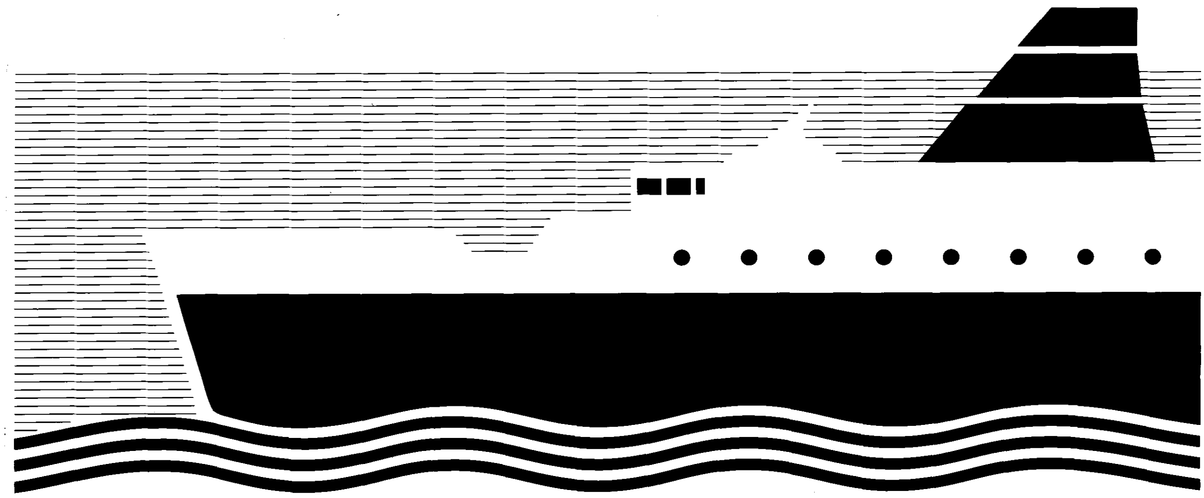
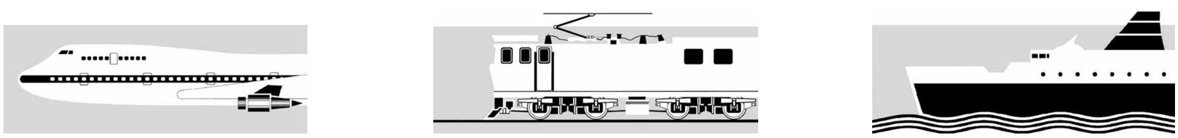


MARINE OCCURRENCE REPORT

04-213 **Restricted limits passenger ferry *Superflyte*, engine room fire, Motuihe Channel, Hauraki Gulf** **22 August 2004**



TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

TRANSPORT ACCIDENT INVESTIGATION COMMISSION
TE KOMIHANA TIROTIRO AITUA WAKA

Report 04-213

restricted limits passenger ferry *Superflyte*

engine room fire

Motuihe Channel, Hauraki Gulf

22 August 2004

Abstract

On Sunday 22 August 2004 at about 1708, the passenger ferry *Superflyte* was proceeding from Matiatia on Waiheke Island to Auckland, with 6 crew and 311 passengers on board, when a fire was discovered in the port engine room.

The master issued a distress call and all passengers were evacuated in due course to other vessels that responded to the call.

Carbon dioxide flooding was used in an attempt to extinguish the fire, but this was unsuccessful due to a fault in the system. The fire was eventually extinguished manually by the crew with assistance from the Fire Service.

Several of the passengers suffered minor abrasions and contusions during the evacuation and some suffered slight smoke inhalation. None of the passengers or crew required medical attention.

Safety issues identified included:

- the method and scope of disseminating information concerning necessary safety-critical remedial work on a specific type of engine
- the content and promulgation of instructions to be followed in case of emergency on restricted limits passenger vessels
- the need for ferry crew, as trained personnel, to provide guidance, help and support to passengers in an emergency situation
- the installation and subsequent surveys of CO_2 smothering equipment.

Safety recommendations were made to the Managing Director of Fullers Group Limited, the Managing Director of Dunsford Marine Limited, the Managing Director of Deutz AG, Germany, and the Director of Maritime Safety to address these issues.

The *Superflyte* alongside at Auckland

Contents

Figures

Abbreviations

° C	degrees Celsius
CCTV	closed circuit television
CO_2	carbon dioxide
Coastguard	Royal New Zealand Coastguard Federation
kg	kilogram(s)
kt	knot(s)
kW	kilowatt(s)
m	metre(s)
Metservice	New Zealand Meteorological Service
mm	millimetres
MPa	mega Pascal(s)
MSA	Maritime Safety Authority of New Zealand
N	newtons
nm	nanometre
POD	pressure-operated direction (valve)
Police	New Zealand Police
SEM	scanning electron microscope
SOLAS	International Convention for Safety of Life at Sea
t	tonne(s)
UHF	ultra high frequency
UTC	co-ordinated universal time
VHF	very high frequency

Glossary

auto ignition temperature	the temperature at which a gas or vapour can explode or burst into flames with no other source of ignition
bowsed	pulled in to the side and secured
catamaran	a twin-hulled vessel
conning	directing the course of the vessel
deckhead	nautical term for a ceiling
distress call	a verbal radio call used to indicate that a ship or aircraft or person is threatened by grave and imminent danger and requires immediate assistance
fatigue limit	the maximum value of the applied alternating stress which a test piece can stand indefinitely
flash point	the lowest temperature at which a liquid gives off enough flammable vapour to ignite and produce a flame when an ignition source is present
grade 10.9 fastener	a steel fastener with a material strength of 1040 N/mm^2
gross tonnage	a measure of the internal capacity of a ship; enclosed spaces are measured in cubic metres and the tonnage derived by formula
martensite	the chief constituent of hardened steel
neap tide	tidal undulation that has the highest low water, and lowest high water, in a series
optical emission spectroscopy	measurement of spectra emitted by atoms and ions with optical transitions in the wavelength range from about 100 nm to 900 nm. This range includes the ultraviolet and visible light (from violet at 380 nm to red at 760 nm), and the near infrared
port	left-hand side of a ship when looking forward
ratchet marks	short ridges along a free edge between relatively flat fracture surfaces. They are indicative of multiple initiation sites (initiation sites are located between adjacent ratchet marks) and are generally oriented normal to the surface where cracking initiated, at least near the surface. Ratchet marks are often found in fatigue failures
scanning electron microscope	a microscope that functions exactly like an optical microscope except that it uses a focused beam of electrons instead of light to "image" the specimen and gain information as to its structure and composition
spring tide	period of highest and lowest tides in a lunar cycle
starboard	right-hand side of a ship when looking forward

Data Summary

Vessel Particulars:

Name:	*Superflyte*
Type:	catamaran passenger ferry
Class:	Auckland enclosed water limits Auckland, Barrier, Tauranga inshore limits
Limits:	restricted limits
Classification:	Bureau Veritas
Length:	41 m
Breadth:	12 m
Gross tonnage:	578
Built:	1996 by Wavemaster International, Western Australia
Propulsion:	2 x Deutz TBD 620 V16 diesel engines each driving a fixed-pitch propeller through a ZF BU775 reduction gearbox
Service speed:	27 kt
Owner/operator:	Fullers Group Limited
Port of registry:	Auckland
Crew:	2 – 8 dependent on passenger loading
Maximum passenger capacity:	651
Date and time:	22 August 2004 at about 1708[1]
Location:	Motuihe Channel, Hauraki Gulf
Persons on board:	crew: 6 passengers: 311
Injuries:	crew: nil passengers: minor scrapes and contusions
Damage:	mechanical damage to engine cylinder head studs and extensive fire damage to the port engine room and wiring and mechanical systems inside the port engine room
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

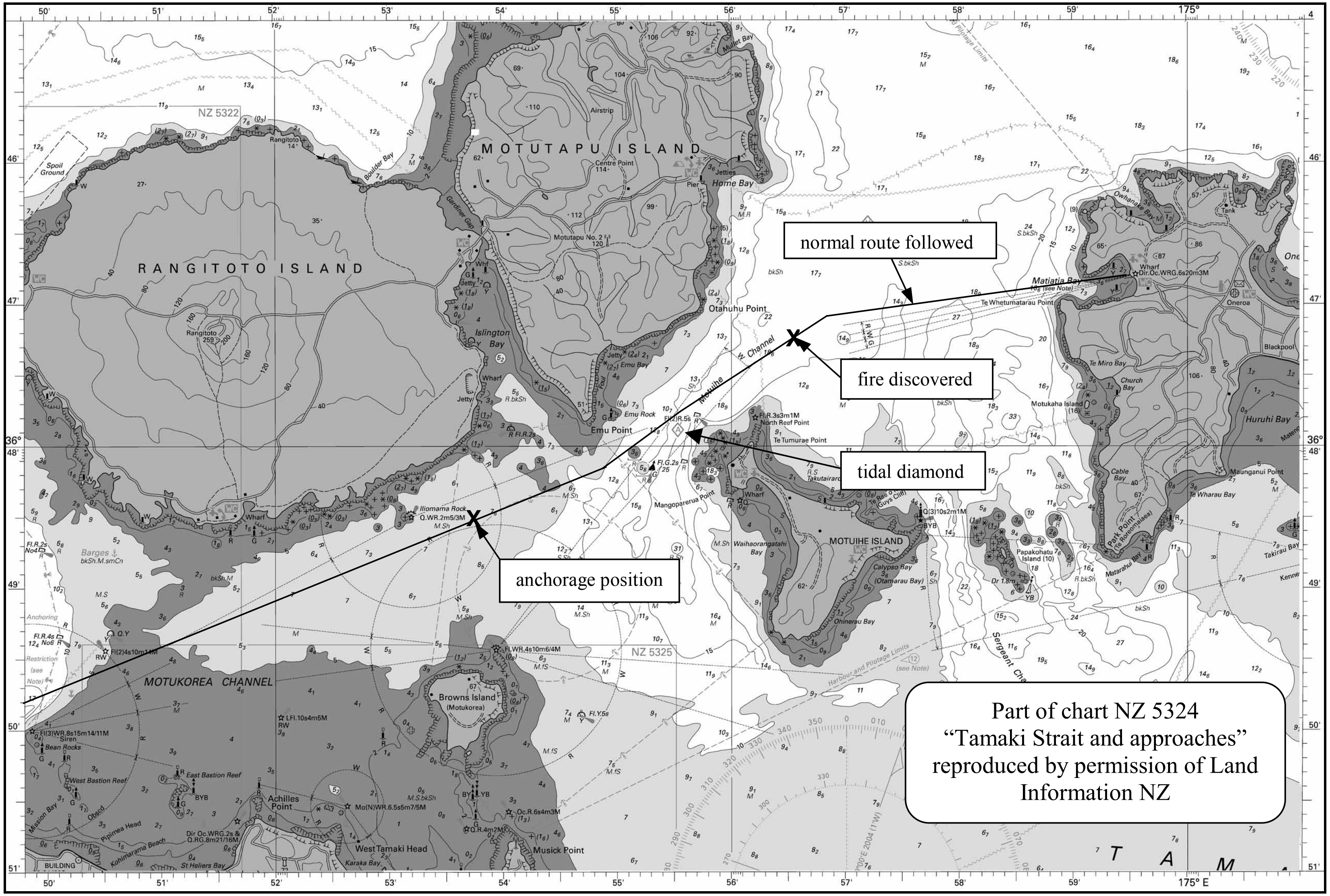


Figure 1
General area of the accident

1 Factual Information

1.1 History of the trip

1.1.1 On Sunday 22 August 2004 at about 1545, a crew change took place in Auckland on the ferry *Superflyte,* which had been in service throughout the day. The relieving crew prepared the *Superflyte* for the 1600 service between Auckland and Waiheke Island.

1.1.2 At about 1602, the *Superflyte* departed from the Auckland ferry terminal with 115 passengers and 6 crew on board. At about 1633, the *Superflyte* arrived at Matiatia Bay, Waiheke Island, after an uneventful trip. At about 1702 the *Superflyte* departed from Matiatia Bay for the return trip to Auckland with 311 passengers and the same crew on board.

1.1.3 At about 1707, the café attendant on deck 2 saw thick black smoke coming from the port engine room air vents. She immediately went to the navigating bridge, situated forward of the passenger space on deck 2, to inform the master. About the same time, an alarm indicating a fire on board sounded in the passenger spaces.

1.1.4 On being informed of the smoke, the master looked at the fire detector panel and saw that the light was illuminated indicating fire in the port engine room. He then looked at the closed circuit television (CCTV) monitor above the fire panel and saw flames and smoke in the port engine room.

1.1.5 The master commenced his contingency plan for a fire emergency. At about 1711 he transmitted a distress call on channel 16 of the very high frequency (VHF) radio. Auckland Maritime Radio answered his call and then issued a distress relay message.

1.1.6 The master then instructed the engineer to close the ventilation and remote fuel shut-offs to the port engine room, and then to visually check that they had closed. The master made an announcement over the ship's internal public address system advising the passengers that there was a fire in the port engine room, and that the crew were going to emergency stations. The master also instructed the passengers to take lifejackets from their stowage, put them on and then make their way to the outside decks. At this time, he also advised the Fullers Group Limited (Fullers) operations base at the Auckland ferry terminal of the fire using the ultra high frequency (UHF) private trunk radio band.

1.1.7 Looking at the CCTV the master realised that the fire was getting out of control, so he decided to inject carbon dioxide (CO_2) smothering gas into the port engine room through the fixed fire extinguishing system. He first pushed the remote control discharge button on the navigating bridge console for the port engine room to select the space and to close the main ventilation fire flaps. That done he pressed the CO_2 release button to automatically inject the appropriate amount of gas.

1.1.8 The master saw on the CCTV what he assumed to be CO_2 entering the engine room in the form of a fog. However, he saw the fire diminish but not extinguish.

1.1.9 The engineer, who had gone to check that the ventilation and fuel shut-offs had operated, heard an explosion on the after deck. After checking that the fuel shut-offs had operated, he looked onto the after deck and saw that the CO_2 room door had blown open and water was leaking from the room. He made his way back to the wheelhouse and informed the master that he did not think that the fire was out, but he had heard the ventilation flaps drop into the closed position.

1.1.10 At about 1716, the Royal New Zealand Coastguard (Coastguard) vessel *Kyrenia* arrived on scene to render assistance as required. At about 1719, the Fullers ferry *Harbourca,* arrived with the capacity to evacuate large numbers of passengers. The crew of the *Harbourcat* used their fire-fighting equipment to provide boundary cooling to the outside hull of the *Superflyte.*

1.1.11 The master and engineer agreed that the fire had probably not been extinguished and that someone should try to enter the space and fight the fire with the on-board portable extinguishers. Meanwhile the master would continue to con the *Superflyte* towards Auckland, on the starboard engine only at a speed of about 12 kt followed by the attending vessels. The master sent the engineer to organise the fire-fighting attempt.

1.1.12 At about 1730, when the *Superflyte* was clear of the Motuihe Channel (see Figure 1), the master lost control of the starboard engine and heard the clutch disengage as the power from the engine decreased. The master decided to anchor the vessel about 0.4 nm off Iliomama Rock beacon.

1.1.13 The service supervisor agreed to don the fire suit and breathing apparatus, with the engineer acting as backup. The engineer was required to change the power generator set over to the starboard system, run the fire pumps and supervise the lowering of the anchor. The engineer enlisted the assistance of a male passenger, who he knew to be a member of the New Zealand Police (Police) stationed on Waiheke Island, to help the supervisor don the fire suit, and carry equipment to the port engine room door.

Photo courtesy of Brooke Archbold, Auckland Coastguard Inc.

Figure 2
Passengers being evacuated from the *Superflyte* to the *Starflyte* with Police and Coastguard boats also in attendance.

1.1.14 The master decided that as he was anchoring his ship and the fire had not been confirmed as extinguished, it would be prudent for him to evacuate the passengers to the vessels that had come to his assistance (see Figure 2). By this time the attending vessels included the Fullers ferries *Harbourcat, Starflyte, Osprey* and *Seaflyte* capable of taking all the passengers, several Coastguard vessels and a Police launch with Fire Service staff on board.

1.1.15 The master made an announcement over the public address system informing the passengers that he did not know if the fire was out, but believed that it was not and he was going to evacuate all the passengers to the other vessels that were alongside. He asked that all male passengers go to the evacuation points to help the crew assist the other passengers to the rescue vessels.

1.1.16 The engineer and the enlisted passenger helped the service supervisor to don the fire suit and the self-contained breathing apparatus. The service supervisor then carefully opened the port engine room door but closed it again after a quick visual inspection as smoke was coming through the door into the passenger cabin. The service supervisor later stated that visibility was severely restricted with the engine room full of thick black smoke. The engineer went and started the starboard electrical generator and returned.

1.1.17 When the engineer returned he requested the service supervisor to switch off the port electrical generator when he entered the engine room. The service supervisor opened the door and entered the engine room wearing breathing apparatus and fire suit and equipped with a CO_2 portable extinguisher from the wheelhouse.

1.1.18 At about 1738, personnel from the New Zealand Fire Service boarded the *Superflyte* from a Police launch that had ferried them and their equipment from the Marine Rescue Centre at Mechanics Bay, Auckland. Shortly afterwards, members of the Saint John Ambulance were put on board having been taken out to the *Superflyte* by a Coastguard vessel.

1.1.19 On entering the engine room, the service supervisor noted flames coming from the top of the engine and doused them using the CO_2 portable extinguisher. However, as he walked past the engine the fire re-ignited and he once again doused the flames and embers. He had used most of the contents of the extinguisher before he had passed the engine on his way to the controls for the generator. As he approached the controls he thought his safety line had become snagged and tried to clear it. However, he was unable to clear the line sufficiently to reach the controls. He retraced his steps to the engine room entrance to find that his line had not become snagged, but was being retrieved by a member of the Fire Service.

1.1.20 The service supervisor handed the fighting of the fire over to the Fire Service personnel, who requested all available CO_2 extinguishers. There were no more available so they used some of the vessel's dry powder extinguishers until their own CO_2 extinguishers were available from the launch alongside. The Fire Service personnel finished extinguishing the fire and kept a watch on the engine room in case of re-ignition.

1.1.21 When the master made his announcement of the fire and evacuation, the crew donned their lifejackets and assisted passengers in donning theirs correctly. The crew then assisted passengers evacuating onto the open deck.

1.1.22 When the evacuation of passengers was complete, the rescue vessels returned to the ferry terminal at Auckland, where Fullers staff met them with offers of help and medical assistance.

1.1.23 The *Superflyte* was later taken in tow by a tug and taken to the ferry terminal in Auckland.

1.2 Vessel information

1.2.1 The *Superflyte* was a catamaran built in 1996 by Wavemaster International in Western Australia. Wavemaster International went into receivership in November 2004 during the investigation and was unable to be contacted for further information after an initial contact was made.

1.2.2 The *Superflyte* had an overall length of 41 m, a breadth of 12 m and a gross tonnage of 578 t. Propulsion was provided by 2 Deutz TBD 620 V16 diesel engines producing a total power of 3640 kW. Each engine drove a fixed-pitch propeller through a ZF BU775 reduction gearbox.

1.2.3 The vessel was owned and operated by Fullers. It was certified to carry 651 passengers in Auckland enclosed-water limits and 450 passengers in Auckland, Barrier, Northland and Bay of Plenty inshore limits. It was operating under safe ship management supplied by Dunsford Marine Limited and under classification by Bureau Veritas. The Safe Ship Management certificate was issued on 2 May 2003 and was valid, subject to periodic audit and inspection, until 30 June 2006.

1.2.4 Bureau Veritas issued only the hull and machinery classification certificate and the international load line certificate. However, Bureau Veritas acting on behalf of the Maritime Safety Authority (MSA) conducted the initial survey of the hull, machinery and equipment, and issued the appropriate initial certification.

1.2.5 The wheelhouse/conning position was at the forward end of deck 2, the upper passenger cabin, and was fitted with steering console, compass, radar, echo sounder, global positioning system, VHF radio communications, UHF trunk radio system, single side band radio system, internal public address system, fire detection panel, CO_2 release panel, CCTV monitor for the engine spaces, electrical switchboard, engine controls and alarm panel.

1.2.6 The engines were located in separate compartments, one in each hull, below the deck of the main passenger cabin. Access to each engine room door was via a companionway from the main passenger cabin. This companionway also provided access to the vessel's public toilets. Additionally a hatch to each engine room was located in the deck of the main passenger cabin. The hatches were for access to, and removal of, the engine during maintenance.

1.2.7 Separate generators, one in each engine space, supplied electrical power. The generators were used alternately.

Fire-fighting equipment

1.2.8 The fire-fighting equipment on board the *Superflyte* was required to comply with Maritime Rules, Part 40A design, construction and equipment – passenger ships which are not SOLAS ships, appendix 3 section 3.3 restricted limits ships. These rules were based on the length of the ship and the number of passengers that it may carry.

1.2.9 The fire-fighting and detection equipment carried on the *Superflyte* exceeded the statutory minimum equipment as specified in the Maritime Rules and was as follows:

Quantity	Fire fighting equipment on board	Statutory requirement / additional equipment
6	Fire hose	Statutory requirement
6	Dual purpose nozzle	Statutory requirement
1	Fireman's axe	Statutory requirement
1	Fireman's outfit	Additional equipment
1	Self contained breathing apparatus	Additional equipment
2	Fire smothering blanket	Statutory requirement
3	4.5-kg dry powder extinguisher	Statutory requirement
1	5-kg CO_2 extinguisher	Statutory requirement
7	9-litre water extinguisher	Statutory requirement
4	9-litre foam extinguisher	Statutory requirement
2	5-kg dry powder extinguisher	Statutory requirement
2	20-litre foam generator	Statutory requirement
2	Power fire pumps (one in each hull space)	Statutory requirement 1
2	Emergency fire pumps (one in each hull space)	Statutory requirement 1
1	Fixed CO_2 flooding system for engine room	Statutory requirement
1	Fire detection and alarm activation system (throughout vessel)	Additional equipment
2	CCTV monitoring system (one for each engine room)	Additional equipment

1.2.10 The fixed CO_2 fire-extinguishing system had been designed and installed by the vessel's builders, and complied with the classification society's rules. Bureau Veritas inspected and tested the system before the commissioning of the vessel, and the system was inspected and serviced annually by the owner's appointed fire equipment service providers.

1.2.11 Bureau Veritas's rule 20 – 053 Fixed gas fire – extinguishing systems, Section 7 piping and accessories, paragraph 74, applicable at the time of construction, stated:

> After mounting onboard, and in complement to tests and inspections at manufacturer's workshop, as per requirements of chapter 15, carbon dioxide pipes and their accessories are to undergo the following tests:
> - pipe lengths between bottles and master valves: hydraulic test, at the workshop or on board, at 128 bar [12.8 MPa]. When the hydraulic test is carried out at the workshop, a leak test with inert gas or air, at 7 bar [0.7 MPa], is to be carried out on board.
> -pipe lengths between master valves and nozzles: test on board with inert gas or air at 7 bar [0.7 MPa].
> The master valves are to undergo a hydraulic test at 128 bar [12.8 MPa].

1.2.12 The fire-extinguishing system used CO_2 stored in bottles at a pressure of about 57 bar [5.7 MPa]. The bottles were connected through a manifold to 2 pressure-operated direction (POD) valves with electrical actuators, one for each engine room (see Figure 3). The CO_2 was directed from the manifold to the discharge pipes in the engine room selected at the control panel in the wheelhouse. When discharged through the nozzles in the engine room, the CO_2 expands, not only smothering a fire but also providing a limited cooling effect from its expansion.

1.2.13 When the CO_2 fire-extinguishing system was operated from the wheelhouse, a series of electrical connections was made that automatically dropped flaps over the engine room vents, opened the valves on 2 of the 4 CO_2 cylinders, and operated the actuator on the POD valve for the selected engine room.

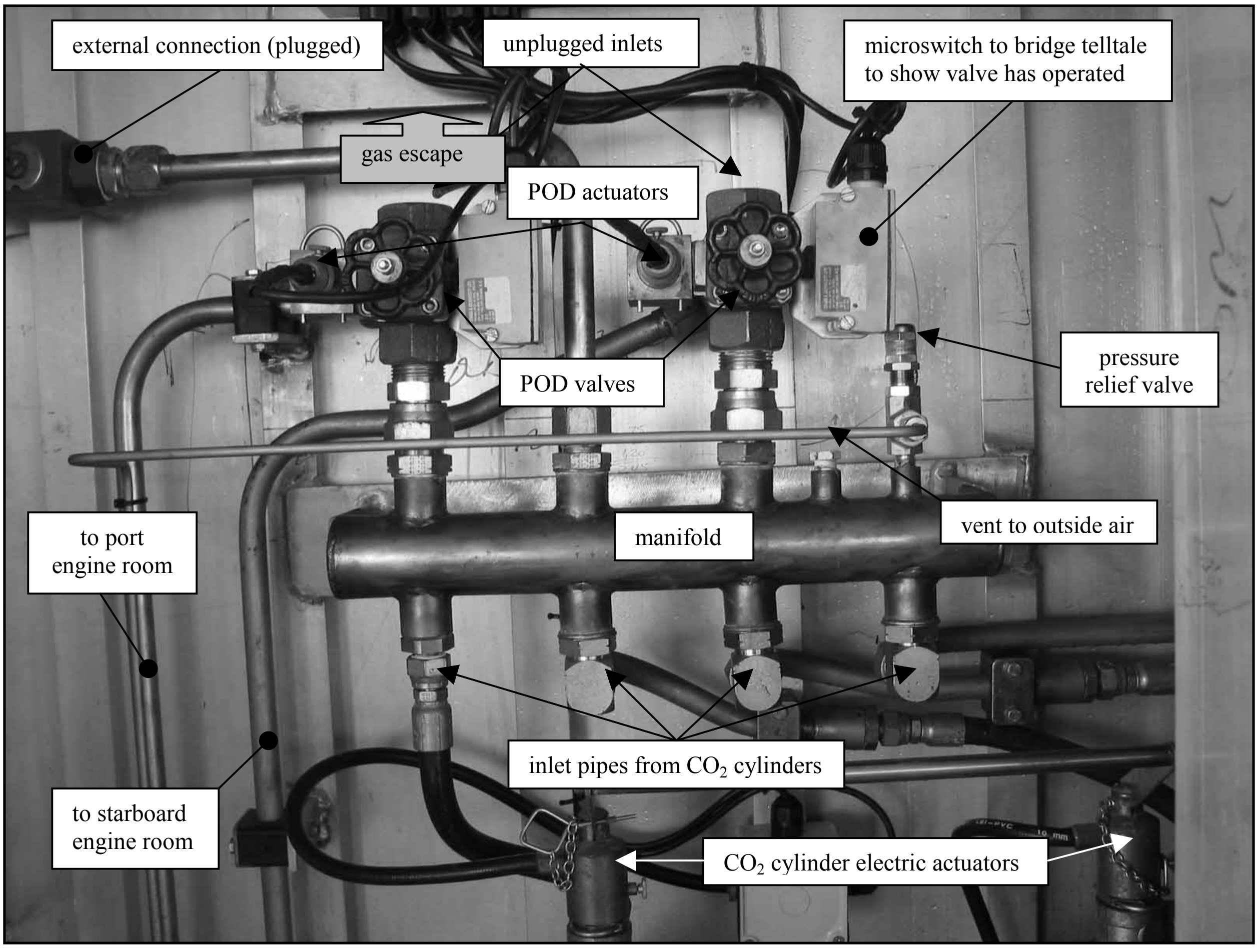


Figure 3
CO_2 manifold, connection pipes and POD valves

This allowed the CO_2 gas to pass from the cylinders through the connection manifold, operate the required POD by its own pressure and discharge into the engine room (see Figure 3).

1.2.14 The POD valves were available in single or dual inlet port configurations. In the dual inlet port configuration both inlet ports led to a common chamber inside the valve body. Wavemaster International fitted dual inlet port valves, although it stated that the fitting of the dual port valves was not the standard practice of the yard. The valves were supplied to Chubb Fire Australia by the manufacturer and were purchased from Chubb Fire by Wavemaster International.

1.2.15 When supplied by the manufacturer, the valves had red plastic plugs inserted into the ports of the valves to protect the screw threads from damage during transit. The manufacturer did not supply installation instructions, but technical information was available on request. The manufacturer recommended a competent installation engineer install the valves, using whichever standards were suitable for the application.

Life-saving equipment

1.2.16 The life-saving equipment on board the *Superflyte* was required to comply with Maritime Rules, Part 40A design, construction and equipment – passenger ships which are not SOLAS ships, appendix 4 section 4.3 restricted limits ships. These rules are based on the length of the ship and the number of passengers that it may carry.

1.2.17 The life-saving equipment carried by the *Superflyte* exceeded the statutory minimum equipment as specified in the Maritime Rules and was as follows:

Equipment required on board	Quantity on board	Statutory quantity
Survival craft (inflatable rescue boat)	1	1
Survival craft (liferafts) (20% of total capacity)	8 x 65 person rafts 520 persons	132 persons
Lifebuoys	9	4
Adult lifejackets (one for each person the ship is certified to carry)	681	651
Children's lifejackets	60	0
Rocket parachute flares	4	4
Buoyant smoke floats	2	2

1.3 Personnel information

1.3.1 The master first went to sea in 1960 with the Royal New Zealand Navy; he left after 20 years and became mate/relieving master on the *Spirit of Adventure* sail training ship. In 1981 he joined North Shore Ferries on the Waitemata Harbour, a predecessor of Fullers, as master of the *Kestrel* and had been master of numerous ferries since then. The master held a certificate as master small home trade ship, which had equivalency to a New Zealand offshore master's certificate limited to within 100 miles of the coast.

1.3.2 The engineer first went to sea in 1988 as a junior engineer and rose to the rank of chief engineer. He held a Honduran foreign-going certificate as chief engineer. In 2001 he commenced working for Fullers Group and held a valid New Zealand marine engineer class 6 certificate.

1.3.3 The service supervisor commenced work with Fullers in 2000 as a café hand, progressing to café and deckhand, and finally service supervisor in 2003. He held no seagoing qualifications at the time of the accident.

1.3.4 One café hand had commenced work with Fullers in November 2002, and had worked in several positions before becoming a café hand. He held no seagoing qualifications.

1.3.5 One café hand had commenced work with Fullers in November 2003, and had worked in the ticket office and as a café hand. He held a valid STCW 95 United Kingdom certificate as a master, class 1.

1.3.6 One café hand had commenced work with Fullers a month before the accident and after completing her induction training had served on board the *Superflyte*. She held no seagoing qualification.

1.3.7 The majority of the crew including the master were on the fourth day of working the 1530 to 0130 shift on board the *Superflyte* after 2 days off. The crew were on their first trip of the day after being off duty from 0130 on the morning of 22 August until 1530 the same day.

1.4 Climatic and tidal conditions

1.4.1 At the time of the accident, a low was situated to the south-south-east of South Island New Zealand with a cold front leading to the north-north-west. A further cold front was ahead of this front situated from the west coast of the South Island in a north-north-westerly direction into the Tasman Sea (see Figure 4).

1.4.2 The route of the *Superflyte* from Waiheke to Auckland lay within the Colville coastal waters forecast area. The New Zealand Meteorological Service (Metservice) issued coastal waters forecasts at well-documented regular intervals.

1.4.3 The Metservice stated that coastal water forecasts were a general indication of average conditions expected in a particular coastal area. The forecasts were for open waters within 60 nm of the coast and did not apply to enclosed areas such as small bays and harbours.

1.4.4 The coastal waters forecast for the Colville area issued at 1649 on 22 August 2004, and valid to midday Monday 23 August 2004 was as follows:

> Northwest rising to 30 knots this evening, changing southwest late morning. Sea rough. Poor visibility in morning rain.
> Outlook following 12 hours: Southwest 25 knots

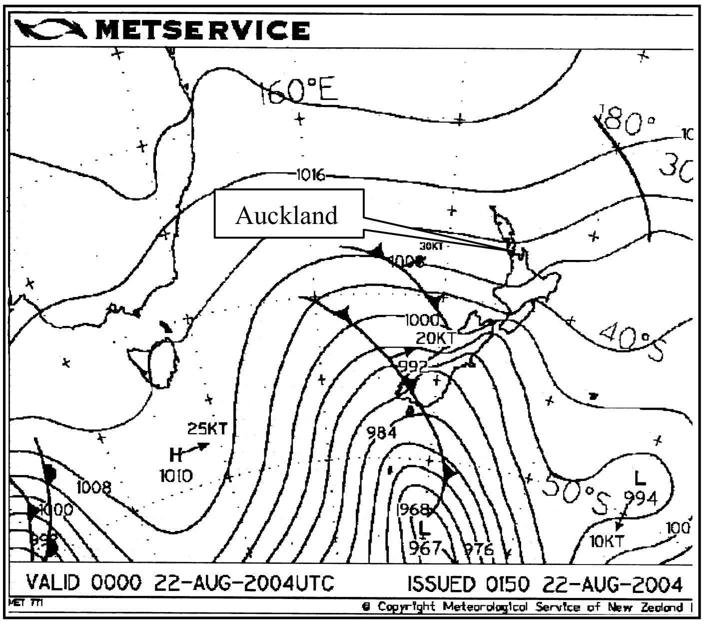


Figure 4
Mean sea level analysis synoptic chart for 1200 22 August 2004

1.4.5 Tidal stream rates were shown on chart NZ 5324 for specific geographical positions designated by a magenta diamond shape enclosing a letter, known as a tidal diamond (see Figure 1). The rates shown were for average spring or neap tides referred to high water at Auckland. If the tidal range is greater than normal the rates will be increased roughly in proportion. The spring rate of tides tabulated in the New Zealand Nautical Almanac for Auckland was 2.60 m and the neap range 1.93 m. The range at the time of the accident was 2.40 m and therefore a spring tide. The spring rates for the relevant diamond were:

Position	Time	Direction	Rate
Diamond "A" 36º 47'.90S 174º 55'.50E	22/08/2004 1641	182º	0.3 kt
	22/08/2004 1741	255º	0.2 kt
	22/08/2004 1841	010º	0.9 kt

1.5 Damage

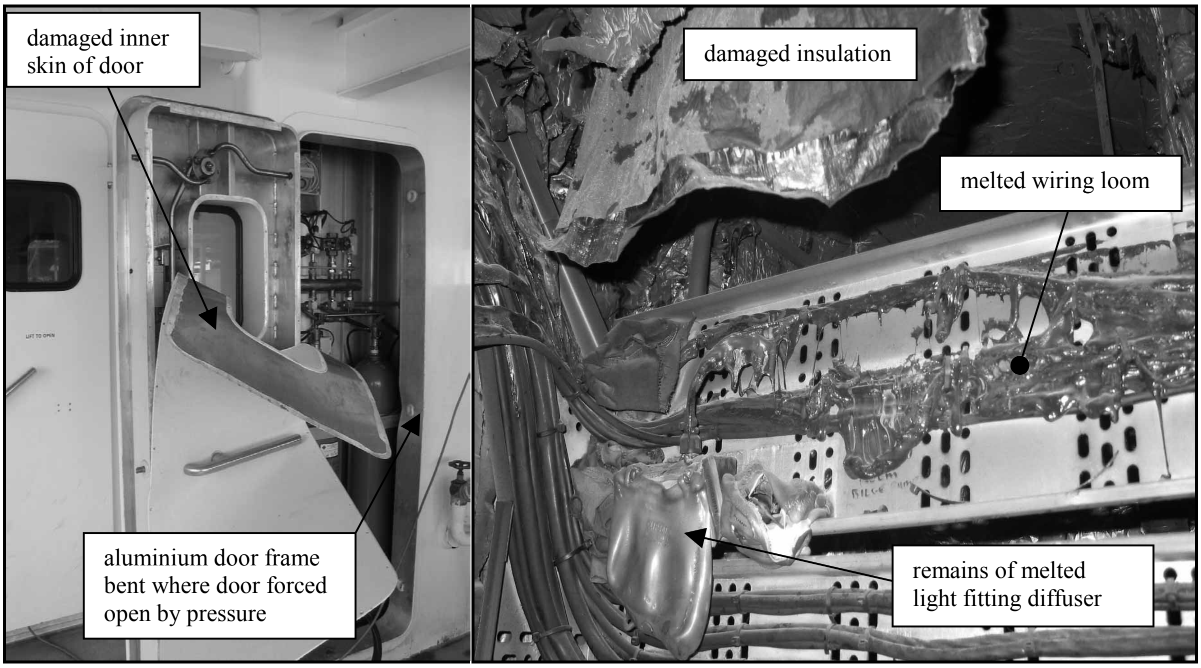


Figure 5
Damage sustained to CO_2 room door on left and in engine room on right

1.5.1 The port engine room sustained extensive damage to all electrical equipment and wiring contained within it (see Figure 5). Insulation on the deckhead of the engine room was extensively damaged, and an aluminium girder supporting the air intakes melted, indicating a temperature in excess of 660º C (see Figure 6).

1.5.2 Two cylinder head studs on cylinder B6 of the port engine failed, requiring all 4 cylinder head studs on this cylinder to be renewed. The forces generated by the loose cylinder head lifting on the compression and firing strokes caused the air inlet manifold to crack, and the bellow joints in the exhaust manifold for that cylinder to crack. During the fire, the air intake filters near the top of the engine ignited, possibly while the engine was still running. The engine had to be completely stripped down to ensure no foreign or burnt matter had been ingested (see Figure 7).

1.5.3 The entire interior passenger area sustained smoke damage.

1.5.4 In the CO_2 room the cover on the electrical connection box situated above the POD valve for the port engine room was shattered when hit by the dust cap which was blown out of the unplugged inlet port of the POD valve by the full force of the cold CO_2 under 5.7 MPa pressure.

1.5.5 While providing boundary cooling to the outside of the *Superflyte*'s hull, the *Harbourcat* made contact with the stern belting of the *Superflyte,* breaking one window on the *Harbourcat*.

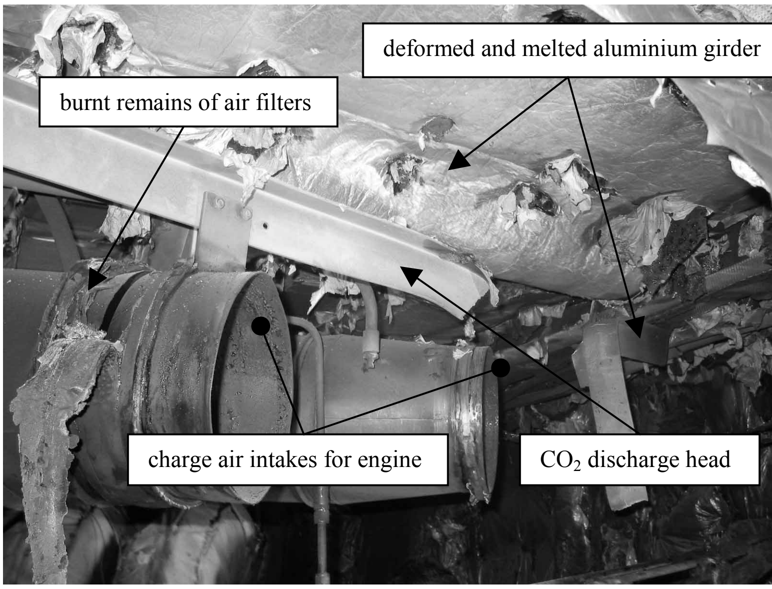


Figure 6
Damage to engine room deckhead showing melted aluminium girder and air intakes

1.5.6 While laying alongside and evacuating passengers, the *Seaflyte* leant heavily against the *Superflyte,* cracking 5 windows in the passenger cabin of the *Seaflyte* due to the disparity in the heights of the vessels.

1.6 Post-fire inspection and investigation

Engine

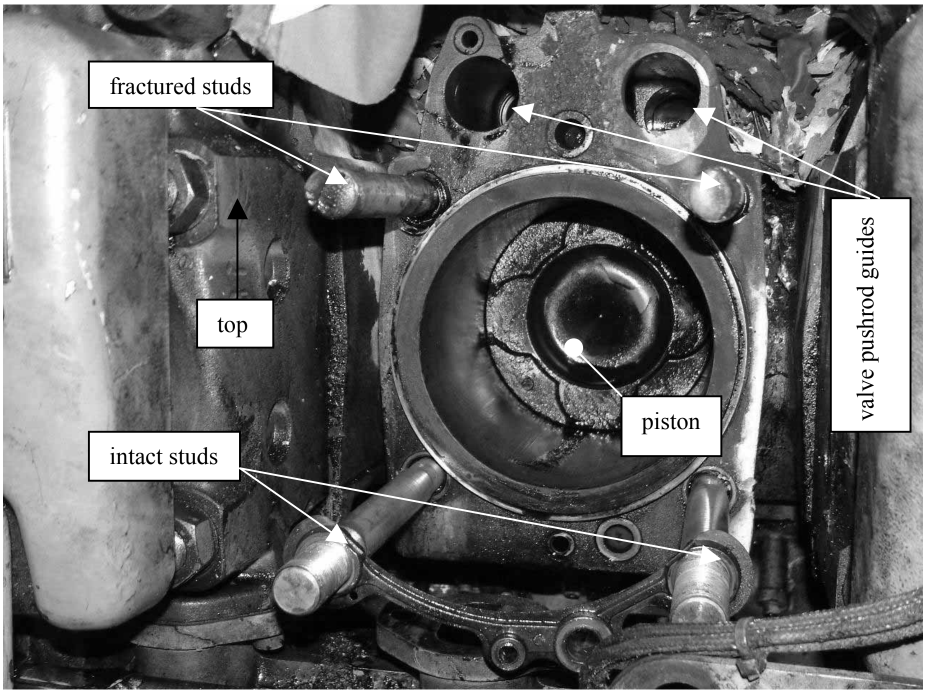


Figure 7
No. 6B cylinder with the head removed showing fractured studs

1.6.1 The last major overhaul of the engines was due after about 16 000 hours of service. However, this overhaul was undertaken after about 13 000 hours in May/June 2000. The next major overhaul of the engines was due after a further 16 000 hours of service. At the time of the accident, the engines had done about 28 130 hours of service, or 15 130 hours since the last overhaul.

1.6.2 Fullers completed the last major overhaul of the engine with the assistance of engineers from Deutz Australia who also supplied the specialist equipment required for correct tightening of the cylinder head nuts on the cylinder head studs.

1.6.3 Part of the specialist equipment supplied by Deutz Australia was a hydraulic jacking mechanism to stretch the cylinder head studs. Once the servicing engineers were satisfied that the cylinder head was in the correct position the cylinder studs were stretched to the correct length by exerting a specified pressure and therefore a specified stretching force on the studs, the retaining nuts were screwed down hand tight and the pressure released. By using hydraulic jacks, the manufacturer overcame the inaccuracies associated with tightening using a torque wrench or other hand device and the variable effect of friction.

1.6.4 The fracture of the 2 top cylinder head studs on cylinder B6 allowed exhaust gases, possibly some unburnt fuel from the cylinder, and lubricating oil from the feed from the crankcase to the cylinder head to spray up under the shroud over the exhaust manifold.

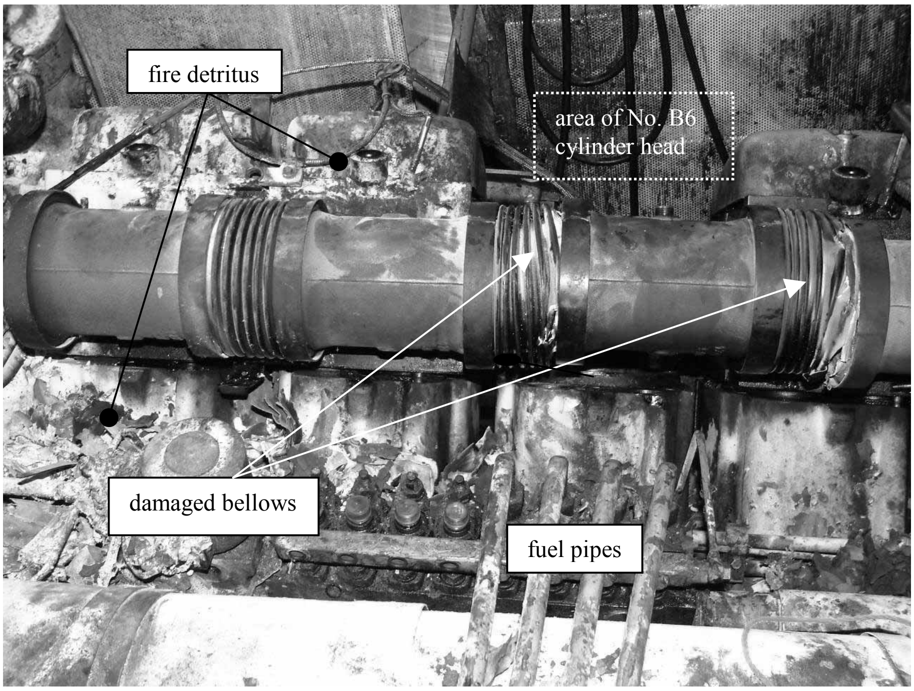


Figure 8
Damaged exhaust manifold with shrouding removed

1.6.5 The cylinder head valve assembly was pressure lubricated from the crankshaft via channels cast in the entablature and the cylinder head. When the joint between the cylinder head and the block or entablature became "loose" due to the fracture of 2 of the 4 holding down studs, lubricating oil under pressure would spray out onto the surrounding engine components.

1.6.6 Fullers staff had previously experienced head studs breaking on the type TBD 620 engines in the fleet. However, they had not had 2 studs fail on the same cylinder before. They had advised Deutz Australia of the previous problems and asked if the manufacturer could suggest any reason for the stud failures. Deutz Australia had advised Fullers that there was a known problem with the head studs and forwarded a copy of Service Bulletin 0122-99-6360 en, issued by Deutz Germany and containing a procedure to eliminate the problem.

1.6.7 The service bulletin stated (in part) that:

> **TBD/TBG 620 – Stud bolts for fastening the cylinder head**
> In individual cases, corrosion damage occurred at the stud bolt for fastening the cylinder head leading so that the stud bolts tore off. Through leaking locking

plugs, coolant could enter the bore of the cylinder head bolt in the cylinder head. These were the finest leakages which cannot be recognised, not even by pressure testing the cold cylinder head with water.
To avoid this corrosion, the following remedies were introduced…

Measures to be taken after the occurrence of corrosion damage to the stud bolts for fastening the cylinder head
When checking the stud bolts, only those stud bolts are replaced which show signs of corrosion. If corrosion damage is found at more than 2 cylinder heads, we recommend to check all cylinder heads. If a stud bolt should be torn off, all of the 4 stud bolts must be renewed and the locking plugs be sealed.

The bulletin was dated 12.03.2002 and was copied to:

- service partners at home and abroad (subsidiaries, agencies, dealers)
- service centres at home
- company departments (2)
- pocket book holders.

1.6.8 Fullers decided that if a cylinder head stud should break, it would carry out the remedial work as detailed in the service bulletin and renew all 4 cylinder head studs as a matter of course whatever the reason for the failure. Fullers further decided that, as a safety measure, it would carry out the remedial work as detailed in the safety bulletin and renew all the cylinder head studs on this type of engine in the fleet as soon as practicable. Fullers had purchased the materials to undertake the work but had been unable to complete the work prior to the accident.

1.6.9 The 2 fractured cylinder head studs were sent for further examination and analysis. Preliminary examination of the forward stud indicated that the fracture was a result of unilateral bending fatigue cracking, initiated in the base of the stud thread. The fatigue cracking appeared to be low cycle and had propagated over 80% to 90% of the fracture surface. Final failure from bending overload had resulted in a shear lip. Microscopic examination indicated cracking had probably initiated at corrosion damage, pitting, occurring at the base of the thread.

1.6.10 Preliminary examination of the after stud indicated the fatigue cracking appeared to be low cycle and had propagated over 70% to 80% of the fracture surface. The fracture was the result of unidirectional bending fatigue cracking initiated in the base of the stud thread. Ratchet marks indicated multiple crack initiation locations.

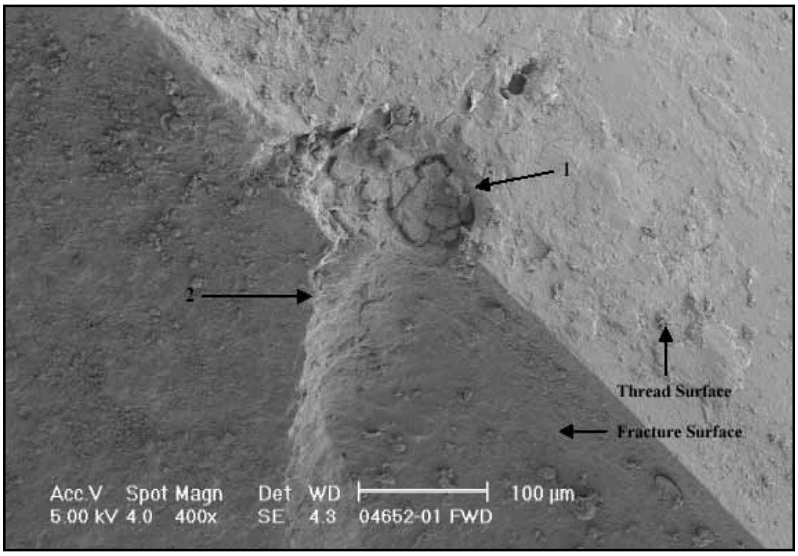


Figure 9
An SEM micrograph of pitting on thread surface [1] associated with ratchet mark [2] on forward stud

The metallurgist stated that microscopic examination indicated the fatigue crack may have initiated at corrosion damage, but indications of corrosion were not as distinctive as observed on the forward stud.

1.6.11 Further examination was undertaken on both studs. A chemical analysis using optical emission spectroscopy showed that the material of the studs was consistent with that specified by Deutz. Hardness tests on the stud parent metal indicated that the stud tensile strength was consistent with a grade 10.9 fastener. Microscopic examination revealed that the microstructure of both studs was similar, being a tempered martensite typical of hardened and tempered alloy steel. No significant metallurgical defects were observed, and the specified plated zinc iron coating was observed to be present.

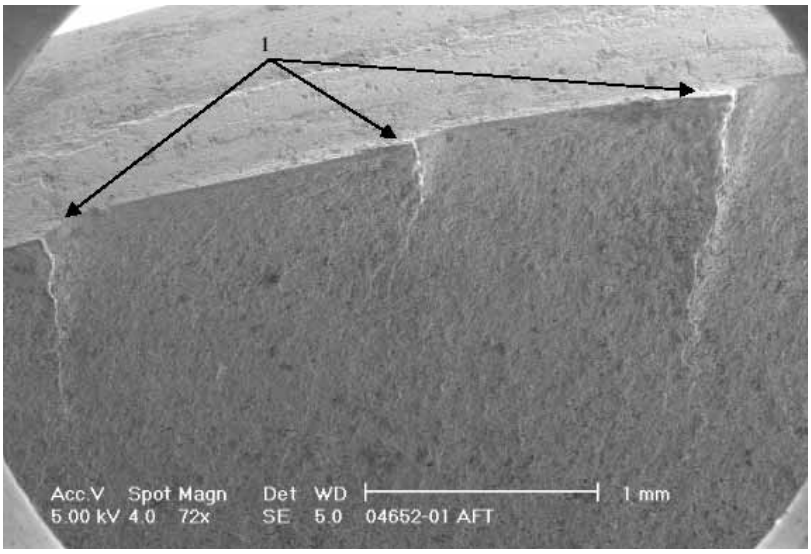


Figure 10
An SEM micrograph of the after stud fracture surface with 3 consecutive ratchet marks [1] with no significant micro-pitting observed

1.6.12 The fractured surfaces of the failed stud ends were prepared and examined under a scanning electron microscope (SEM) (see Figures 9 and 10). This examination indicated the presence of some localised corrosion on both stud thread surfaces adjacent to the thread surfaces. Corrosion on the thread of the forward stud was more prevalent than on the after stud. One ratchet mark on the forward stud surface was observed to have an associated micro-pit.

1.6.13 The broken ends of the studs sustained damage due to the lifting of the partially restrained cylinder head during the engine cycles before the engine stopped. Further damage and corrosion possibly occurred during the ensuing fire, and possibly during extraction of the stud remains from the cylinder block after the fire.

1.6.14 The engine lubricating oil used in the engine was Mobil Delvac 1 SHC, 5w – 40 synthetic diesel engine oil with a flash point of 226º C.

1.6.15 Lubricating oils have a flash point[2] of between 210° C and 257° C. The technical data sheet for Delvac 1 SHC 5w – 40 showed that the oil had a flash point of 226° C. The auto ignition temperature[3] of lubricating oils was not required to be contained in technical data sheets and so was usually excluded from the technical information. Consequently, precise data was difficult to ascertain. However, the National Fire Protection Association 921: A Guide for Fire and

[2] Flash point temperature is the lowest temperature at which a liquid gives off enough flammable vapour to ignite and produce a flame when an ignition source is present.
[3] Auto ignition temperature is that at which a gas or vapour can explode or burst into flames with no other source of ignition.

Explosion Investigation Chapter 22 Motor Vehicle Fires indicated that lubricating oil had an auto ignition temperature of between 260 °C and 371 °C. The auto ignition temperature of diesel fuel is 257º C and the flash point is greater than 60º C

1.6.16 The manufacturer tested the engines at 100% load prior to their being fitted into the vessel. The cylinder total mean temperature was about 490º C and the temperature of the engine exhaust before the turbo charger was about 590º C. The temperature of the exhaust manifold would be expected to be about the temperature of the engine exhaust gas.

1.6.17 The air filters on the air intake pipes for the engine were situated above the top of the engine and exhaust manifold in the vicinity of cylinder B6. The air filters were standard Deutz spare parts and were constructed with a paper core. These filters had been supplemented by the addition of a proprietary woven mat filter attached to the exterior of the Deutz filter to increase the filtration of the air to the engine (see Figure 6).

Fire and fire fighting

1.6.18 When the master pushed the control in the wheelhouse to discharge CO_2 into the port engine room the equipment functioned correctly. The CO_2 entered the POD valve, opening the discharge to the engine room and discharging some CO_2 into the engine room, however the majority of the gas passed through the common chamber and exited through the upper inlet port, blowing the red dust cap out and pressurising the room in which the equipment was located. The CO_2 room had a small vent in the lower port side, but this was not large enough to discharge the excess pressure. As a result the door was blown outward on its hinges, discharging the CO_2 over the after deck where the passengers were mustering (see Figure 5).

1.6.19 After the accident the port engine room POD valve was tested under workshop conditions and setup as it was installed on the vessel. First with 1.4 MPa of compressed air through the inlet port, the compressed air was discharged via the correct outlet as well as the upper inlet port. A test was carried out with a dust cap in place in the upper inlet port and a pressure of about 1.2 MPa was required to dislodge the dust cap. A test was carried out with the upper inlet port plugged with an approved plug and first a pressure of about 1.4 MPa and then the CO_2 working pressure of 5.7 MPA was applied with compressed air. In both cases the valve held pressure and could only be vented by use of the hand wheel or by initiating the transfer block.

Evacuation procedures

1.6.20 The lifejackets on the *Superflyte* were MSA approved non-SOLAS lifejackets. The adult lifejackets were located in pockets under each of the passenger compartment seats with others located in lockers located around the vessel. The child lifejackets were located in lockers located around the vessel, as detailed below:

Locker location	Type of jacket
One locker, deck 3, observation deck, central aft at top of stairs	Adult
One locker, deck 3, observation deck, port aft under funnel	Child
Two lockers, deck 2, upper passenger deck, port side open deck	Adult
One locker, deck 2, upper passenger deck, under bench seat by stairs to deck 1	Child
Two lockers, deck 1, main passenger deck, by stairs down to toilet facilities	Child

All the lockers were clearly marked with graphical pictograms as approved by the International Maritime Organization resolution A760(18) and amended by MSC.82(70). Routes to the evacuation points and the evacuation points themselves were also similarly marked.

1.6.21 Lifejacket donning instructions were placed conspicuously around the passenger cabins and on the lockers containing the lifejackets. Donning instructions were also stamped on the lifejackets.

1.6.22 The café hands helped passengers with lifejackets and supplied other passengers with children's lifejackets. However, the majority of the passengers were left to interpret the donning instructions for themselves.

1.6.23 At the commencement of the trip from Waiheke to Auckland the master had made a brief announcement welcoming the passengers on board and detailing the location of lifejackets. He also suggested that passengers familiarise themselves with the location of their nearest lifejacket and emergency exit, and informed them that in the case of an emergency they were to remain seated and wait for instructions from the crew. This announcement complied with the regulations contained in Maritime Rules Part 23 section 27.

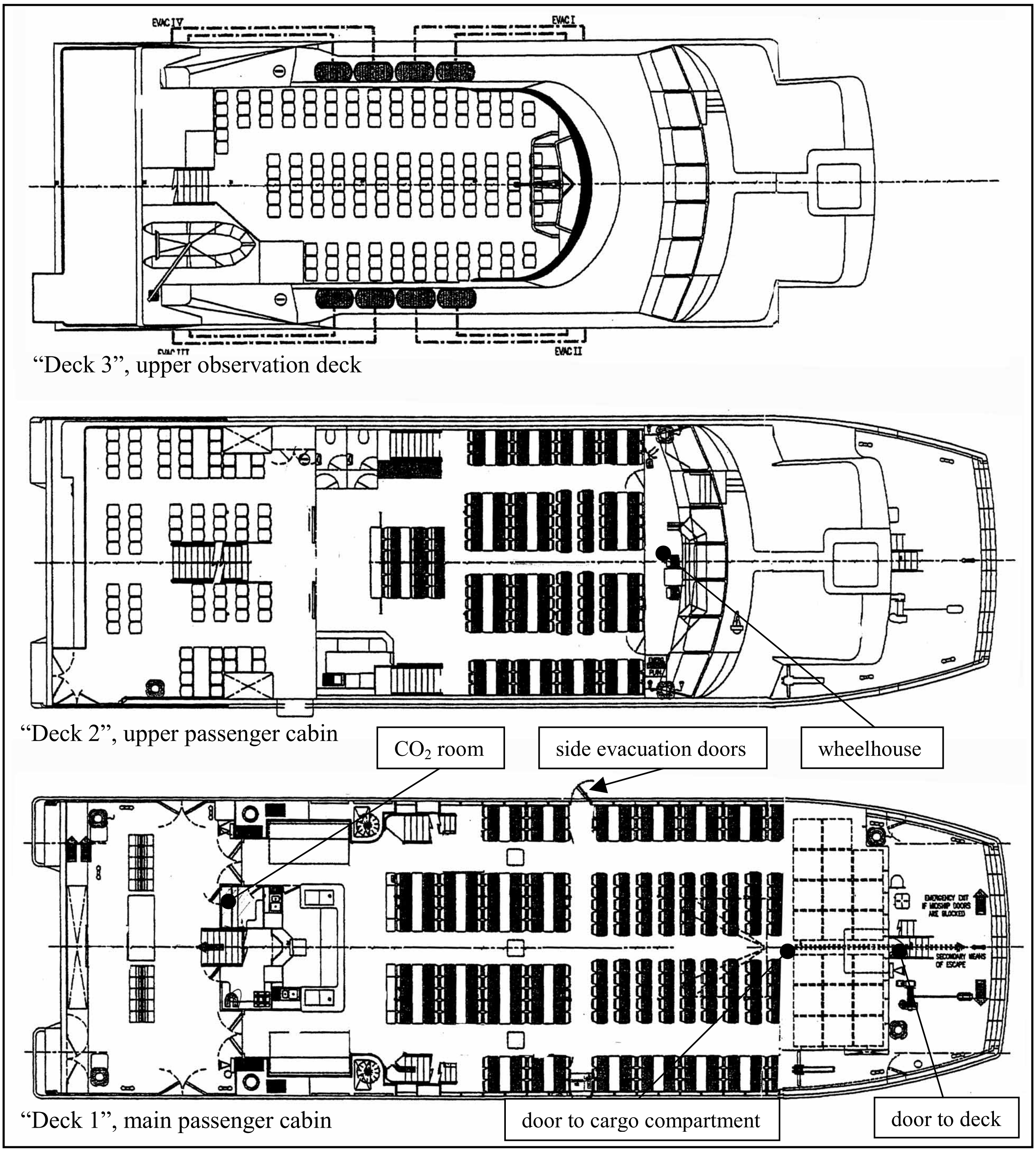


Figure 11
Deck plan of the *Superflyte*

1.6.24 The *Superflyte* was also equipped with a safety video containing information of the safety features and donning instructions for the lifejackets. This was screened on a monthly basis only.

1.6.25 Having given the instruction to don lifejackets, the master ordered all passengers to make their way out of the passenger cabins. While the passengers were making their way out of the passenger cabins the door of the CO_2 room exploded outward when the master discharged the CO_2. Fortunately the door hit no one, but CO_2 was escaping through the open door.

1.6.26 Given that the fire was on the port side and the CO_2 escaping on that side also, the crew ushered the passengers to the starboard side of the decks. The service supervisor helped one café hand close the port side door on the lower deck before going to the wheelhouse. On his way he also ushered passengers away from the port side of the upper passenger deck.

1.6.27 The passengers experienced some difficulty in opening the door onto the fore deck. This exit route was designated as a secondary means of escape if the primary means, at the rear and sides, were obstructed. The opening action of the door handle was to lift, as is usual on watertight doors on ships, rather than to push down to open as could be expected ashore.

1.6.28 Two side doors, although designated as a primary means of escape, were used for embarkation into life rafts. These doors opened from the lower passenger cabin directly over the water. Although passengers initially opened these doors, the crew closed and locked them to prevent passengers falling through them into the sea.

Communications

1.6.29 The master was communicating with the rescue services using VHF channel 16, the internationally approved distress, safety and calling channel. He was communicating with Fullers' shore base and other Fullers ferries using UHF trunk radio private radio channel.

1.6.30 The only way the master could communicate with the crew, other than the engineer who had a portable radio, was by using the public address system. The *Superflyte* was also fitted with a voice-activated intercom system with terminals located at the life raft boarding points.

1.7 Operating procedures

1.7.1 Section 4 – daily operating procedures (engineer) of the operator's safe ship management manual contained start-up and check routines to be completed prior to commencement of service each day. The engineer was required to initial the engine logbook to confirm that this was done. Section 10 – vessel servicing and maintenance of the manual stated that:

> The vessel engine logs are used for monitoring and documenting daily vessel watchkeeping inspections and tests.

1.7.2 Each engine log sheet contained the following notations:

> D. engineer to take all gauge readings from engine room
> F. engineroom inspections and readings minimum of once per hour

1.7.3 On the Waiheke ferry service, usual practice was for the engineer to visit the *Superflyte*'s engine rooms once on the outward leg to Waiheke and once on the return leg to Auckland for a visual inspection of the engine and space. While the *Superflyte* was berthed at either end, the engineer inspected the engine rooms and also recorded the machinery readings in the log.

1.7.4 The engineer had inspected the engine rooms prior to departure from Auckland and Waiheke, and once on passage from Auckland to Waiheke. He later stated that he did not notice anything unusual when conducting his rounds and taking readings.

1.7.5 The emergency procedures to be followed in the event of a fire on board or to abandon ship were documented in the safe ship management manual in the form of flow diagrams (see Appendices 1 and 2).

1.7.6 In addition to the flow diagram for abandon ship procedure, the safe ship management manual contained instructions on crew positions (see Appendix 3) and evacuation procedures that noted:

> The master should, at the earliest possible time, advise the crew and passengers of a probable evacuation. Crew can be alerted via the vessel internal intercom system. Passengers can be advised by the public address system. Passengers and crew will be requested to don lifejackets and remove any sharp objects from their person and/or clothing.
>
> At this stage, contact should be made with shore based rescue facilities. They should be advised of at least:
>
> Vessel name, number of passengers, position and type of distress.
>
> During this time, the Engineer should activate the pumps or fire services depending on the nature of distress and co-ordinate with the Master for the shutting down of vessel systems.
>
> On the Master's instruction to ***'Prepare to Evacuate'***, crew should go to their designated evacuation point (as instructed in evacuation drills) and passengers should be instructed to remain in or return to their seats.
>
> Once life rafts are bowsed at the evacuation points, the order to ***'Abandon Ship'*** will be given. Passengers should then make their way to their evacuation point.

1.8 Previous occurrences

1.8.1 On Thursday 16 January 2003, the restricted limits passenger ferry *Harbourcat* suffered a fire in the starboard engine space (TAIC Marine Occurrence report 03-201). Safety issues identified included:

- access to engine rooms on passenger ferries
- adequacy of procedure and training of ships' crew in tackling engine space fires
- the provision of fire-detection and fire-extinguishing systems for enclosed engine room spaces in restricted limits passenger vessels.

1.8.2 The *Harbourcat* was owned by Fullers Group Limited and was in safe ship management with SGS Ships Management Systems New Zealand Limited.

1.8.3 On 22 July 2003, the Commission recommended to the Managing Director Fullers Group Limited that he:

- ensure that all crews serving on the company's ferries are aware that, when investigating a suspected or indicated fire within an enclosed space, opening the access may rapidly exacerbate the fire endangering the crew, passengers and the vessel. The procedure in the operations manual should include a caution and a reminder that where a fixed fire fighting system is installed for the engine spaces, its use should be considered as a possible safer alternative to opening the space, especially in vessels with twin-engine spaces (023/03).

- in consultation with the Safe Ship Management provider, amend the emergency fire procedures for each of the group's ferries to better reflect the characteristics of each vessel, the use of available equipment on board and the safest possible method of fire fighting in the differing areas on board especially enclosed spaces (024/03).

Fullers Group Limited provided evidence on 24 September 2004, that the fire procedures for the *Harbour Cat* had been updated, but it was still working on the procedures for the other vessels in the fleet.

2 Analysis

2.1 When the alarm sounded in the passenger spaces, one of the café hands was on her way to the wheelhouse to alert the master. The master was unaware of the fire until he turned and looked at the fire alarm panel and CCTV system because the fire detection panel in the wheelhouse was not equipped with an audible alarm. With the master concentrating on conning the vessel towards the Motuihe Channel, an audible alarm would have alerted him to the fire more readily.

2.2 After he was alerted to the fire, the master followed the procedures laid down in the company's manuals. However, the manuals had not been updated with vessel-specific procedures reflecting the equipment available on board the *Superflyte*. Had the master been less experienced, or less sure of himself and the capabilities of his crew, he may not have made best use of the available equipment and thereby increased the risk to both passengers and crew.

2.3 When the cylinder head studs fractured, combustion gasses, unburnt fuel and lubricating oil would have sprayed over the exhaust manifold out of the failed joint between the cylinder head and block. Fire resulted because the temperature of the exhaust manifold was above the auto ignition temperature of the fuel and lubricating oil.

2.4 If studs are correctly tightened it is highly unlikely that they would fail due to fatigue. The engine manufacturer's tightening regime using a hydraulic jack to stretch the stud ensured a more accurate tension in the stud and thus reduced the chance of fracture due to fatigue. However, there are several different types of hydraulic jack that can be used and an expert in the use of one type would not necessarily be an expert in the use of another. This could lead to minor inaccuracies in the use of the equipment that could result in the incorrect tensioning of the studs, over or under tightening, thus increasing the possibility of inducing stresses that could cause fatigue failure.

2.5 The metallurgist reported that the stud fracture morphologies were consistent with other bolt/fastener failures that had occurred as a result of fatigue from over and/or under tightening. However, corrosion of the stud can either initiate the propagation of a fatigue crack by forming a pit in the surface, which raises the stress levels at that point, or assist in the propagation of a crack formed by other stresses.

2.6 The manufacturer of the engine had identified a problem with the type of engine and issued a service bulletin detailing a remedy. However, the service bulletin was issued only to accredited Deutz agents and partners, and was not readily available to engine owners. Fullers only became aware of the service bulletin and the method of resolving it when they made specific enquiries to Deutz Australia.

2.7 The amount of corrosion required to initiate corrosion fatigue failure is extremely small and not readily visible to the naked eye, being fully visible only under a microscope. To expect a service engineer to detect this amount of corrosion under what could be less than ideal conditions of lighting and cleanliness was less than prudent. A more prudent course of action for Deutz would have been to contact all owners of the type of engine to explain the problem and suggest that remedial work be carried out on all cylinder studs as soon as practicable.

2.8 From examination it was found that the failed studs had a chemical composition and hardness consistent with those specified by Deutz, and were probably genuine Deutz components. The larger overload zone of the after stud indicated that it was more highly loaded at final failure than the forward stud, and probably failed after the forward stud.

2.9 The metallographic examination of the after stud fracture showed that micro-pitting corrosion was present in the thread fracture initiation zone. Branched secondary cracking propagating from the fracture surface would indicate that there was a corrosion contribution in the crack propagation mechanism. Some localised corrosion was present on the forward and after stud thread surfaces adjacent to the fractures, which was probably pre-fracture corrosion.

2.10 Due to the extent of the post-fracture damage, it was unclear as to how significant corrosion was in the failure mechanism. If the corrosion was a significant factor, failure due to corrosion fatigue may have occurred under normal operating stresses. However, if the corrosion was a lesser factor in the failure, an abnormal operating stress such as under or over tightening of the studs may have initiated and propagated the fatigue mechanism.

2.11 When the master operated the controls for the discharge of CO_2, the electrical discharge system worked as it was designed to do. The ventilation flaps shut and so began to starve the fire and engine of oxygen. However, because the second port was not plugged properly, it blew out and not enough CO_2 to extinguish the fire entered the engine room.

2.12 Had the designed amount of CO_2 entered the engine room the gas would most likely have extinguished the fire. The electrical cables that linked the port and starboard engines would possibly not have been damaged enough to cause the loss of control to the starboard engine and the *Superflyte* would probably have been able to complete the trip back to Auckland ferry terminal on its starboard engine unassisted, albeit at a reduced speed. Had the rescue boats been required, the subsequent distance from Auckland would have been reduced.

2.13 The presence of dust caps in the POD valve second inlets indicates that most likely these had been in place since the builders installed the system. It is unlikely that the extra inlets were ever plugged with a gas-tight plug capable of withstanding the pressures of a full discharge of CO_2 as the red dust caps would have had to be removed to allow a plugging system to be installed.

2.14 During construction the system was probably first checked in the workshop and then tested on board with a pressure of 0.7 MPa according to the classification society's rules. This pressure was less than that required to dislodge the dust caps. The system was further inspected and tested annually, but the tests were probably carried out with an open line to the engine room using compressed air at a pressure less than that required to dislodge the dust caps.

2.15 Although a single port POD valve would have been appropriate for the extinguishing system, the fitted dual port POD valves were adequate for the job provided the unused second port was properly plugged. There had been ample opportunity to discover and rectify the unplugged ports both at the time of fitting and during the 8-year life of the vessel. However, none of the parties involved had noticed the provision of the dual port POD valves and the absence of the correct blanking plugs.

2.16 The action of the service supervisor in offering to enter the engine room to fight the fire was commendable. Under the Maritime Rules for a restricted limits ship the *Superflyte* was not required to carry either a fire suit or a self-contained breathing apparatus. This equipment provided the service supervisor with much-needed protection against the heat and fumes. However, the fire suit and breathing apparatus possibly boosted the confidence of the service supervisor that he could enter the engine room and safely tackle the fire, but with one suit only he was deprived of any form of backup within the fire area.

2.17 The fire that the service supervisor doused in the vicinity of the top of the engine was probably the remains of air filters that had become fuel and oil soaked when they dropped on top of the engine, re-igniting from the intense heat of the engine room and the engine's exhaust manifold.

2.18 When the crew were told to go to emergency stations, they donned their lifejackets and helped the passengers don theirs. However, as soon as the crew were wearing their lifejackets they became unrecognisable amongst all the passengers similarly outfitted. This made it difficult for the crew to gain control and direct the passengers in the emergency procedures.

2.19 The signage with regard to the donning of lifejackets was attached to the bulkheads around the passenger cabins and to the lifejacket lockers on the exterior decks. The master's announcement at the start of the trip mentioned locating the nearest lifejacket but did not mention any instructions on how to don the lifejacket. Passengers were left to familiarise themselves with the donning instructions. However, many passengers did not take the opportunity to familiarise themselves with the positioning or donning instructions of the lifejackets. When told to don their lifejackets some passengers were unable to get close enough to a sign to read the instructions. Basic instructions were printed on the lifejackets, but were necessarily succinct and may not have been readily understood by all on board.

2.20 The lifejacket donning instructions complied with both New Zealand and international regulations. However, where time permits, passengers may well be more attentive to a physical or video demonstration of lifejacket donning and emergency exits.

3 Findings

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

3.1 The *Superflyte* was correctly manned and certified at the time of the occurrence.

3.2 The fire-fighting and life-saving equipment on board the *Superflyte* was above regulatory requirements.

3.3 Crew fatigue was not considered to be an issue in this occurrence.

3.4 The fire was caused by the fracture of 2 cylinder head studs on cylinder B6 of the port engine allowing a flow of hot lubricating oil, combustion gases and unburnt fuel to escape from the cylinder and on to the hot exhaust manifold.

3.5 The studs fractured due to the initiation and propagation of fatigue, with the forward stud probably fracturing first.

3.6 The cause of the fatigue failure could not be positively identified but could possibly be due to one, or a combination of:

- incorrectly tightened studs during routine overhaul of the main engine thus inducing cyclic stresses
- corrosion micro-pits at the base of the forward cylinder head stud threads inducing corrosion-induced fatigue failure
- stress induced in the after stud once the forward stud had fractured.

3.7 Corrosion probably assisted in the crack propagation mechanism. However, due to the extent of the post-fracture damage to the cylinder head studs, the extent to which corrosion played a role in the failure mechanism could not be accurately determined.

3.8 The engine manufacturer had been aware of a possible problem concerning the corrosion of the cylinder head studs but had not widely promulgated the information to all owners of that type of engine.

3.9 Had independent operation of the *Superflyte*'s 2 main engines from the bridge been possible, the *Superflyte* could probably have been conned closer to Auckland and safety.

3.10 Use of dual port POD valves with one port not properly plugged prevented the correct amount of CO_2 entering the port engine room.

3.11 None of the parties involved in the construction, classification, certification, maintenance or operation of the vessel noticed the provision of the dual port POD valves and the absence of the correct blanking plugs.

3.12 A significant number of passengers were unable to don their lifejackets successfully without assistance due to either not reading or not understanding the signage provided.

3.13 Once the crew had donned their lifejackets they became indistinguishable from the passengers similarly attired.

4 Safety Actions

4.1 After the accident, Fullers Group Limited implemented the following actions:

- all the cylinder head studs on both engines were renewed and the remedial work to prevent coolant leakage carried out
- the CO_2 flooding system was modified by fitting single port POD valves
- the size of the CO_2 room gas escape aperture was increased
- the lifejacket pockets under the seats in the main passenger cabins were modified to provide easier opening
- a greater selection of sizes of children's lifejackets was provided
- a new fire-detection system was installed which allowed for the cancellation of passenger cabin alarms without disabling the detection capabilities of the system; this system also included an audible as well as a visual alarm in the wheelhouse
- modification of the engine control system to include a switch to allow for control of either engine independently in an emergency situation when one engine was disabled.

4.2 In view of these actions taken by Fullers Group Limited, no safety recommendations covering these aspects have been made to Fullers Group Limited.

5 Safety Recommendations

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

5.1 On 23 March 2005 the Commission recommended to the Managing Director of Fullers Group Limited that he:

5.1.1 in conjunction with the safe ship management company, amend the safe ship management manual, section on emergency management procedures throughout the fleet to ensure in the event of an emergency that at least one member of the crew to be positioned on each passenger deck so as to be able to assist passengers. (012/05)

5.1.2 in conjunction with the safe ship management company, amend the safe ship management manuals throughout the fleet to contain in the training of crews the necessity in an emergency situation of making passengers aware of the crew's presence and the need for them, as trained personnel, to provide guidance, help and support to passengers. (013/05)

5.1.3 in conjunction with the safe ship management company, include in the safe ship management manuals throughout the fleet a prepared safety briefing to be made immediately before or immediately after sailing on all company vessels to comply with the requirements of Maritime Rules Part 23 section 27. (014/05)

5.1.4 in conjunction with the safe ship management company introduce the fire-fighting procedures recommended in safety recommendations number 023/03 and 024/03 for all of the group's vessels. (015/05)

5.2 On 2 May 2005, the Operations Manager of Fullers Group Limited replied:

> I would like to confirm that recommendations 012/05, 013/05, 014/05 and 015/05 have been finalised and sent off to Dunsford Marine [Safe Ship Management Company]. We are awaiting the return of the hard copies so that we can put them into the vessels' Safe Ship Management files on board.

5.3 On 23 March 2005 the Commission recommended to the Managing Director of Dunsford Marine Limited that he:

5.3.1 in conjunction with Fullers Group Limited, amend the safe ship management manual, section on emergency management procedures throughout the fleet to ensure in the event of an emergency that at least one member of the crew to be positioned on each passenger deck so as to be able to assist passengers. (016/05)

5.3.2 in conjunction with Fullers Group Limited, amend the safe ship management manuals throughout the fleet to contain in the training of crews the necessity in an emergency situation of making passengers aware of the crew's presence and the need for them, as trained personnel, to provide guidance, help and support to passengers. (017/05)

5.3.3 in conjunction with Fullers Group Limited, include in the safe ship management manuals throughout the fleet a prepared safety briefing to be made immediately before or immediately after sailing on all company vessels to comply with the requirements of Maritime Rules Part 23 section 27. (018/05)

5.3.4 in conjunction with Fullers Group Limited, amend the emergency fire procedures for each of the groups' ferries to better reflect the characteristics of each vessel, the use of available equipment on board and the safest possible method of fire fighting in the differing areas on board especially enclosed spaces. (019/05)

5.3.5 in conjunction with Fullers Group Limited, ensure that all crews serving on the company's ferries are aware that, when investigating a suspected or indicated fire within an enclosed space, opening the access may rapidly exacerbate the fire endangering the crew, passengers and the vessel. The procedure in the operations manual should include a caution and a reminder that where a fixed fire-fighting system is installed for the engine spaces, its use should be considered as a possible safer alternative to opening the space, especially in vessels with twin-engine spaces. (020/05)

5.4 On 5 May 2005, Dunsford Marine replied (in part):

> With regard to the safety recommendations
>
> 016/05 This is being included in the manual in the emergency procedures.
>
> 017/05 This has been included in the manual in the emergency procedures. However, there is still some work being done.
>
> 018/05 Several proposals are currently being looked at with a view to implementing.
>
> 019/05 Fire procedures have been modified for each vessel.
>
> 020/05 This area will form part of crew training and it is proposed to have the company's fire protection service company hold practical training for senior personnel.

5.5 On 12 April 2005 the Commission recommended to the Managing Director of Deutz AG, Germany that he:

5.5.1 ensure that the contents of all current and any future service bulletins where safe operation of engine types may be affected be promulgated by the best means possible to all known owners of the type of engine affected. (021/05)

5.6 On 12 April 2005 the Commission recommended to the Director of Maritime Safety that he:

5.6.1 undertake a cost benefit analysis with a view to drafting an amendment to Maritime Rule Part 23, Operating Procedures and Training, for the Minister's consideration to change the content and method of promulgation of the contents of "the instructions to be followed in the event of an emergency" for restricted limits passenger vessels. The amendment to include, at least, verbal advice of life jacket donning instructions so as to enable passengers to safely don the lifejackets carried on board. (022/05)

5.6.2 undertake a cost benefit analysis with a view to drafting an amendment to Maritime Rule Part 42A Safety Equipment – Life saving appliances, Performance, Maintenance and Servicing for the Minister's consideration. The amendment to include a requirement for the provision of equipment to make crew members readily distinguishable from passengers in the event of an emergency. (023/05)

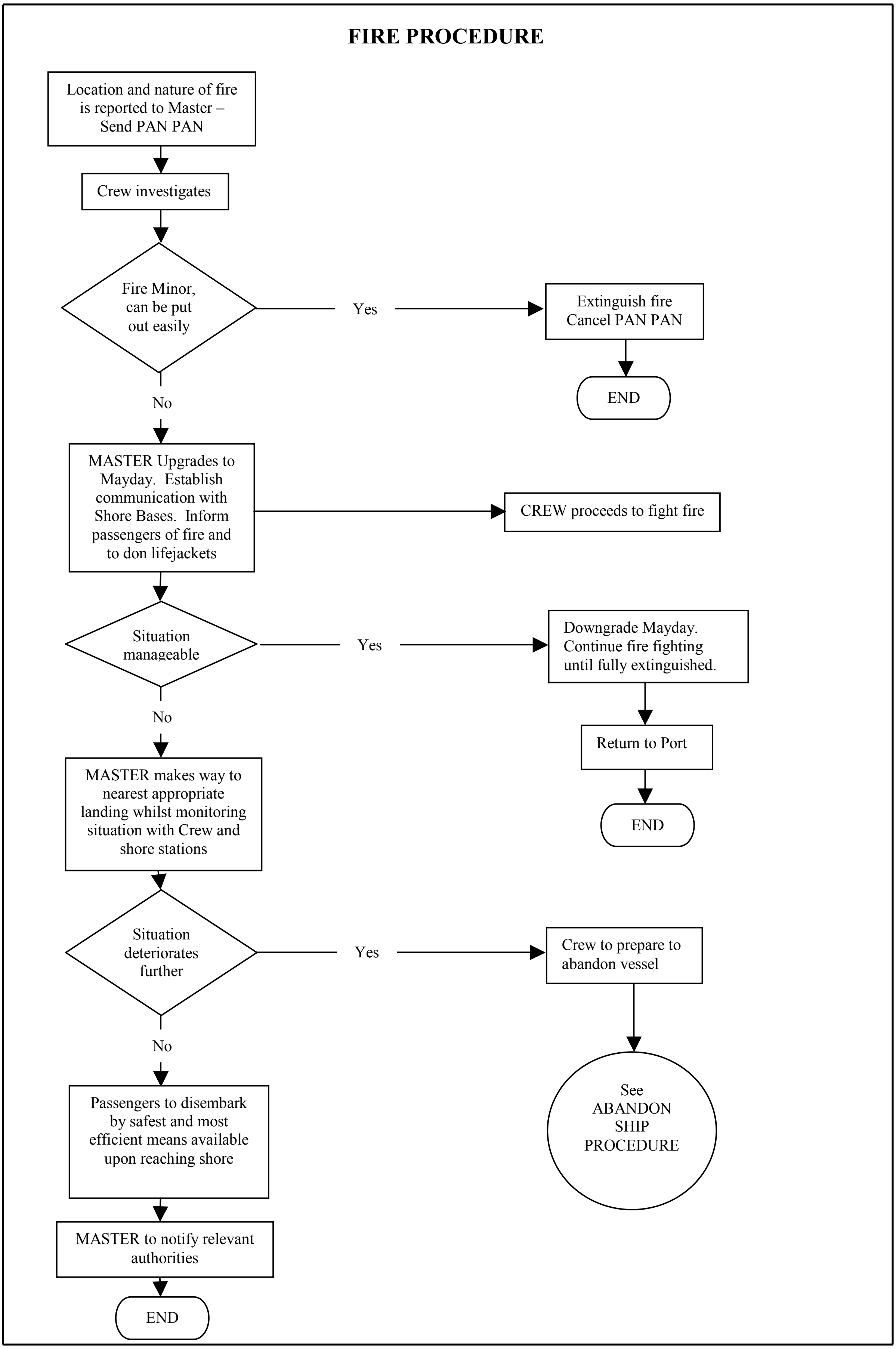
5.7 The Director of Maritime Safety replied to the final safety recommendations, that reply dated 21 April 2005, was (in part):

> Recommendation 022/05
> This recommendation is acceptable to the Maritime Safety Authority, provided suitable funding is sourced to conduct this work in its rules bid with the Ministry of Transport, for the financial year 05/06
>
> Recommendation 023/05
> This recommendation is acceptable to the Maritime Safety Authority, provided suitable funding is sourced to conduct this work in its rules bid with the Ministry of Transport, for the financial year 05/06

Approved for Publication 28 April 2005

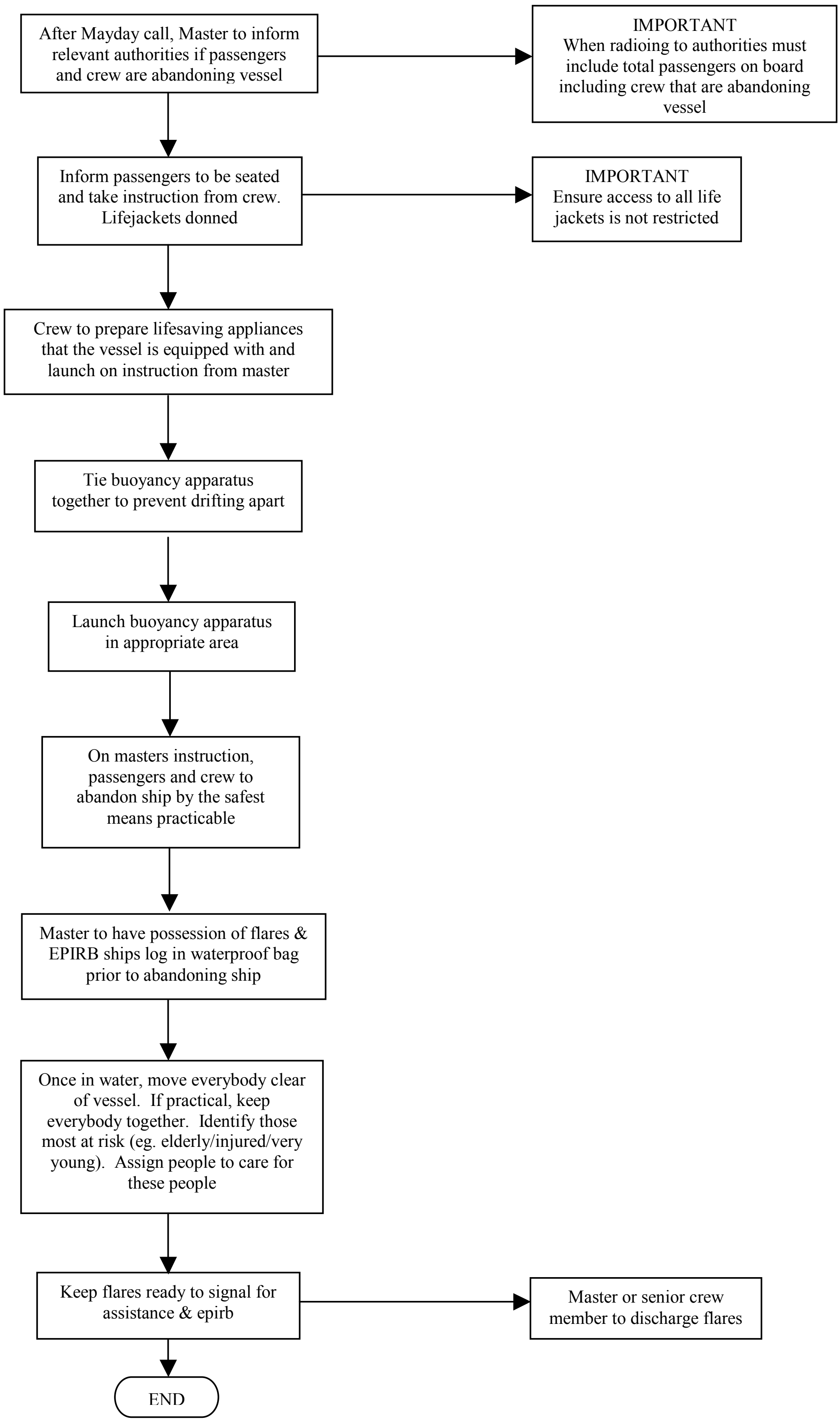
Hon WP Jeffries
Chief Commissioner

Appendix 1


FIRE PROCEDURE
Location and nature of fire is reported to Master – Send PAN PAN
Crew investigates
Fire Minor, can be put out easily
Yes
Extinguish fire Cancel PAN PAN
END
No
MASTER Upgrades to Mayday. Establish communication with Shore Bases. Inform passengers of fire and to don lifejackets
CREW proceeds to fight fire
Situation manageable
Yes
Downgrade Mayday. Continue fire fighting until fully extinguished.
Return to Port
END
No
MASTER makes way to nearest appropriate landing whilst monitoring situation with Crew and shore stations
Situation deteriorates further
Yes
Crew to prepare to abandon vessel
See ABANDON SHIP PROCEDURE
No
Passengers to disembark by safest and most efficient means available upon reaching shore
MASTER to notify relevant authorities
END

Appendix 2

ABANDON SHIP PROCEDURE



Appendix 3

CREW POSITIONS FOR EVACUATION

Crew Number	*Position for Evacuation*
No.1 - Master	Remains on bridge to co-ordinate evacuation, establish and maintain communication and activate distress alerts. Auto release for life rafts fitted on bridge – Master to release
No.2 – Engineer	Leaves bridge. Has a visual check of all upper deck passengers and guides them down stairs to **Evacuation Points III and IV** then lowers evacuation ladders port and starboard sides to **Evacuation Points I and II** midship doors. Proceed to **Evacuation Point IV**, position evacuation ladder, adjust bowsing and painter lines to manoeuvre life raft into position ready for loading. On advice from Master, proceed to disembark passengers. Then receive bowsing and painter line for the second raft and secure alongside. Transfer passengers from first raft to second. ***Passenger numbers for Evacuation Point IV total 102 passengers and one crew.*** In charge of Evacuation Station IV life rafts 8 & 6 Engineer to launch rescue vessel and/or tend to the emergency
No.3 – Service Supervisor	Proceed to **Evacuation Point I**, position evacuation ladder, adjust bowsing and painter lines to manouevre life raft into position ready for loading. On advice from Master, proceed to disembark passengers. Then receive bowsing and painter line for the second raft and secure alongside. Transfer passengers from first raft to second. Life Raft Nos. 1 & 3. ***Passenger numbers for Evacuation Point I total 105 passengers and one crew.***
No.4 – Crew	Proceed to **Evacuation Point III**, position evacuation ladder, adjust bowsing and painter lines to manouevre life raft into position ready for loading. On advice from Master, proceed to disembark passengers. Then receive bowsing and painter line for the second raft and secure alongside. Transfer passengers from first raft to second. Life Raft Nos. 5 & 7. ***Passenger numbers for Evacuation Point III total 104 passengers and one crew.***
No.5 – Crew	Proceed to **Evacuation Point II**, position evacuation ladder, adjust bowsing and painter lines to manouevre life raft into position ready for loading. On advice from Master, proceed to disembark passengers. Then receive bowsing and painter line for the second raft and secure alongside. Transfer passengers from first raft to second. Life Raft Nos. 2 & 4. ***Passenger numbers for Evacuation Point II total 103 passengers and one crew.***
No.6 - Crew	Assist as required under instruction from Master

The Engineer should join rafts at Evacuation Point IV or tow rafts with rescue tender. Whilst proceeding to these points, they should check cabins and toilet areas to ensure all passengers have left the vessel. Once all personnel are aboard the rafts, the crew should cut the rafts free from the vessel using the attached raft knives.

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03-209	container vessel *Bunga Teratai 4* and fishing vessel *Mako*, collision, Tasman Bay, 4 July 2003
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Price $24.00 ISSN 0112-6962