he intended to use the tugs, but it is unlikely the master would have questioned him if he had, unless the pilot had explained the fast or slow options discussed in 2.3.2 above.

2.4.9 Although the standard of BRM was reasonable, it is of concern that the crew of the *T.A. Explorer* did not as a matter of course, plan the passage from berth to berth, nor was berth to berth planning stipulated in the International Safety Management manuals sighted on board. The passage of a ship through pilotage waters is the most perilous part of the voyage. For an International Safety Management system on board to not recognise this, constitutes a major non-conformity with one of the fundamental objectives of the system; to establish safeguards against all identified risks. Also of concern was the lack of a dedicated pilot information card in the form promoted by the International Maritime Organisation.

2.5 Communications and training

2.5.1 Each act of pilotage is different, and each individual pilot will adopt his /her own style. Because pilotage involves the use of tugs, each of which may be under the command of different skippers, it is desirable that good communication exists between the pilots and those skippers to ensure that everyone shares the same concept of the plan, in much the same way as good bridge resource management will ensure that the bridge personnel work together as a team.

2.5.2 Such communication becomes particularly relevant when either a pilot or tug master intends to change the way in which they operate, due to new technology or new ideas. A structured approach to sharing information and ideas, together with a system of quality control, such as peer review, would be an effective way to achieve this.

2.5.3 Peer review by pilots will provide the opportunity for any bad practices which may creep in to be corrected, and improvements on existing practices to be identified and reviewed.

2.5.4 While the initial training requirements for pilots and tug skippers operating in Port Nelson are already set down in the port company procedures, a common minimum level of on-going training for both pilot companies could be difficult for the harbourmaster to achieve, unless a good working relationship and understanding exists between the two companies.

2.5.5 Although Tasman Bay Pilots were not involved in the grounding of the *T.A. Explorer*, it became apparent during the investigation, that the Tasman Bay Pilots had yet to be involved in the Launceston simulator training, and none had attended a BRM course. The question of whether the Tasman Bay Pilots would participate in the additional training had arisen since the High Court decision in 1995.

2.6 Tug line maintenance

2.6.1 While it is unlikely the parting of the towline from the *Huria Matenga* contributed to the grounding, if the *Huria Matenga* had applied an indirect pull to the stern of the *T.A. Explorer*, the towing forces imparted on the line would have been greater and the line may have parted earlier.

2.6.2 While it is not practicable to determine for how long each chaffed or fused strand had been broken, examination of the rope indicated that only a small portion of the strands failed as a result of direct contact with the Panama lead on the *T.A. Explorer*. A significant number of strands, therefore, must have been worn or fused before the *Huria Matenga* commenced the *T.A. Explorer* towage.

2.6.3 The condition of the tow line when it parted indicated that a more frequent and thorough inspection of tug towlines was required.

3. Findings

Findings and safety recommendations are listed in order of development and not in order of priority.

3.1 The crews of the *T.A. Explorer* and the two tugs had appropriate qualifications for their role.

3.2 Neither mechanical nor equipment failure contributed to the grounding of the *T.A. Explorer*.

3.3 A combination of the inherent turning characteristics of the *T.A. Explorer*, its small under-keel clearance and large trim, meant that the ship required tug assistance to make the turn out of Port Nelson safely.

3.4 The tug *Huria Matenga* had sufficient bollard pull to have provided the required turning assistance for the *T.A. Explorer*, if the tug had been used effectively.

3.5 The position the pilot chose to secure the *Huria Matenga*, through the centre lead aft, had the potential to be the most effective position for assisting the *T.A. Explorer* to make the turn.

3.6 The speed of the *T.A. Explorer* as it entered and during the initial stages of the turn was too high for the *Huria Matenga* to assist using the direct pull method agreed between the tug skipper and the pilot.

3.7 While the skipper of the *Huria Matenga* endeavoured to comply with the pilot's instructions, the tug was swept into a position where it provided high retarding forces to the *T.A. Explorer*, but reduced its rate-of-turn. The reduction in rate-of-turn was enough to cause the *T.A. Explorer* to ground, but at minimal speed.

3.8 The parting of the tow line from the *Huria Matenga* as the *T.A. Explorer* grounded did not contribute to the grounding.

3.9 The pilot placed the stand-by tug *W.H. Parr* in the least effective position to render turning assistance at the speed the *T.A. Explorer* was travelling; consequently, when the *Huria Matenga* encountered difficulties, the *W.H. Parr* could not assist the ship in the turn effectively.

3.10 Theories fostered by ship simulator training and various publications misled the pilot about the true manoeuvring capabilities of the *Huria Matenga*.

3.11 The tugs were not used to their full potential on this occasion, as the pilot had not properly reviewed, assessed and tried the new method for using tugs in the escort mode, before implementation.

3.12 Port Nelson management, by not having a structured procedure in place for reviewing and implementing new methods, but instead relying on informal random communication between themselves, the pilots and tug skippers, fostered an environment where the pilots or tug skippers could instigate change without first fully reviewing the consequences.

3.13 The traditional nature of maritime pilotage, whereby, once trained, pilots are left to form their own individual style, warrants a system of quality control to ensure that unsatisfactory practices are corrected, and improvements on existing practices can be identified and reviewed.

3.14 The master of the *T.A. Explorer* did not plan routinely for what is considered to be the riskiest part of the voyage. This omission constituted a major non-conformance with the International Safety Management system on board.

3.15 While the standard of bridge resource management on board the *T.A. Explorer* was reasonable, there was room for further improvement.

4. Safety Recommendations

4.1 On 17 July 1998, it was recommended to the Shipping Services Manager for Port Nelson Limited that Port Nelson Limited:

4.1.1 Implements a system of regular structured meetings of all pilots and tug masters operating in the port, to foster good communication and a shared concept of operational requirements. Such a system should supplement, rather than replace, the informal communication which exists between pilots and tug masters, (040/98); and

4.1.2 Implements a system of quality control, such as peer review, among the pilots and tug masters whereby, from time to time each pilot and tug master is observed by another so that any potential unsatisfactory practices can be corrected, and improvements on existing practices can be identified and reviewed, (041/98); and

4.1.3 Implements a system of familiarisation in tug operations for maritime pilots, as required, (042/98); and

4.1.4 Ensures that all pilots and tug masters operating in Port Nelson receive, in addition to the initial training, on-going training which:

- is required by the port company and city council, and
- is consistent with national and international trends and guidelines, (043/98); and

4.1.5 Clarifies the responsibilities of the tug masters with respect to tug and towline maintenance, with emphasis on the need for on-going thorough inspections of the towline. (044/98)

4.2 On 23 July 1998, the Shipping Services Manager for Port Nelson Limited responded as follows:

4.2.1 **040/98** This has already been implemented by Port Nelson limited. The first meeting of all tug masters and pilots working Port Nelson was held on Thursday 16 July 1998. It is intended to hold meetings now on the basis of three to four per annum, initially.

4.2.2 **041/98** At the meeting held on 16 July, the subject of peer reviews for pilots and tug masters was raised. It was agreed between the two pilot companies that they would implement a system of peer review in the near future.

4.2.3 **042/98** Most of the Port Nelson and Tasman Bay Pilots, including the pilot of the T.A. Explorer when it grounded, have completed some form of tug familiarisation. The issue was discussed at the meeting on 16 July, and a schedule drawn up for initiating and/or completing tug familiarisation as required.

4.2.4 **043/98** Port Nelson Limited has some difficulty with this recommendation. As with most other services in the port, Port Nelson Limited competes for the piloting service.

Port Nelson Limited has embarked on a contract with the Australian Maritime College in Launceston, Tasmania to have the port of Nelson fully simulated. This simulation will be used by Port Nelson Limited pilots to gain skills in emergency procedures, such as ships blacking out in the channel, sudden changes in environmental factors, helm being wrongly applied, and the like.

The cost of setting up the port simulation is high, as is the daily cost for the pilots to practice in the simulator. In addition, Port Nelson Limited is committed to sending its pilots on bridge resource management (BRM) courses, again, at some considerable cost.

Port Nelson Limited may, at its discretion, make the port simulation available to other pilots; however, the daily costs for running the simulator, and the cost of bridge resource management training would have to be met by them.

Although port simulation and BRM are consistent with international trends, and Port Nelson Limited is providing training for its pilots using these techniques, it feels that it is unable to force the concept on to other pilots operating in the port, until such time as they become in some way mandatory.

Having said that, Port Nelson Limited has recently entered into a memorandum of understanding with Tasman Bay Pilots in which it is stated that either company will provide pilots for the other if the circumstances dictate. The memorandum contains the clause:

> "Bridge Resource Management - Port Nelson Limited pilots practise BRM techniques. As a minimum requirement, when Tasman Bay Pilots are contracted to Port Nelson Limited, their pilots must produce a passage plan for the ship master and brief the bridge team of the ship prior to conducting the act."

4.2.5 **044/98** Port Nelson Limited now has on each tug, a file which tells when the line was last inspected, and any maintenance taking place on the line. I have arranged through the manufacturers of the tow line, for their representative to call at Nelson on 29 July 1998, when they will show Port Nelson Limited staff, including the tug masters, what specifically to look for in wear and tear on a tow line. I will, after discussion with the manufacturer, decide on whether to undertake further testing of the tow line.

4.3 On 17 July 1998, it was recommended to the owner of the *T.A. Explorer,* Oldendorff, that the company:

4.3.1 Includes in the International Safety Management system for the *T.A. Explorer*, the requirement for masters to plan each passage from berth to berth, (074/98)

4.3.2 Ensures that the *T.A. Explorer*, and other vessels belonging to the company, have an appropriate pilot information card, (075/98)

4.3.3 Embarks on a programme for bridge resource management training for ships officers in their employ. (076/98)

4.4 On 28 July 1998, the Fleet Manager for Oldendorff responded as follows:

4.4.1 The company's voyage planning requirements will be extended to berth to berth for all vessels. Implementation will be completed by the end of August 1998.

4.4.2 All vessels will be reminded to complete the pilot information card. Implementation will be completed by the end of August 1998.

4.4.3 Bridge resource management training is carried out on board all of our vessels since the implementation of the ISM Code in December 1997.

Approved for publication on 5 August 1998

Hon. W P Jeffries
Chief Commissioner

Glossary of marine abbreviations and terms

aft	rear of the vessel
beam	width of a vessel
bilge	space for the collection of surplus liquid
bridge	structure from where a vessel is navigated and directed
bulkhead	nautical term for wall
cable	0.1 of a nautical mile
chart datum	zero height referred to on a marine chart
command	take over-all responsibility for the vessel
conduct	in control of the vessel
conning	another term for "has conduct" or "in control"
deckhead	nautical term for ceiling
dog	cleat or device for securing water-tight openings
draught	depth of the vessel in the water
EPIRB	emergency position indicating radio beacon
even keel	draught forward equals the draught aft
freeboard	distance from the waterline to the deck edge
free surface	effect where liquids are free to flow within its compartment
focsle	forecastle (raised structure on the bow of a vessel)
GM	metacentric height (measure of a vessel's statical stability)
GoM	fluid metacentric height (taking account the effect of free surface)
GPS	global positioning system
heel	angle of tilt caused by external forces
hove-to	when a vessel is slowed or stopped and lying at an angle to the sea which affords the safest and most comfortable ride
Hz	hertz (cycles)
IMO	International Maritime Organisation
ISO	International Standards Organisation
kW	kilowatt
list	angle of tilt caused by internal distribution of weights
m	metres
MSA	Maritime Safety Authority
NRCC	National Rescue Co-ordination Centre
point	measure of direction (one point = 11¼ degrees of arc)
press	force a tank to overflow by using a pump

SAR	Search and rescue
SOLAS	Safety Of Life At Sea convention
sounding	measure of the depth of a liquid
SSB	single-side-band radio
statical stability	measure of a vessel's stability in still water
supernumerary	non-fare-paying passenger
telegraph	device used to relay engine commands from bridge to engine room
ullage	distance from the top of a tank to the surface of the liquid in the tank
VHF	very high frequency
windlass	winch used to raise a vessels anchor