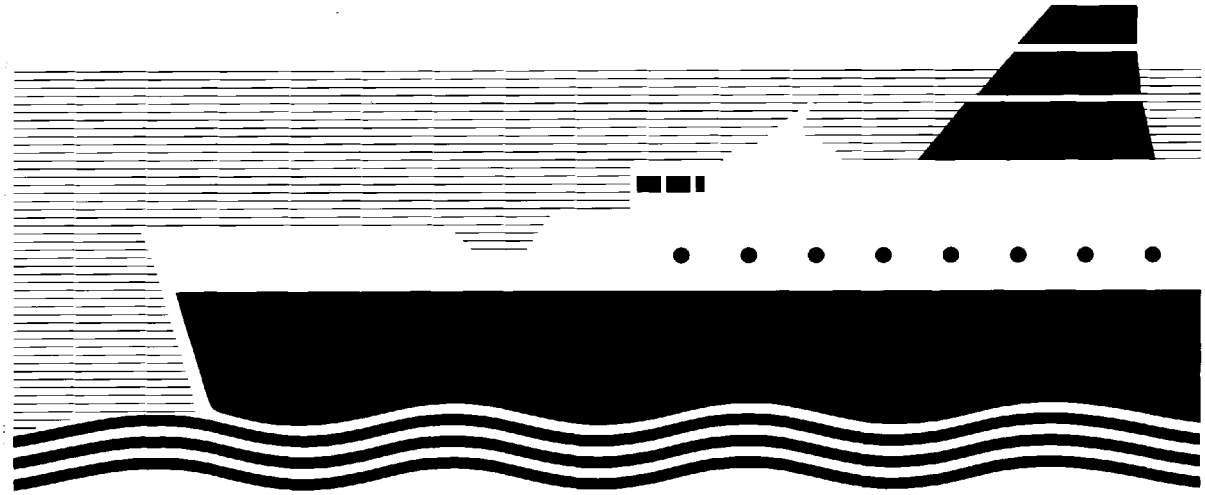
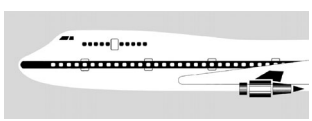
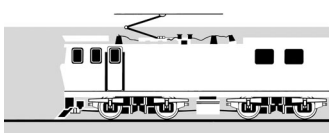


MARINE OCCURRENCE REPORT

03-210 **passenger freight ferry *Aratere*, collision with moored fishing vessel *San Domenico*, Wellington Harbour** **5 July 2003**


TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.
The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Report 03-210

passenger freight ferry *Aratere*

collision with moored fishing vessel *San Domenico*

Wellington Harbour

5 July 2003

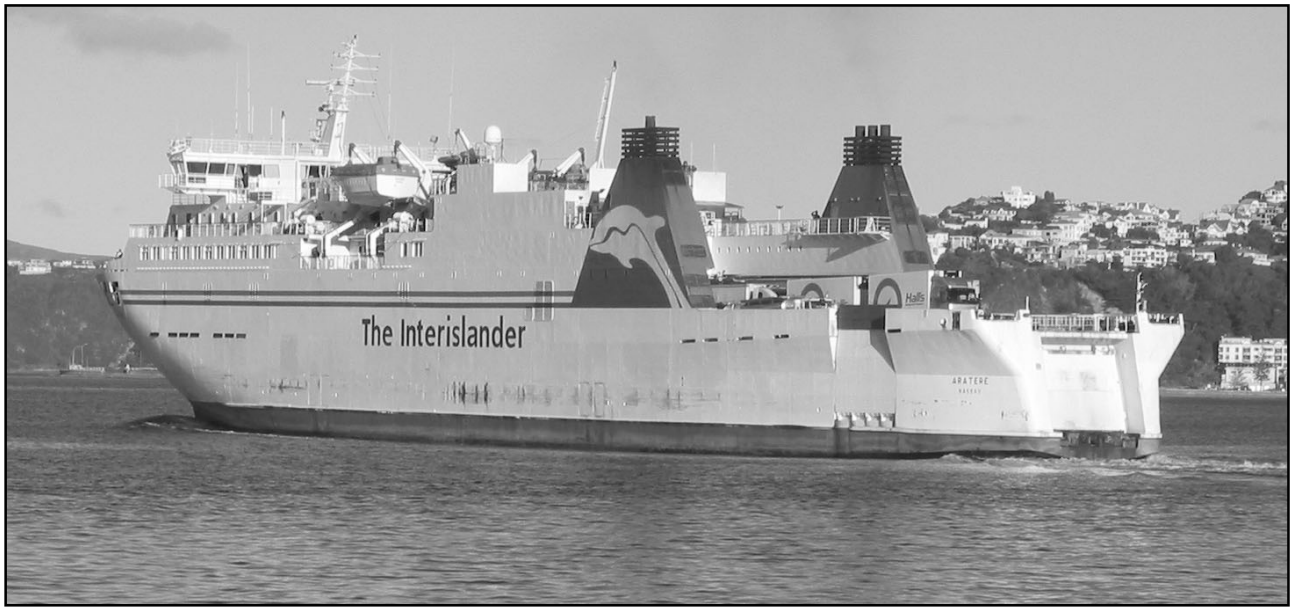
Abstract

On Saturday 5 July 2003 at about 2100, the passenger freight ferry *Aratere* collided bow first with the starboard side of a fishing vessel moored at Aotea Quay in Wellington Harbour. The fishing vessel, *San Domenico,* and the quay suffered extensive damage.

The safety issues identified included:

- the undertaking of safety critical tasks while suffering from the effects of chronic sleep loss
- the adequacy of provision of medical data concerning sleep disorders in the Maritime Rules
- the adequacy of the requirement to report to owners and operators any condition that may affect the ability of staff involved in safety critical tasks to perform their duties.

Safety recommendations were made to the Director of Maritime Safety to address these issues.



The *Aratere* in Wellington Harbour (note bulbous bow)

The *San Domenico* alongside Aotea Quay after the collision, damage visible on starboard side

Contents

Figures

Abbreviations

ARPA	automatic radar plotting aid
ECDIS	electronic chart display and information system
GPS	global positioning system
kts	knots
kW	kilowatt(s)
MSA	Maritime Safety Authority of New Zealand
nm	nautical mile
rev(s)	revolution(s)
ro-ro	roll on – roll off
t	tonne(s)
UHF	ultra high frequency
VHF	very high frequency

Glossary

ARPA	automated system to plot and monitor targets on radar. Used by a watchkeeper to assist in collision prevention
bollard pull	a measure of the static pull a vessel can exert
bow	the front of a ship
chart datum	zero height referred to on a marine chart
con (conduct)	directing the course and speed of a ship
course	direction steered by a ship
displacement	the amount of fluid, measured in tonnes, displaced by an object floating or immersed in it
draught	depth in water at which a ship floats
ECDIS	a type-tested navigation system that displays selected information from electronic charts along with positional information from navigation sensors
echo sounder	a device for measuring the depth of water below a ship's bottom
forefoot	foremost end of a ship's keel
gross tonnage	a measure of the internal capacity of a ship; enclosed spaces are measured in cubic metres and the tonnage derived by formula
helm	the amount of angle that the rudder is turned to port or starboard to steer the ship
heading	direction in which a ship is pointing at any moment
knot	one nautical mile per hour
leeway	the sideways movement of a ship caused by the wind
long line	a long backbone of line with a buoy at one end is paid out from the vessel. Numerous hooked and baited drop lines or snoods come off of the backbone at regular intervals. The line is left to fish passively for a time before it is retrieved and the hooked fish landed
made fast	tied up, attached
obstructive sleep apnoea	a medical condition where intermittent obstuction of the upper airways during sleep leads to repeated sleep disturbance and excessive daytime sleepiness
polysomnography	a diagnostic test during which a number of physiologic variables are measured and recorded during sleep
port	left hand side when facing forward
rake	a number of rail wagons coupled together to form a length that will fit on a particular ship
starboard	right hand side when facing forward

Data Summary

Vessel Particulars:

Name:	*Aratere*	*San Domenico*
Type:	passenger freight ferry	fishing vessel
Class:	✠ 1A1 car and train ferry A, general cargo carrier RO/RO DG-P	fishing vessel, unlimited area.
Classification / SSM company:	Det Norske Veritas	Survey Nelson Limited
Length (overall):	150.00 m	35.5 m
Breadth (extreme):	20.25 m	
Gross tonnage:	12 596	98
Built:	1998, Hijos de J. Barreras S.A. in Vigo, Spain	1980, Japan
Propulsion:	four 3680 kW diesel-driven generators driving four 2600 kW electric motors coupled in pairs through a reduction gearbox to two 4-bladed fixed-pitch propellers	Diesel
Service speed:	19.5 kts	
Owner:	Wilmington Trust Corporation	Pescatore Fishing Limited
Operator:	Tranz Rail Limited	Pescatore Fishing Limited
Port of Registry:	Nassau	Napier
Minimum crewing requirement:	12	5

Date and time:	5 July 2003, 2059[1]	
Location:	Wellington Harbour	
Persons on board:	crew: 31 passengers: nil	crew: 3 passengers: nil
Injuries:	nil	nil
Damage:	nil	constructive total loss
Investigator-in-charge:	Captain I M Hill	

[1] Times in this report are New Zealand Standard Time (UTC + 12 hours) and are expressed in the 24-hour mode

1 Factual Information

1.1 History of the event

1.1.1 On Saturday 5 July 2003, The Interisland Line passenger freight ferry *Aratere* departed from Wellington's Rail Ferry Terminal berth 2 (RFT2) at about 1815, to allow another ferry the *Arahura*, to berth and discharge its passengers and cargo.

1.1.2 Ferry sailings across Cook Strait had been cancelled due to bad weather, so after the *Aratere* cleared the ferry terminal and commercial wharves, the master conned the ship into a position where it could safely lie and await a berth. The masters of the *Arahura* and the *Aratere* discussed, by cellphone, which ship would occupy which berth. Arrangements were made that the *Aratere* would re-berth at RFT2 and the *Arahura* would move to a lay berth at Aotea Quay once its discharge was finished.

1.1.3 At about 2045 the master of the *Aratere* heard the master of the *Arahura* on the ultra high frequency (UHF) radio ordering the mooring lines to be let go. When he heard this he conned the *Aratere* towards a position that was the normal end of sea passage waypoint position when arriving in Wellington from Picton.

1.1.4 As the *Arahura* cleared the ferry terminal and moved parallel to Aotea Quay, the master of the *Aratere* having gained a position close to the ferry terminal commenced his berthing manoeuvre. As the master was manoeuvring the *Aratere* and looking aft, he glanced forward and saw that the *Arahura* appeared to have stopped leaving him insufficient room to manoeuvre into the ferry terminal berth. Shortly afterwards the third mate, stationed aft, informed the *Aratere*'s master by UHF radio that the stern would not swing clear of the long arm of the ferry terminal.

1.1.5 The master of the *Aratere* delayed swinging the ship to prevent the stern colliding with the long arm of the ferry terminal. However, this action caused his ship to close with the vessels moored along Aotea Quay.

1.1.6 At about 2100, seeing that the bow of the ship was closing dangerously with the moored vessels, the master of the *Aratere*, manoeuvred the ship in an attempt to stop it colliding with the moored vessels. However before his actions had time to take effect, the ship collided with the fishing vessel *San Domenico* that was moored alongside Aotea Quay.

1.1.7 The *San Domenico* was moored port side to the quay at about berth No. 5. On board the 3 crew were transferring the fishing long line from a reel on the vessel to a reel on the quay.

1.1.8 As the *Aratere* approached, the crew of the *San Domenico* were in the wheelhouse monitoring the foredeck of the vessel and the quay. One of the crew looked up and saw the bow of the *Aratere* about to collide with the side of the *San Domenico*. He shouted a warning to the other crewmembers, and they all vacated the wheelhouse.

1.1.9 The bulbous bow of *Aratere* struck the *San Domenico* below the waterline, causing the port side of the *San Domenico* to rise up on the wharf piles before rolling back upright as the bulbous bow continued through the vessel. The force of the movement caused one of the crewmembers to lose his footing and fall to the lower deck, but all 3 managed to scramble ashore.

1.1.10 In attempting to avoid collision, the master had put the *Aratere's* engines to full astern. The astern movement slowly took effect and the ship began to back away and pull clear of the *San Domenico*. As the *Aratere* pulled clear and swung to starboard the flare of the bow made momentary contact with the bow of the *San Liberatore* a fishing vessel moored ahead of the *San Domenico.* This contact was seen and felt by witnesses on the *San Liberatore*. The master of the *Aratere* then proceeded to manoeuvre the ferry stern first into the berth at RFT2.

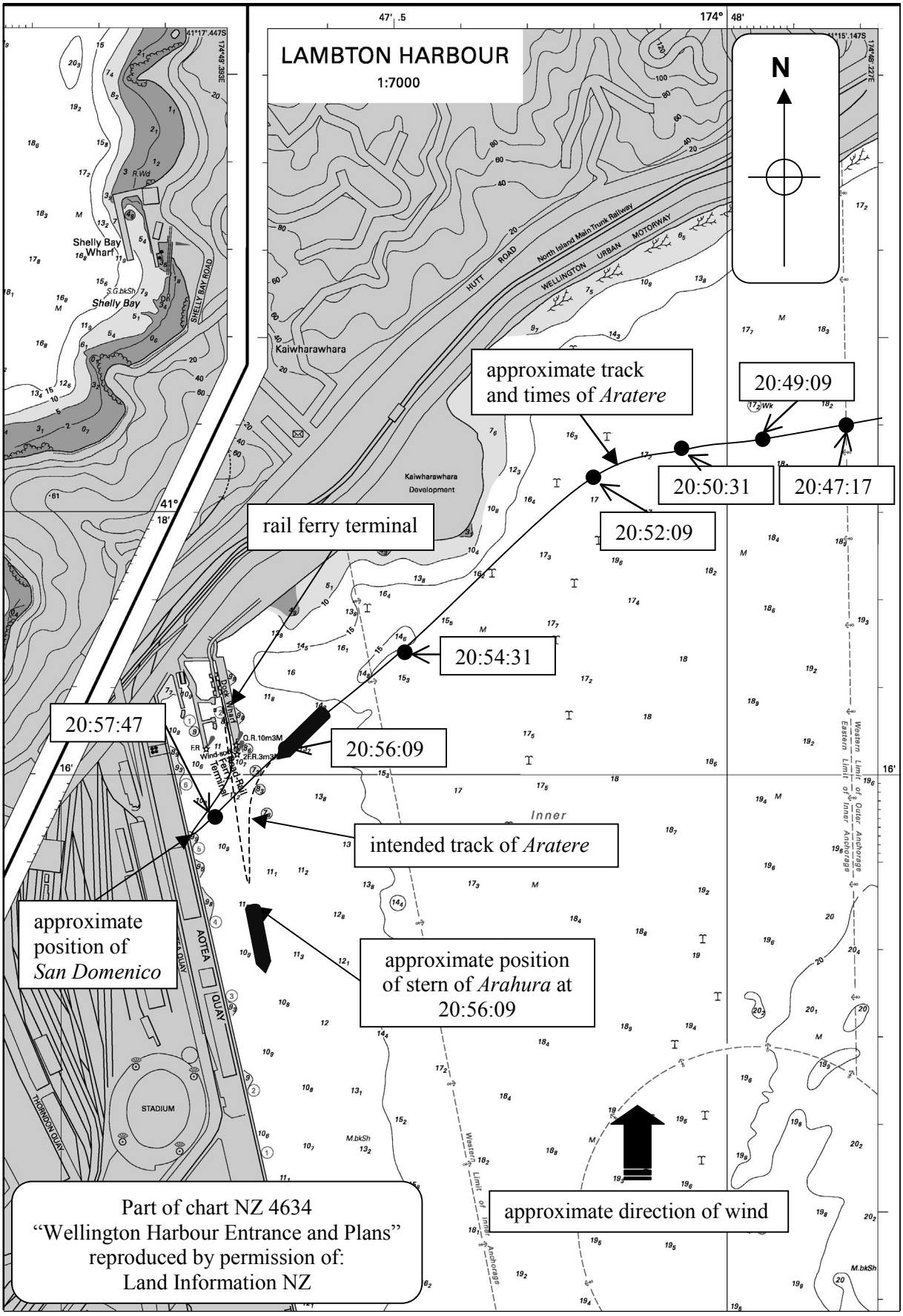


Figure 1
Approximate track of *Aratere* prior to collision

1.1.11 Once the collision had occurred, the master of the *Aratere* ordered the second mate, the other member of the bridge team, to contact the ferry terminal's duty manager on the operators' working radio channel and request her to contact the emergency services and Wellington Harbour Radio and arrange for them to attend the fishing vessel at Aotea Quay.

1.1.12 One of the crew of the *San Domenico* went to the *San Liberatore* to get assistance. Some of the crew of the *San Liberatore* went to the *San Domenico* to help; while another crewmember radioed Beacon Hill, Wellington Harbour Radio, to advise that the *San Domenico* was leaking diesel fuel into the harbour.

1.1.13 The Police and Fire Service attended the scene of the collision under the guidance of the regional harbourmaster. The Police took one of the *San Domenico's* crew to hospital for a check up but he was not detained. The Fire Service pumped out the *San Domenico* until the vessel's own pumps could cope with the ingress of water. The Fire Service then stood by the vessel until the morning. The regional harbourmaster and staff monitored the significant oil spill in the harbour caused by the collision.

1.2 Berthing manoeuvre, berths, arrangements and Bridge Resource Management

1.2.1 RFT2 was a purpose built ro-ro berth with a link span fitted at the inner end. Dock Wharf referred to as the 'Long Arm', was approximately 212 m long, with a link span protruding 68 m from near the root of the wharf. There was a clear water width of approximately 133 m between Dock Wharf and Aotea Quay (see Figure 2).

1.2.2 Between the Long Arm and Aotea Quay a smaller wharf, referred to as the 'Short Arm', extended into the harbour a distance of about 180 m. This wharf had 2 smaller jetties extending from it towards Dock Wharf, which provided the other side of the berthing facility for the rail ferries. A second berth, rail ferry terminal 1 (RFT1) was located between the Short Arm and Aotea Quay (see Figure 2).

1.2.3 Aotea Quay was one of the main commercial wharves in Wellington Harbour; it was about 1115 m long and stretched from the root of the wharf adjacent to the rail ferry terminal to the juncture with Thorndon Container Wharf. The wharf was constructed with a concrete apron on wooden piling supports, and had wooden fendering along its outer face.

1.2.4 Prior to departure from RFT2 at 1815 the master of the *Aratere* had arranged for rail cargo to be loaded to increase the draught of the ship and the effectiveness of the bow thrusters. After adjustment of water ballast on board, the *Aratere* was on an even keel draught of 5.3 m.

1.2.5 The master of the *Aratere* knew that the *Aratere* would not sit well at anchor in the prevailing weather conditions so he decided to allow the ship to drift. As the *Aratere* drifted and manoeuvred in the harbour, the wind caused the ship to make leeway.

1.2.6 After the *Arahura* had berthed at RFT2, the masters of the ferries discussed which ship would go to the lay by berth at Aotea Quay and which ship would occupy the rail ferry terminal. Because the *Aratere* required a shore crane to position the gangway at Aotea Quay and still had a partial crew change to complete at 2100, the masters agreed that the *Arahura* would lay by at Aotea Quay and the *Aratere* would re-berth at RFT2.

1.2.7 The master of the *Arahura* arranged to leave the berth at about 2045 after completing cargo discharge and loading 2 rakes[2] of rail cargo to deepen the ship and assist manoeuvrability. At 2048, the master ordered the second mate to advise the *Aratere* that they were about to depart the berth. At 2050, the last mooring line was let go and the master conned the *Arahura* clear of the terminal and proceeded parallel to Aotea Quay towards his assigned berth.

[2] A number of rail wagons coupled together to form a length that will fit on a particular ship.

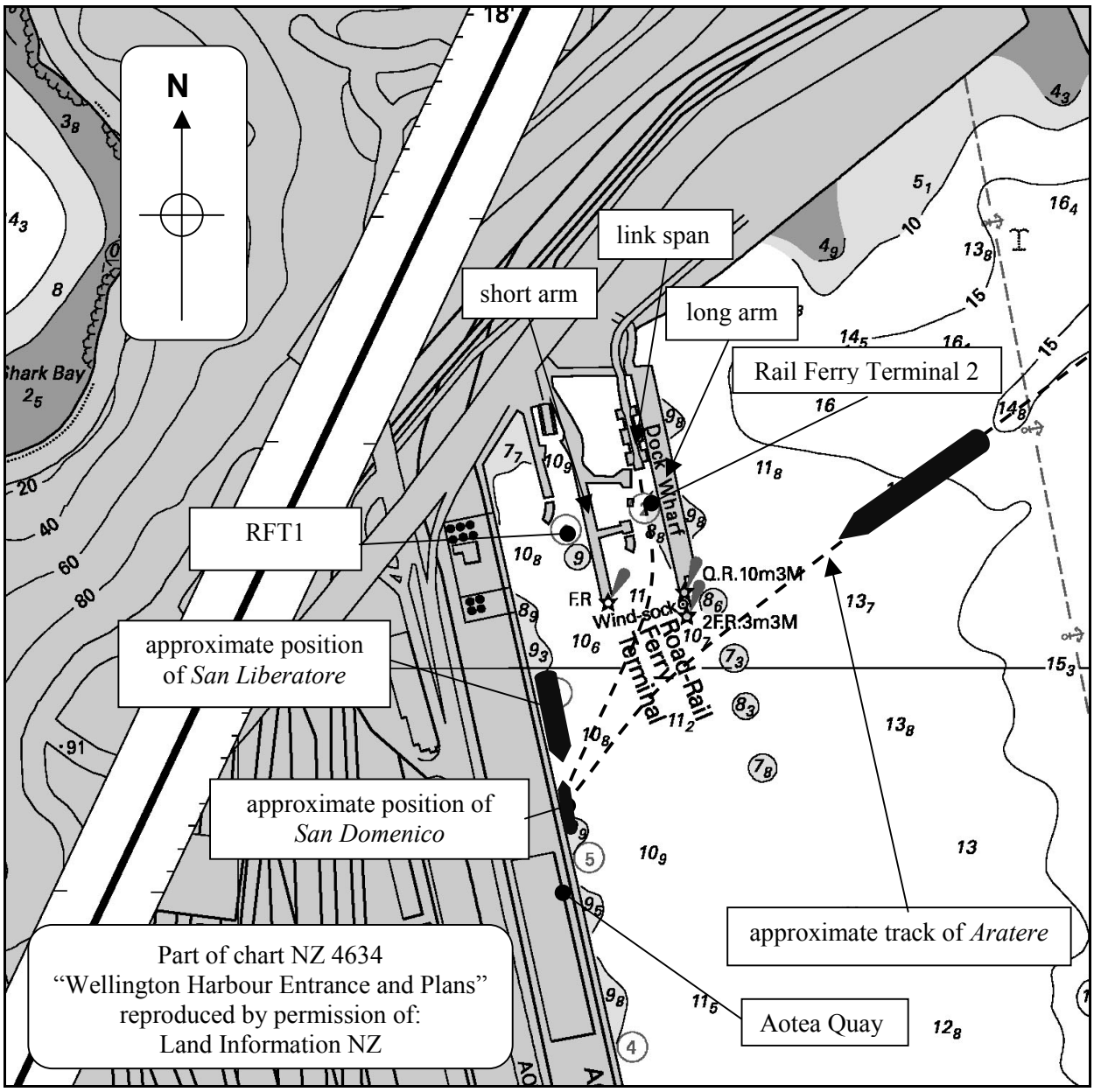


Figure 2
Plan of rail Ferry Terminal and Aotea Quay

1.2.8 Arrangements had been made that the lines gang at RFT2 who had let the *Arahura's* moorings go would help secure the *Aratere* before proceeding to Aotea Quay to re-moor the *Arahura* at its lay-by berth.

1.2.9 When the master of the *Aratere* overheard, on the UHF radio, the *Arahura* preparing to depart, his ship was positioned about 0.5 nm east of the Kaiwharawhara development. As he saw the *Arahura* begin to leave RFT2, he adjusted the course to take the ship towards a position suitable for manoeuvring stern first into RFT2.

1.2.10 As the master conned the *Aratere* towards a position close to RFT2, he ordered the bow thrusters to be started, ensured that 4 steering motors were running and rang standby on the engine telegraphs ready for berthing. Three diesel generators had been automatically engaged because the *Aratere* was in "enclosed waters mode".

1.2.11 The master was conning the *Aratere* from the starboard wheelhouse console. As the ship approached a position close to RFT2, it was on a more southerly heading than the master was used to. The master directed his attention aft to give him a better indication of the position of

the ship's stern relative to the ferry terminal, and to allow him to visually con the ship into the berth. Glancing forward the master saw the *Arahura* ahead on the port bow and thought that it had stopped and not left him sufficient room to manoeuvre. The master instructed the second mate to contact the *Arahura* by UHF radio and request that the ship move further away. A member of the bridge team on the *Arahura* replied, but was not fully understood on the bridge of the *Aratere.*

1.2.12 When instructed by the master, the second mate ascertained the direction of the wind by observing the windsock at the end of the Long Arm, he also contacted the *Arahura* by UHF radio and requested them to move further away. As the *Aratere* approached Aotea Quay, the second mate was looking ahead while the master was concentrating astern.

1.2.13 The voyage data recorder on the *Aratere* showed that when the ship was approaching RFT2, the clearance between it and the *Arahura* was about 0.19 nm [352 m] and holding steady (see Figure 1).

1.2.14 The master of the *Aratere* saw that his ship had been affected by leeway while approaching RFT2 and the stern of the ship was closer to the Long Arm than he had anticipated. The third officer, stationed aft, confirmed the distance of the ship to the Long Arm by UHF radio and told the master that the stern would not swing clear of the Long Arm.

1.2.15 To help keep the *Aratere's* stern away from the Long Arm the master put full thrust to starboard on both bow thrusters as the ship moved ahead. When the third officer reported that the stern was swinging clear, the master realised the bow was dangerously close to Aotea Quay and the fishing vessels moored alongside.

1.2.16 As the *Aratere* approached Aotea Quay, the second mate was keeping the master informed of the situation ahead. He noticed the master adjusting the control settings but did not register exactly what the master was doing. The second mate said later that he felt confident in challenging the master as and when he felt it necessary to do so. However, he was happy with what was happening and did not think there was any need for him to challenge the master.

1.2.17 Endeavouring to swing the ship parallel to Aotea Quay, the master put the helm hard to port and increased both engine settings to slow ahead. He also put both bow thrusters to full thrust to port. Shortly afterwards the master realised that the ship was not swinging fast enough to prevent a collision and put the main engine controls to full astern.

1.2.18 Before the engines had time to react, the bow of the *Aratere* collided with the starboard side of the *San Domenico*. The bulbous bow of the *Aratere* piercing the fishing vessel's hull, and the flare of the bow damaging the foremast. As the engines began to take effect, the *Aratere* moved astern. The bow disengaged from the *San Domenico* and swung to starboard, grazing the bow of the *San Liberatore.* The master subsequently manoeuvred the ship, using a combination of engines, helm and bow thrusters, astern into the berth at RFT2.

1.3 Ships and equipment information

1.3.1 The *Aratere* was a passenger and freight ferry operated by The Interisland Line, a division of Tranz Rail (the operator). The ship was certified to carry a total of 399 persons and was capable of carrying both rail and vehicular cargo. The *Aratere* was in class with Det Norske Veritas and was built in Spain in 1998. The ship traded on a scheduled service between Wellington and Picton with a service speed of 19.5 kts.

1.3.2 The *Aratere* was powered by up to 4 diesel driven DC generators that provided electrical power as required, via frequency converters, to 4 AC electric propulsion motors; 2 to each shaft. The 2 electrical motors on each shaft drove a fixed-pitch propeller through a reduction gearbox. The maximum power rating of the propelling machinery was 10 400 kW.

1.3.3 To provide astern movement, the fixed-pitch propellers had to rotate in the opposite direction to that required for ahead movement. The physical constraints of stopping the motors, gearbox and propeller and then reversing their direction, caused a delay of 12 to 15 seconds between altering the control on the bridge and the action being accomplished.

1.3.4 Steering was provided by 2 rudders, one aft of each propeller. The rudders could be used either linked, where both rudders moved in the same direction to the same degree, or independently, where the operator controlled the direction and the degree of each rudder independently. In this case the master was using the rudders linked. In addition the *Aratere* had 2 bow thrusters each with a maximum power rating of 1000 kW, equivalent to 18 tonnes bollard pull each.

1.3.5 The navigating bridge of the *Aratere* was fitted with 3 manoeuvring consoles, the main console located in the centre of the wheelhouse and one each located at the port and starboard extremities of the wheelhouse. All the consoles had controls for the bow thrusters, engine, steering, telephone communications, VHF radio communications, searchlights, screen wipers and an electronic chart display and information system (ECDIS). The ship was also fitted with 2 ARPA radars that could be linked into the ECDIS system. Readout of the wind direction, velocity and the ship's rate of turn were also fitted.

1.3.6 When in "docking mode", the ECDIS system graphically displayed a position of the ship overlaid on a large scale chart, the revolutions for the engines and bow thrusters, rudder indicators and readouts for the ship's position, wind velocity and direction (true and relative), direction and speed of the ship and sideways movement (see Figure 3).

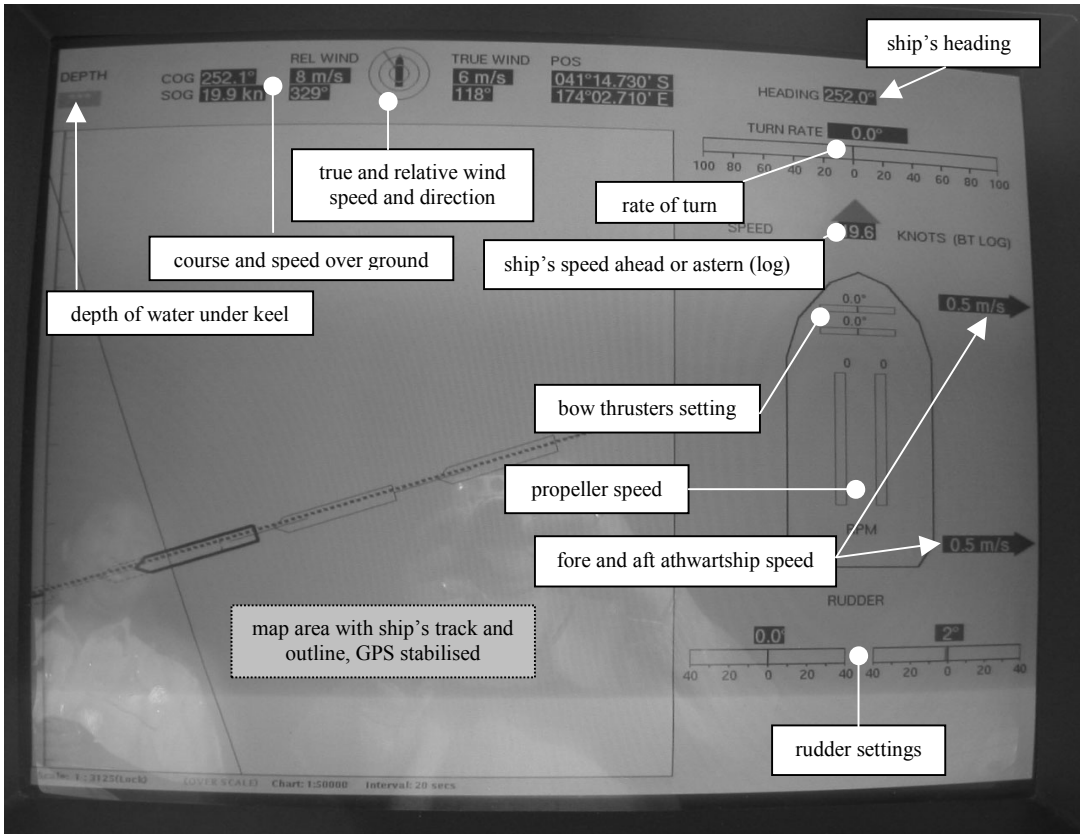


Figure 3
ECDIS display in docking mode, showing information available

1.3.7 The *San Domenico* was built in Japan in 1980. It had a glass reinforced plastic (GRP) hull and was used by its current owners as a tuna long line fishing vessel. It was 35.5 m long and powered by a diesel engine producing 485 kW that drove a single fixed pitch propeller. The *San Domenico* had berthed port side to the quay at No. 5 berth Aotea Quay on Friday 4 July 2003.

1.4 Personnel

1.4.1 The master of the *Aratere* had started his seagoing career in 1960 in the United Kingdom and gained his United Kingdom Master Foreign Going certificate in 1971. After several periods of shore employment interspersed with seagoing employment he re-validated his certificate in Australia and commenced employment with a New Zealand coastal shipping company in 1995. He joined The Interisland Line in 1999 as a third mate rising over the years to first mate/relieving master in 2001, the position he held at the time of the incident. The master had attended a Bridge Resource Management course. He had sailed on the *Aratere* for the previous 3 years and held pilotage exemption certificates for Wellington and Picton.

1.4.2 He had acted as relieving master on 10 occasions, prior to his joining the *Aratere* on 3 July 2003 as detailed below:

Date	Number of duties	cumulative No. of duties
30/08/2001	7 nights	7
13/09/2001	3 days	10
27/09/2001	7 nights	17
22/11/2001	7 nights	24
03/01/2002	7 nights	31
17/01/2002	7 nights	38
20/06/2002	7 nights	45
18/07/2002	7 nights	52
13/03/2003	7 nights	59
27/03/2003	7 nights	66

Under Maritime Rules Part 90.13, to maintain the currency of his pilotage exemptions, he was required to pilot his ship at least once inward and outward in a period of one year.

1.4.3 Prior to the collision, the master had the following work pattern leading up to his roster as night master on Thursday 3 July 2003:

- joined as first mate on Thursday 5 June for 7 days
- off from Thursday 12 June for 7 days
- joined as first mate on Thursday 19 June for 7 days
- off from Thursday 26 June for 7 days
- joined as night master on Thursday 3 July for 7 days.

1.4.4 The master's sleep and duty history immediately prior to the accident is summarised in Figure 4. It should be noted that he was working a 12 hour on duty followed by a 12 hour off duty shift system: The accuracy of the sleep information is inherently limited by the fact that subjective reports of sleep duration and timing are not necessarily reliable, and by the fact that the accident had intervened between the sleep episodes and when they were being recalled.

1.4.5 The second mate of the *Aratere* had started his seagoing career in New Zealand during the 1960's and after a period working ashore in the 1970's, he resumed his career at sea. He had been employed by The Interisland Line for the previous 8 years and had mainly served as second mate on the *Aratere* since its arrival in New Zealand in 1999. He held a First Mate Foreign Going certificate issued in New Zealand. The second mate had attended a one day Bridge Resource Management course at Auckland Maritime School in 2001 as part of his certificate revalidation.

1.4.6 The third officer of the *Aratere* had started his seagoing career in about 1973 and had served on ships of several nationalities. He held a Chief Mate No Limitations certificate issued in the United Kingdom. He had served on the *Aratere* for about 3 years prior to the accident. The third officer had attended a Bridge Resource Management course.

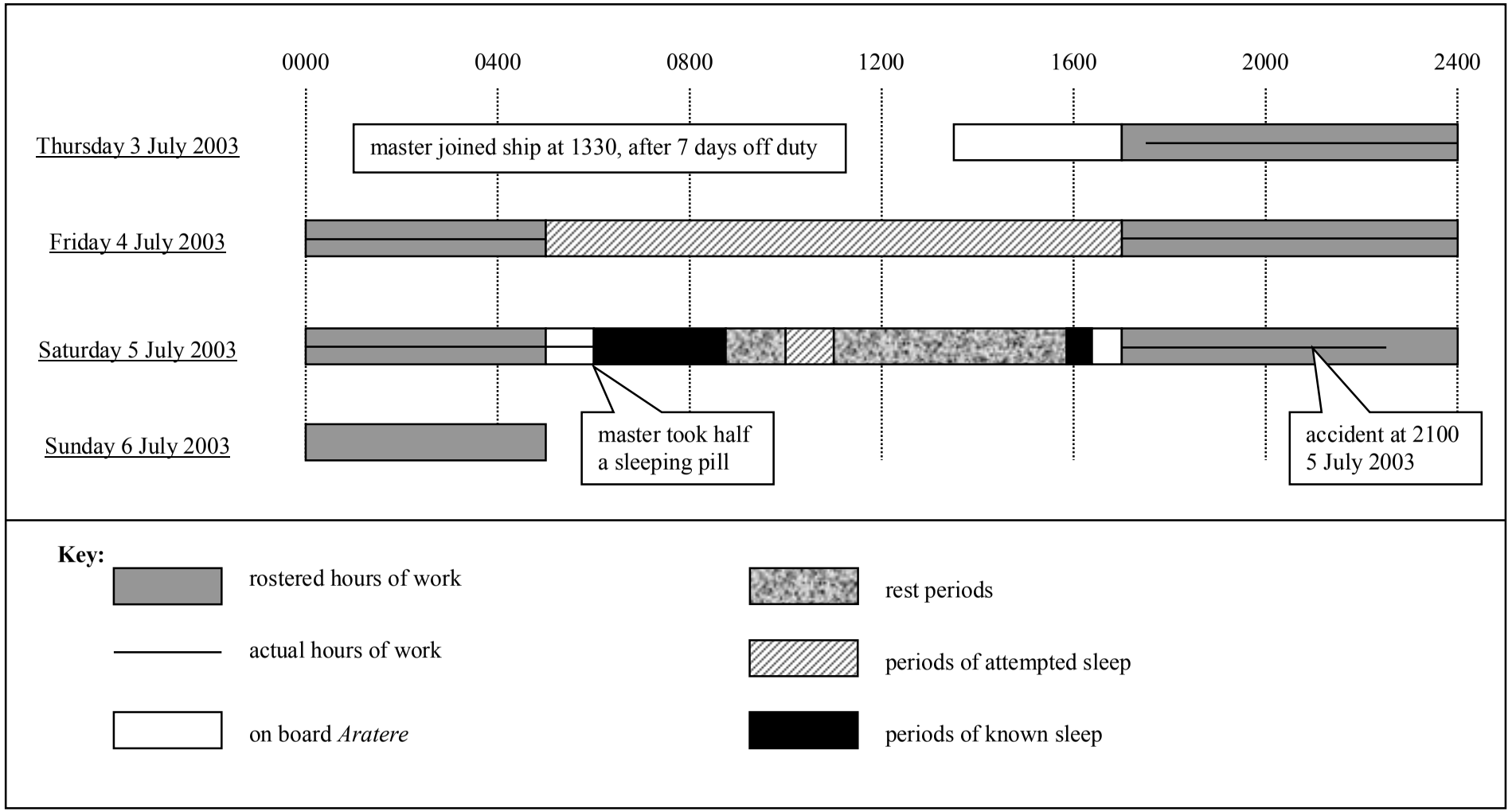
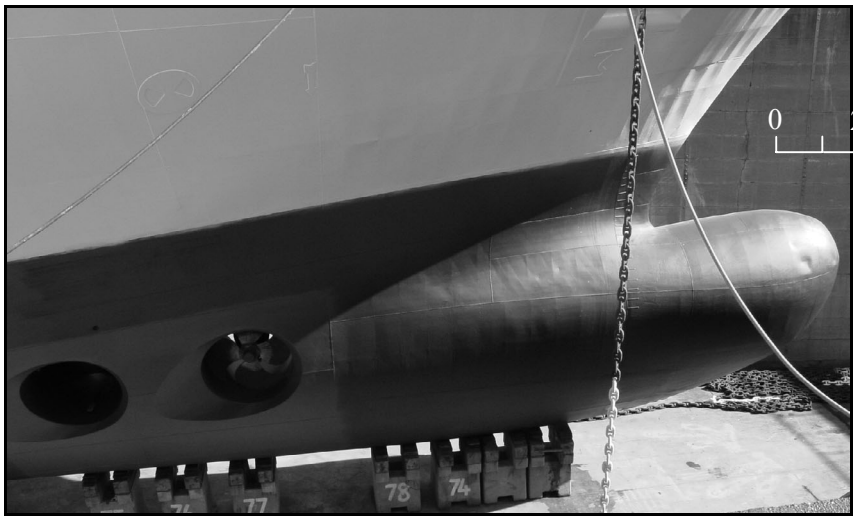


Figure 4
Master's sleep wake information

1.4.7 The crew of the *Aratere* comprised of live-aboard crew and walk-on crew who joined the ship for their particular shift and left again at the end of their shift. The master, night master, first mate, second mate, chief engineer, second engineer, 3 watch keeping engineers and the boatswain all lived on board for their respective duty periods. The remainder of the crew, approximately 20, were walk-on crew.

1.4.8 The 3 deckhands on the fishing vessel had sailed as fishing deckhands for varying numbers of years.

1.5 Damage



(Photo courtesy of The Interisland Line)

Figure 5
***Aratere*'s forefoot showing the bulbous bow and 2 bow thruster tunnels**

1.5.1 The *San Domenico* suffered extensive damage. Damage to the hull consisted mainly of a 3 m diameter hole in the starboard side extending from just above the waterline to keel level, and an 8 m long split to the bilge hard chine on the port side with other splits spreading out from it. A section of wooden wharf pile was embedded into the port side of the hull aft of the split and sections of the bilge keel had been ripped off. Additionally the foremast was severely bent towards the port side. The damage was such that the *San Domenico* was declared a constructive total loss and broken up.

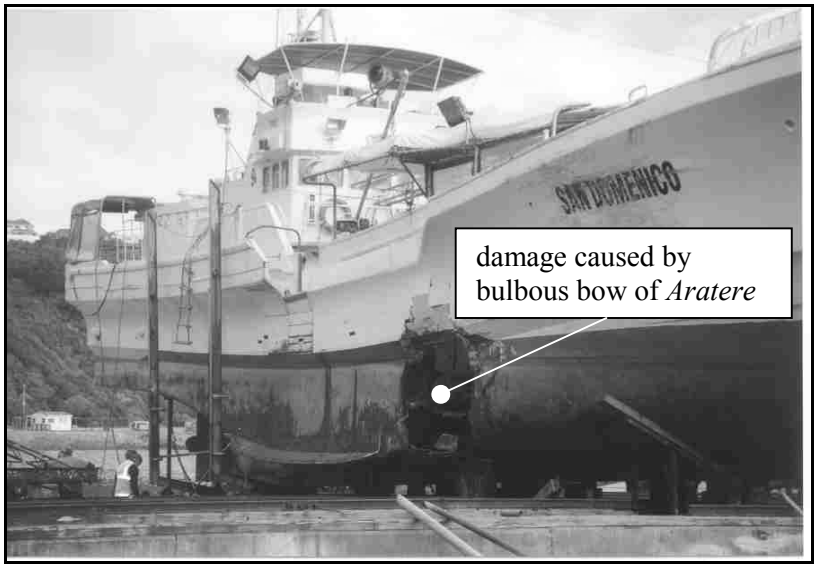


Figure 6
The *San Domenico* showing damage to the starboard side of the hull

1.5.2 The *San Liberatore* suffered minor damage to the hull paintwork only.

1.5.3 The *Aratere* suffered damage to the hull paintwork only.

1.5.4 Aotea Quay suffered damage to the quay pilings and facings.

1.6 Climatic conditions

1.6.1 The weather recorded at Beacon Hill signal station, situated on the western side of the entrance to Wellington Harbour, was as follows:

Time	Wind		Weather
	Speed	Direction	
2045	25 – 55 kts	150º	Overcast with heavy rain/sleet/hail
2100	25 – 60 kts	160º	
2115	25 – 45 kts	200º	

During the above period, the signal station experienced wind gusts in excess of 70 kts.

1.6.2 The adverse weather conditions in the harbour may have differed to those observed above but various reports confirm that severe winds and gusts were experienced throughout the afternoon and while the *Aratere* was re-berthing.

1.6.3 The weather conditions were more severe than the master of the *Aratere* had experienced previously while berthing the ship, although he had berthed the ship in moderately bad weather before.

1.6.4 The range of tide, as tabulated in the New Zealand Nautical Almanac, for Wellington gave a spring range of 1.02 m and a neap range of 0.90 m. The predicted tide for Wellington as detailed in the New Zealand Nautical Almanac for 5/6 July 2003, was:

Low Water		High Water		Low Water	
1508	0.6 m	2121	1.6 m	0348	0.6 m

The predicted range was 1.0 m, and therefore a spring tide.

1.7 Medical information

1.7.1 The operator had in place a health and safety programme, a part of which was an Employee Assistance Programme (EAP). The EAP was a confidential self or company referral programme for personal problems, available to all employees of Tranz Rail. The operator had also conducted a series of voluntary courses on "Alertness Management in Ferry Operations", developed by Professor Phillipa Gander in 1998, which was prior to the master being employed by The Interisland Line. Professor Gander also carried out, on behalf of the operator and in conjunction with the NZ Merchant Service Guild, a survey of fatigue and shift work among masters and mates.

1.7.2 Under the operator's conditions of employment there was no requirement for the master and officers to report openly to the operator that they were taking regular prescribed medication or suffering from a condition that may affect their work performance.

1.7.3 The master stated that during his work period on board, he'd had trouble sleeping for any length of time and often felt and looked fatigued when starting his shift. He also stated that his sleep patterns during leave periods were interrupted and he had trouble adjusting his sleep patterns

between his leave and work periods. The master, in consultation with his wife, thought that he might be suffering from sleep apnoea[3].

1.7.4 From literature that accompanied the final report on the survey of fatigue and shift work among masters and mates, the master remembered seeing a note to contact The Interisland Line medical consultant if he thought he had a sleep problem

1.7.5 The master used the EAP programme in September 2002 and at a meeting with the operations manager at that time the master informed the operations manager that he was on medication and attending the EAP programme.

1.7.6 At the end of April 2003, while serving as first mate, the master contacted The Interisland Line medical consultant directly about his sleep problem. The medical consultant referred the master to a sleep clinic, which the master was due to attend on 15 July 2003. Because of confidentiality provisions, the medical consultant did not mention the master's problem to The Interisland Line operations manager. However, in a meeting at the end of May 2003 with the operations manager, after seeing the medical consultant, the master mentioned that he had seen the company medical consultant and was to attend the sleep clinic.

1.7.7 Under Maritime Rules Part 34.7 (1) the master was required to hold a current medical certificate before he joined or began employment on board a ship.

1.7.8 The master had a current medical certificate issued by a Maritime Safety Authority approved medical practitioner in October 2002. During the medical examination for the certificate he made full disclosure of all medications and medical conditions prevailing at the time. He was issued with an unrestricted sea going certificate by the Maritime Safety Authority.

1.7.9 The master had been prescribed, by his own doctor, medication for depression in August/September 2002 to which he had adverse side effects. The medication was changed in January 2003 for one which had insomnia as a common side effect, and later his doctor had reluctantly prescribed sleeping tablets.

1.8 Human Factors

1.8.1 Stress, attention and workload are 3 related factors that affect human performance. Stress is the body's response to stressors. Attention is the ability to focus one's mind on information providers or senses. The mind has a limitation on the amount of information that can be absorbed and processed at any one time; consequently attention may be channelled to what is perceived as important or relevant to the exclusion of other information. Workload is the amount of work that an individual is required to do at any one time.

1.8.2 When the demands of certain tasks approach or exceed the capability of an operator, stress develops; this is termed task or acute stress. One of the primary outcomes of this type of stress is that the person starts to load-shed and focuses on one or more tasks to the exclusion of others. An extreme form of load-shedding results in channelled attention where an individual gives all their attention to one aspect of the situation only. Load shedding and channelled attention are primary symptoms of poor situational awareness, preventing an operator from forming an accurate overall mental model and enabling them to take the correct action to recover from an unexpected situation.

1.8.3 When an unexpected event occurs, an individual's workload suddenly increases as they react to the situation. The effect of this sudden increase in workload can be minimised by having practised contingency plans in place, thus saving the need to go through the involved cognitive process of forming a plan, evaluating whether it would be successful and then implementing it. Contingency planning reduces an individual's workload and the likelihood of load-shedding.

[3] Sleep Apnoea correctly known as obstructive sleep apnoea is a medical condition where intermittent obstruction of the upper airways during sleep leads to repeated sleep disturbance and excessive daytime sleepiness.

1.8.4 Humans can suffer from hazardous attitudes from which hazardous thoughts develop and affect the standard of their decision-making. These attitudes depend upon an individual's characteristic and the type of environment they are operating in. Factors that can influence decision-making are commercial pressure, peer-pressure and the corporate environment in which the decisions are made.

1.8.5 Decision-making, the assimilation of information before an action is carried out, can be separated into 2 basic types: analytical and intuitive. Analytical decisions are knowledge-based and primarily made by someone who is competent but not particularly experienced. They tend to be slower and take a large proportion of the available cognitive processes, leaving less time for other tasks. Intuitive decisions are skill-based and are based on experience gained over many years. They are rapid and take less of the available cognitive processes but they are susceptible to biases, which may result in an incorrect decision being made.

1.9 Fatigue

1.9.1 Professor Philippa Gander PhD, an internationally recognised sleep and fatigue management expert was engaged by the Commission to assist in the area of fatigue considerations associated with this investigation. Particular parts of her opinion, which are relevant to this investigation, follow.

1.9.2 The method followed was derived from a method developed by the US National Transportation Safety Board and the NASA Fatigue Countermeasures Program. It focuses on the physiological factors known to cause fatigue-related impairment, and their likely impact on the behaviour of key personnel involved in an accident.

1.9.3 Performance capacity waxes and wanes across the daily cycle of the circadian body clock. There is clear evidence, from laboratory studies, workplace studies, and incidents and accidents in a variety of industries, that the early hours of the morning are when people are most prone to falling asleep inadvertently, and when cognitive processing and reaction times are slowest.

1.9.4 The collision occurred around 2100. This corresponds to time in the cycle of the circadian body clock when the biological tendency to fall asleep is beginning to increase, in preparation for (nocturnal) sleep.

1.9.5 Laboratory studies consistently show that biological sleepiness increases the longer a person stays awake[4].

1.9.6 To be alert and able to function well, each person requires a specific amount of nightly sleep. If individual "sleep need" is not met, the consequences are increased biological sleepiness, reduced alertness, and impaired physical and mental performance.

1.9.7 For most people, getting 2 hours less sleep than they need on one night (an acute sleep loss of 2 hours) is enough to cause measurable impairment of performance and alertness the next day. The reduction in performance capacity is particularly marked if less than about 5 hours sleep is obtained.

1.9.8 The effects of several nights of reduced sleep accumulate into a "sleep debt", with sleepiness and performance becoming progressively worse. Recovery sleep after an accumulated sleep debt is usually deeper and more efficient, and the lost hours of sleep do not need to be recovered hour for hour. It typically takes at least 2 full nights for sleep and daytime functioning to return to normal after sleep loss.

1.9.9 The master considered 7 hours adequate for a good night's sleep. He also said that he could manage on 6 hours a night, and that 8 hours a night "would be magic".

[4] The increase in biological sleepiness associated with increasing time awake is superimposed on the rises and falls in sleepiness associated with the cycle of the circadian biological clock.

1.9.10 The restorative value of sleep, in terms of reducing biological sleepiness and improving subsequent waking function, depends not only on the amount of sleep obtained but also on its quality. Sleep that is restless and fragmented by frequent awakenings also leaves a person sleepy and at increased risk of impaired alertness and performance. There are a large number of recognised disorders that can disrupt the quality of sleep.

1.9.11 Regarding the master's health and sleep problems, Professor Gander had access to correspondence from the Medical Consultant for The Interisland Line, and a Respiratory Physician who the master had been referred to at a sleep clinic. This correspondence conveys specialist medical opinion that the master was experiencing chronic sleep difficulties that were having an impact on his waking function.

1.9.12 The Interisland Line medical consultant commented in his referral letter to the sleep clinic that:

> There are no particular safety concerns in regard to work, but I am concerned about his driving to and from the Kapiti Coast [about 50 kms from Wellington]. He has had to pull off the road on one or two occasions.

Whether this comment was the opinion of the medical consultant or was attributable to the master of the *Aratere* could not be verified.

1.9.13 A recent review by Y. Harrison and J.A. Horne[5] of the impact of sleep deprivation on decision-making concluded that the behaviours most likely to be affected by sleep deprivation include:

> flexibility of thinking, avoidance of distraction, risk assessment, awareness for what is feasible, appreciation of one's own strengths and weaknesses at that current time, (meta-memory), and ability to communicate effectively.

1.9.14 Professor Gander made the following observations on the suitability of roster change:

- Roster change is only one of a variety of possible fatigue management strategies that can be considered in ferry operations.
- Roster change can involve major reorganisation, both on board and potentially at home.
- In my view, roster change should only be undertaken to correct identified problems that are roster-related. There should be specific goals, in terms of improvements, for the new roster, and the extent to which they are achieved should be assessed.
- Active workforce participation in this process is critical to its acceptance and success.
- There is no perfect roster for 24-hour operations and each person in the workforce is affected differently, as each officer brings a unique combination of skills, experience, and life circumstances to the workplace.

1.10 Sleep Laboratory results

1.10.1 The Master attended sessions at a sleep laboratory, the first being on 15 July 2003, 10 days after the accident. The supervising respiratory physician commented to The Interisland Line medical consultant after a successful polysomnography[6] study was carried out on 24 July 2003, as follows:

- I have reassured [the master] that he doesn't have obstructive sleep apnoea syndrome and explained that shift work combined possibly with the use of Aropax is the main reason for the deterioration in sleep

[5] "The impact of sleep deprivation on decision making: a review". *Journal of Experimental Psychology: Applied 6*, 2000, pp.236-249

[6] Polysomnography is a diagnostic test during which a number of physiologic variables are measured and recorded during sleep

quality this year. On his current work schedule there has been an improvement in sleep in that he is achieving a greater total sleep duration of around 6-7 hours per 24 hours and waking feeling more refreshed. As I mentioned in my last letter, the night shift when working as ship's master relief had the greatest impact on his sleeping patterns. It is quite likely that in future this shift would be associated with a similar reduction in total sleep time and therefore increased concern regarding alertness and cognitive function. As you know, there is also a well-recognized effect of age on ability to cope with shift work. I have suggested that he see you to discuss this further in terms of planning future work schedules. In the meantime, I have recommended that he avoid the night shift as ship's master.

2 Analysis

2.1 As soon as the master of the *Aratere* overheard on the radio that the *Arahura* had let go lines at RFT2, he commenced conning his vessel towards the berth. In such adverse weather conditions it would have been prudent for him to have waited until the *Arahura* was well clear before commencing his approach.

2.2 The range of tide and the amount of tidal current in Wellington Harbour is unlikely to have had any appreciable effect on *Aratere* during the evening of 5 July 2003.

2.3 The master of the *Aratere* may have been sub-consciously concerned about the following whilst in the process of undertaking his berthing manoeuvre:

- relieving his 'walk on-walk off' crew at the usual time of 2100
- the fact that the Arahura would have been unable to securely moor until he had finished with and dispatched the lines gang to Aotea Quay.

These concerns could have caused him to put himself under pressure to complete the manoeuvre as soon as possible and to suffer from hazardous thoughts.

2.4 Bridge Resource Management (BRM) training emphasises the need to recognise "hazardous thoughts" and replace them with opposite "safe thoughts". Four hazardous thoughts and their opposite safe thoughts, as used in Bridge Resource Management concepts, were relevant to the master of *Aratere* when he approached RFT2 berth to commence his berthing manoeuvre.

Hazardous Thought	Safe Thought
It won't happen to me	It could happen to me
I can do it	Why take chances
We've always done it this way	Then it's about time we changed
Do something quickly	Not so fast, think

2.5 The master would have suffered anxiety when he glanced forward and saw the *Arahura* closer than he had anticipated. His workload suddenly increased as he tried to initiate strategies to assist him in completing his manoeuvre whilst avoiding a collision.

2.6 The ECDIS system, as fitted to the *Aratere,* gave a wealth of information to the person conning the ship in an easily understandable graphical format. However, the master approaching his chosen position from an unusual direction in poor weather conditions was as usual conning the vessel more by eye than by observing the ECDIS system; and may not have noticed the amount of leeway the ship was experiencing. As it was an unusual situation for this master, his workload would have increased placing him under stress and possibly causing him to channel his attention and therefore ignoring some of the information that was available to assist him.

2.7 When the master was faced with the unexpected event of being too close to the Long Arm, he further channelled his attention into manoeuvring to avoid it. Consequently his situational awareness decreased and he would have been unable to form an accurate mental model, possibly to the extent that he would have been unaware of the *San Domenico* ahead of him.

2.8 The master in delaying his manoeuvre to swing the *Aratere* into RFT2 gave him more room astern and although using the thrusters prevented the stern colliding with the Long Arm, it placed the ship in the invidious position of being too close to Aotea Quay and the fishing vessels tied up alongside. In avoiding the collision with the Long Arm, the master placed himself in a situation of having to solve the more complicated problem of avoiding a collision with the fishing vessels. The time available to the master to formulate a plan to avoid the vessels was minimal and his workload would have increased dramatically, further increasing the stress that he was under.

2.9 The master's initial attempt to avoid collision by turning the ship to port to parallel Aotea Quay in the limited space available was beyond the manoeuvring capabilities of the ship. The subsequent attempt to avoid a collision by putting the engines astern did not allow sufficient time for the engines to stop the forward motion of the ship.

2.10 In instructing the second officer to contact the duty manager at The Interisland Line terminal to arrange for the emergency services after the collision, the master was able to concentrate on his actions. However, it may well have been prudent for the master to have instructed the second officer to have contacted Wellington Harbour Radio on the designated working channel. This would have reduced the possibility of miscommunication and may have provided a quicker response as the Harbour Radio operators are prepared to accept this type of call. On an open radio channel any other vessels in the vicinity monitoring the channel would have been warned of the situation and could have provided assistance if required.

2.11 The master had served on the *Aratere* for a considerable time as third, second and first mate. However, he had only served intermittently as first mate/relieving master. In the time that he had acted as relieving master he had successfully berthed the *Aratere* in Wellington and Picton on numerous occasions without incident but never in the weather conditions that were prevailing at the time of the collision. Although competent at berthing the *Aratere,* the master would not be considered as experienced as a long serving full-time master, so his decision-making would be more analytical than intuitive and thus slower than a more experienced master.

2.12 Due to the intermittent nature of carrying out the duties of relief master prior to his duty period that included the accident, the master had not served as master on board the *Aratere* since the end of March 2003, some 3 months prior. He would have been less familiar with carrying out the berthing manoeuvre than a full time master. However, the number of times that he had carried out the pilotage and berthing manoeuvre was far in excess of the statutory requirement to maintain the currency of his pilotage exemption certificate.

2.13 Bridge Resource Management also emphasises the need for challenge and response between members of the bridge team. The second mate was basically following the principles of Bridge Resource Management in working in a team environment, keeping the master informed of what was happening in front of the ship while the master was concentrating on the after part.

2.14 The master had also indicated to the second mate what his berthing manoeuvre was going to be. For the second mate to be in a position to challenge the master, the master would need to continually verbalise his control actions. Verbalising his actions may not have slowed the master's speed of response as he was working in analytical mode. However, for more experienced masters who were working in intuitive mode, having to verbalise their actions may have slowed their decision-making processes to the detriment of the berthing manoeuvre.

2.15 Properly formulated contingency planning, either mental or physical, discussed with other members of the bridge team prior to the berthing evolution, for possible scenarios would have

reduced the master's workload and reduced the likelihood of load shedding. The master did not appear to have a properly formulated contingency plan if the ship was unable to berth at RFT2, rather he reacted to each situation as it unfolded.

2.16 The concerns raised about the master having to pull off the road on occasion while driving home from Wellington to the Kapiti Coast because of fatigue were appropriate. Taking a break is recognised as a defence to counteract the dangers of driving while fatigued. However, at these times, the then first mate had just finished a tour of duty on the ferry in the safety critical role of keeping a navigational watch with up to 399 persons on board, and was probably suffering the same fatigue while doing so. The concerns about his driving while fatigued would have been equally appropriate to his role on board, but no such concern was recorded.

2.17 While circadian rhythm related patterns of wakefulness were likely to have entered a period of declining arousal, this is unlikely to have significantly affected the master's mental performance in the period of duty when the accident occured.

2.18 The accident occurred about 4.5 hours after the end of a brief nap (perhaps 30 minutes) and about 12.25 hours since the master woke from a short sleep. Thus, extended wakefulness per se would not have been expected to contribute to his functioning at the time of the accident.

2.19 In the 24 hours prior to the accident, the master reported a total of about 3 hours sleep. Based on this, he was undoubtedly experiencing the effects of acute sleep loss at the time of the accident.

2.20 The master had been on leave for 7 days prior to joining the *Aratere* on the afternoon of Thursday 3 July. However, since he was experiencing chronic difficulties obtaining restorative sleep, it seems unlikely that he joined the ship fully rested. It is thus highly likely that the master was experiencing the cumulative effects of chronic sleep loss at the time of the accident.

2.21 Professor Gander opined that the circumstances of this accident highlight a number of structural problems with current medical surveillance of seafarers in that:

> At the general practice level, prescribing an older shift worker medication for depression that has insomnia as a common side-effect, and then treating that insomnia with hypnotics (albeit reluctantly), does not seem appropriate. It seems particularly surprising, given the highly responsible, safety critical nature of the master's work.
>
> More than two months prior to the accident, The Interisland Line medical consultant referred the master for specialist evaluation at a sleep clinic, but the master was not evaluated until after the accident. The sleep clinic alludes to difficulties scheduling the master's appointment, first due to his work patterns, and subsequently due to the respiratory physician being overseas attending a conference.
>
> With regard to the Medical Standard in Part 34 of the Maritime Rules, the complete absence of any reference to sleep disorders or difficulties associated with shift work must be considered a serious omission, particularly for an aging workforce such as the Ferry Masters and Mates.

2.22 Although the *Aratere*'*s* master made a full and open disclosure of the medications he was taking, the MSA-approved doctor appeared not to appreciate the consequences of the effects the medication may have had on the master's ability to perform his duties in a safety critical role.

3 Findings

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

3.1 Having been affected by leeway while waiting for the *Arahura* to clear the terminal, the *Aratere* was so close to the Long Arm that the master was unable to continue turning to port in preparation for berthing.

3.2 Although the master perceived that the *Arahura* was stopped, leaving him insufficient room to manoeuvre, the *Arahura* was sufficiently distant not to impede the progress of the *Aratere* and was still moving slowly ahead, keeping the distance constant.

3.3 The master halted the swing to port to clear the Long Arm, but in doing so, with the ship still travelling forward, a risk of collision with the *San Domenico* right ahead was created. The master's initial attempt to avoid collision in trying to turn the *Aratere* parallel to the moored vessels on Aotea Quay was inappropriate considering the manoeuvring characteristics of the ship and the minimal space available.

3.4 The master's subsequent attempt to avoid collision by going full astern on the engines would probably have succeeded had the action been taken in sufficient time for the ship to react to the astern movement before the bulbous bow struck the *San Domenico*.

3.5 The master of the *Aratere* did not have a suitable contingency plan to adequately cope with the situation as it developed.

3.6 The master of the *Aratere* was relatively inexperienced. His decision-making would probably have been slower than a more experienced master due to working in analytical mode as opposed to intuitive mode.

3.7 The master of the *Aratere* was most probably experiencing the cumulative effects of chronic sleep loss at the time of the accident.

3.8 The master of the *Aratere* was taking medication that possibly contributed to his chronic sleep loss at the time of the accident.

3.9 The master had made a full disclosure of his medications, but the MSA-approved doctor did not recognise the risk associated with the master's sleeping problems or medication.

3.10 The operator had in place a health and wellbeing programme. However, there was no requirement for the master to report to the operator that he was on medication that might affect his work performance, although he had done so.

3.11 Neither the operator nor the master were fully aware of the extent of the master's sleep deprivation and fatigue, and for whatever reason, an opportunity to assign him to a less safety critical position was lost.

3.12 The medical standards in the Maritime Rules Part 34 did not contain any reference to sleep disorders or difficulties associated with shift work or their effect on the safety critical actions of senior personnel.

3.13 The *Aratere* was correctly certified and manned at the time of the accident.

3.14 The *San Domenico* was correctly moored at its berth on Aotea Quay.

4 Safety Actions

4.1 After the accident Tranz Rail Limited implemented the following actions:

- issued a fleet memorandum using the accident as an educational tool by detailing the accident, highlighting lessons to be learnt and reminding others that it could happen even to them
- created and filled a further 2 master positions to provide relief when others are on leave to reduce the likelihood of first mates having to fulfill an acting master role on an as required basis. Two first mates were also identified as regular acting masters to act as backup for the two relief masters should they be required
- further developed its master training scheme to cover all aspects of the master's position. Tranz Rail was confident that the ship handling section of the training programme would meet the requirements of the Maritime Rules Part 90 Pilotage requirements
- identified all current officers who had not completed a full bridge resource management training course and ran a series of courses in February 2004, to rectify the situation
- trained 2 occupational nurses in fatigue and alertness subjects covered in the seminars run by Professor Gander in 1998. These nurses travel on each ship twice a month to help crew with medical and health issues on a confidential basis
- agreed a policy to issue all Tranz Rail sea staff a copy of the booklet "Alertness Management in Ferry Operations" before March 2004, to raise awareness across the fleet of this subject, which will be one of the themes of the occupational nurse's visits.

4.2 In view of the safety actions taken by Tranz Rail Limited, no safety recommendations have been made to the operator.

5 Safety Recommendations

Safety recommendations are listed in order of development and not in order of priority.

5.1 On 18 February 2004, the Commission recommended to the Director of Maritime Safety that he:

5.1.1 draft an amendment to Maritime Rule 34 for the Minister's consideration, to:

- provide educational material for examining medical practitioners as to the difficulties of shift work, sleep disorders, fatigue, prescribed medications, and the impact these have with seafarers, particularly those engaged in safety critical tasks (059/03)
- require medical practitioners to consider if there is evidence of any such sleep disorders or fatigue when conducting their examinations (061/03).

5.1.2 prepare educational material for employers and seafarers on the problems associated with stress, including fatigue, medical conditions and certain types of medication, and the impact this may have on the fitness for duty of those working in safety critical tasks (060/03).

5.2 On 4 March 2004, the Director of Maritime Safety replied, as follows:

5.2.1 Recommendation 059/03 and 061/03

The Maritime Safety Authority accepts these recommendations. Policy work for rule amendment will be conducted in the year 04/05, and a rule amendment, if supported by the policy work, will be drafted for the Ministers consideration in 05/06.

5.2.2 Recommendation 060/03

This recommendation is accepted by the Maritime Safety Authority. The proposed educational material will be developed in the year 04/05.

Approved for publication 25 February 2004

Hon W P Jeffries
Chief Commissioner

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