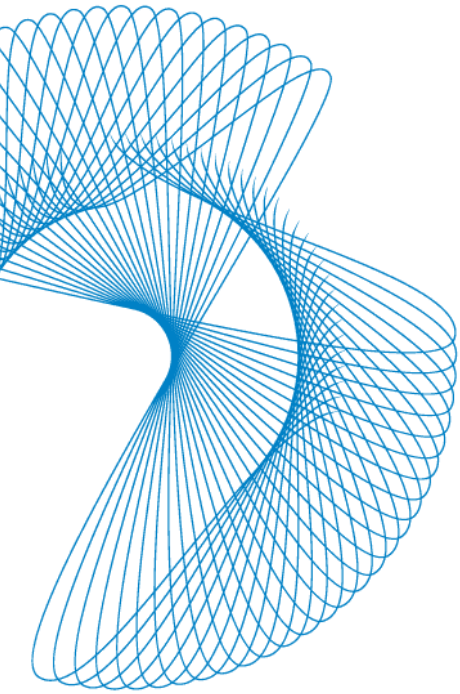
MARITIME NEW ZEALAND



Accident Report

Ammonia Leak

San Nikunau

7 December 2004

Class A

San Nikunau

REPORT NO.: 05 3749

VESSEL NAME: *SAN NIKUNAU*

Ship Type:	Commercial Fishing
Certified Operating Limit:	International
Port of Registry:	Auckland
Flag:	New Zealand
MSA No.:	129683
Built:	1982
Construction Material:	Steel
Length Overall (m):	79
Gross Tonnage:	1 957
Net Tonnage:	587
Registered Owner:	Sanford Ltd
SSM Company:	SGS-M&I
Accident Investigator:	Ian Howden

SUMMARY

San Nikuanu is a tuna purse seine vessel that suffered an ammonia leak in the pipe alley whilst fishing in Kiribati waters near the Phoenix Island Group on 7 December 2004. Two crew suffered ammonia burns caused by ammonia venting from a ruptured pipe as they escaped from the pipe alley. Initial attempts to isolate the ammonia leak were unsuccessful due to high concentrations of ammonia in the pipe alley and the danger this presented to crew. The Master ordered the hatches to be opened to vent the ammonia. After approximately four hours the Chief Engineer was able to isolate the ruptured pipe. During the leak, approximately 4,000 lbs (1814 kilos) of anhydrous liquid ammonia was vented into the pipe alley. Temporary repairs were carried out and the vessel proceeded to Majuro in the Marshall Islands to complete permanent repairs and replace the ammonia lost from the system.

This accident was not reported to Maritime New Zealand as required under the Maritime Transport Act. Nor was it reported to the vessel's Safe Ship Management (SSM) Company as required under the vessel's SSM system. It was only whilst Maritime New Zealand was imposing conditions on the vessel in Auckland on 28 May 2005 and a Maritime New Zealand inspector queried an entry in the vessel's log that the accident was bought to Maritime New Zealand's attention. An investigation commenced immediately. The Master, First Mate, Chief Engineer and one of the injured crewmen were interviewed on board the vessel in Auckland between 27 May and 2 June 2005. The company's Tuna Fleet Operations Manager was interviewed at Maritime New Zealand's office in Auckland on 13 June 2005. Documentation for the vessel was obtained. This included log entries, SSM documentation, crew qualifications and engineering maintenance records. On examination of engine room records it was discovered that a previous unreported ammonia leak occurred on 21 March 2004 when a liquid ammonia line was described as having "blown out" with the escape of 1500lbs of ammonia (680.4 Kilos)

This report:

- Details the obligations of the owner under the Health & Safety in Employment Act and the Maritime Transport Act in terms of reporting accidents and providing a safe working environment for employees.

- Details the obligations of the master under the Health & Safety in Employment Act and the Maritime Transport Act in terms of reporting accidents and providing a safe working environment for employees.

- Examines the danger presented to persons working on board vessels that contain ammonia.

- Makes recommendations to improve safety standards for seafarers working on vessels that operate with ammonia.

- Examines current industry standards.

VESSEL & CREW

San Nikunau is a steel New Zealand registered tuna seine vessel. Records indicate she was built in 1991. Her homeport is Auckland. Her gross tonnage is 1957. She has a registered length of 74 metres. Originally, she was built as a drum trawler and was converted to purse seine operations in 1991.

She is owned and operated by Sanford Ltd since her purchase in 2001. Total crew complement is 20.

San Nikuanu holds a valid SSM Certificate, issued on 11 April 2003 and valid to 11 January 2006, allowing unlimited operation.

The Master is a United States of America national who holds a United States Coast Guard License as Master of an Uninspected Fishing Industry Vessel of not more that 2 000 gross tonnes upon oceans, issued in December 2001. His License was recognised by Maritime New Zealand in January 2003 as equivalent to a New Zealand Certificate of Competency as Master of a Deep Sea Fishing Vessel. Recognition was limited to service on the company vessels *San Nikunau* and *San Nanumea*.

The Mate holds a Master Deep Sea Fishing vessel Certificate of Competency. He has also worked on the other company purse seine vessel *San Nanumea* since her purchase in 2001. He has extensive experience in the fishing industry. He had completed two courses on the dangers of ammonia.

The Chief Engineer is an Argentinean national. A letter of authority issued in May 2005 by Maritime New Zealand confirmed that as the holder of an Argentinean Certificate of Competency as Chief Engineer, he met all the requirements as Marine Engineer Class 4 (MEC4). He sat and passed his Motor Engineer Class 1 on 24 October 2004. The MCE4 has a limit of 3 000kW. He was qualified as Chief Engineer of *San Nikunau.*

NARRATIVE

N.B. All times given are UTC (Co-ordinated Universal Time) unless otherwise stated.

On 7 December 2004, *San Nikunau* was fishing in Kiribati waters near the Phoenix Island Group. The vessel had departed PagoPago, American Samoa, on 15 October 2004.

Shortly before 0215 hours, three crew including the Chief Engineer, were working in the pipe alley to reduce brine temperatures when a small ammonia gas leak was detected from a rusted section of the discharge line from the receiver. The Chief Engineer instructed the Assistant Engineer and Oiler to close valves to isolate the section of pipe whilst he went under the catwalk to check for further leaks. As the valves were being closed, but before the pipe could be isolated, it commenced venting a large quantity of ammonia. The Engineer ordered the crew to evacuate the pipe alley. As he left, he closed the king valves, however, the discharge continued as the venting pip was not fully isolated. The two crew who were forward of the leak escaped by running aft, through the venting ammonia, and in so doing sustained ammonia burns to their legs and arms. *(See Figures 1 & 2 - Photographs of the pipe alley showing area where ammonia vented & pipe that failed).*

The Chief Engineer went immediately to the bridge whilst the Assistant Engineer made an announcement on the public address system in the engine room advising there was a major leak in the pipe alley. The Master sounded the general alarm and altered course to allow the wind to vent leaking ammonia from the vessel. The crew mustered aft of the bridge at the muster station and a head count was made. Two crew were missing. The Second Mate donned a chemical suit and breathing apparatus (BA) and located the two crewmembers who were brought to the muster station. The Chief Engineer then attempted unsuccessfully to enter the pipe alley wearing a chemical suit and BA gear. Following this both the Chief Engineer and Assistant Engineer donned chemical suits and BA gear and attempted to close down the venting ammonia with similar results. A third attempt by the Chief Engineer also failed. The attempts failed due to the dangerous level of ammonia and the danger of tearing the suits in the confined alley space, they were unable to isolate the venting pipe. After the last attempt, it was found that the air in the BA bottles was depleted, rendering the chemical suits inoperable. The Master determined it was too dangerous to make further attempts to access the pipe alley and ordered forward hatches be opened to vent the ammonia and improve visibility. The vessel was positioned with the wind on the port side to facilitate venting. After approximately 20 minutes the Chief Engineer was able to enter the pipe alley dressed in wet weather gear wearing a cartridge mask. He was able to isolate the venting pipe. The area was left for a further four hours to vent before entry and repairs. After reporting the situation to the company office in Auckland advice was sought on repairing the pipe. By 1800 hours, repairs had been completed and the vessel was underway en route to Majuro for permanent repairs.

Injuries

The two injured crew in the 7 December accident sustained moderate to minor burns on their arms and legs. The Oiler was immediately put in a shower for approximately 50 minutes and had gel bandages applied to his burns. Due to the unhygienic work required of crew for the remainder of the trip, he was confined to his bunk for the final leg to Majuro. The Assistant Engineer had similar treatment. He continued with his duties for the remainder of the trip. On arrival in Majuro both men were examined by a doctor and received no further treatment. The Master assessed both crew's injuries as minor and for this reason did not seek medical advice by radio although this was available. The Master, Mate and Chief Engineer held ship medical qualifications.

Treatment

Both injured crew treated their injuries with large amounts of water and had their injuries bandaged.

Refrigeration system

The Pipe Alley

The pipe alley runs along the duct keel from the engine room to the No. 1 fish well in the bow section. Access to the pipe alley is from the engine room. At the forward end there is an escape exit up onto the main deck. A catwalk running the full length of the alley separates it to an upper and lower section. Three receiver units in the alley contain ammonia for refrigerating fish wells. Each unit is capable of holding 1500 litres. During operation, one unit is kept in reserve. At the time of the accident the units were at 75% capacity. The pipe that failed was on the port side of the catwalk behind large condenser pipes. Heavy rust was found at the section that failed. Behind the bulkheads on both sides of the alley are fish wells *(See Figures 1 & 2 - Diagram of below main deck and refrigeration system (not to scale) plus photograph of pipe alley from position of leak)*

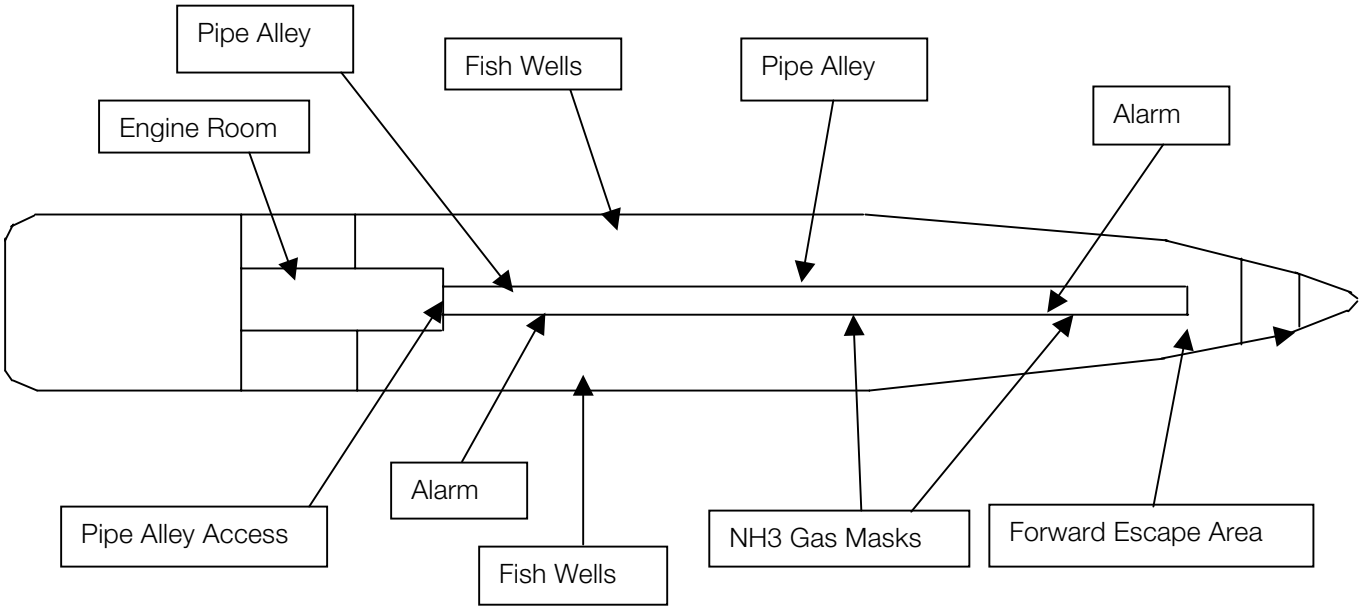


Figure 1
San Nikunau – Below Maindeck Diagram
(not to scale)

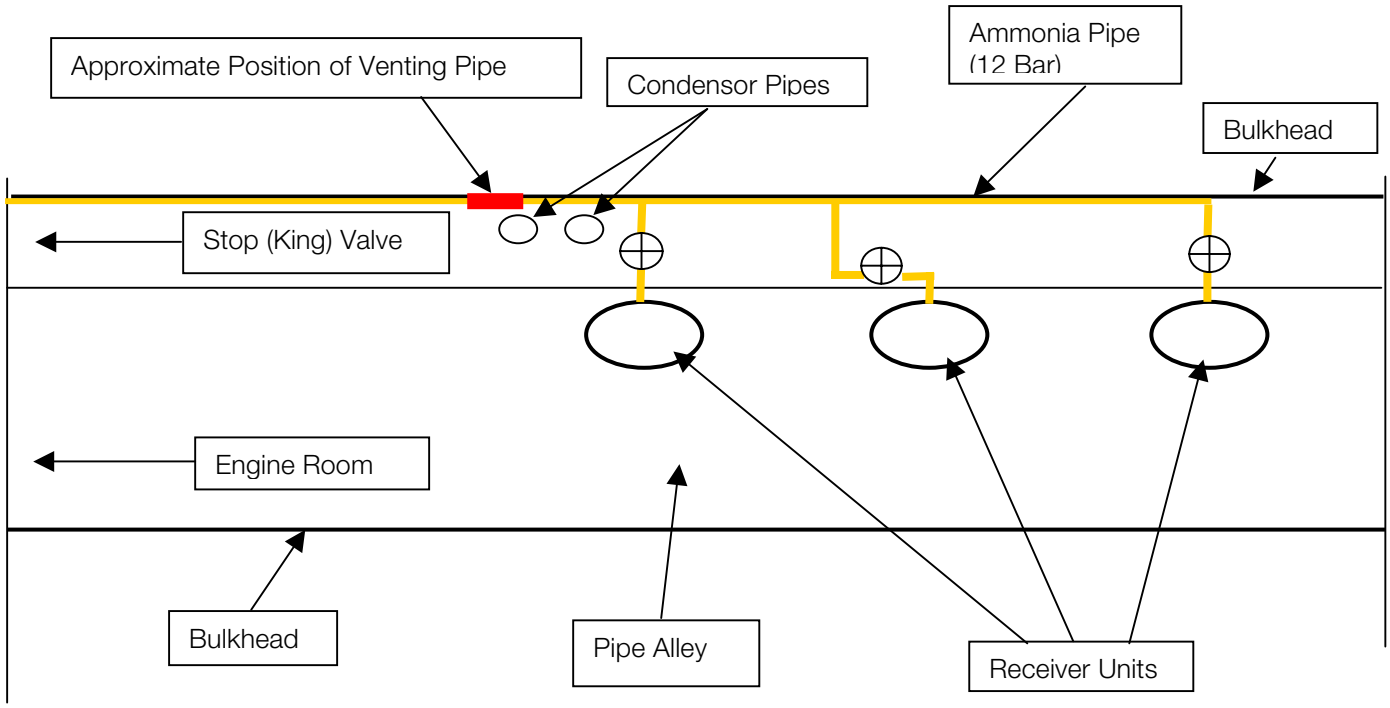
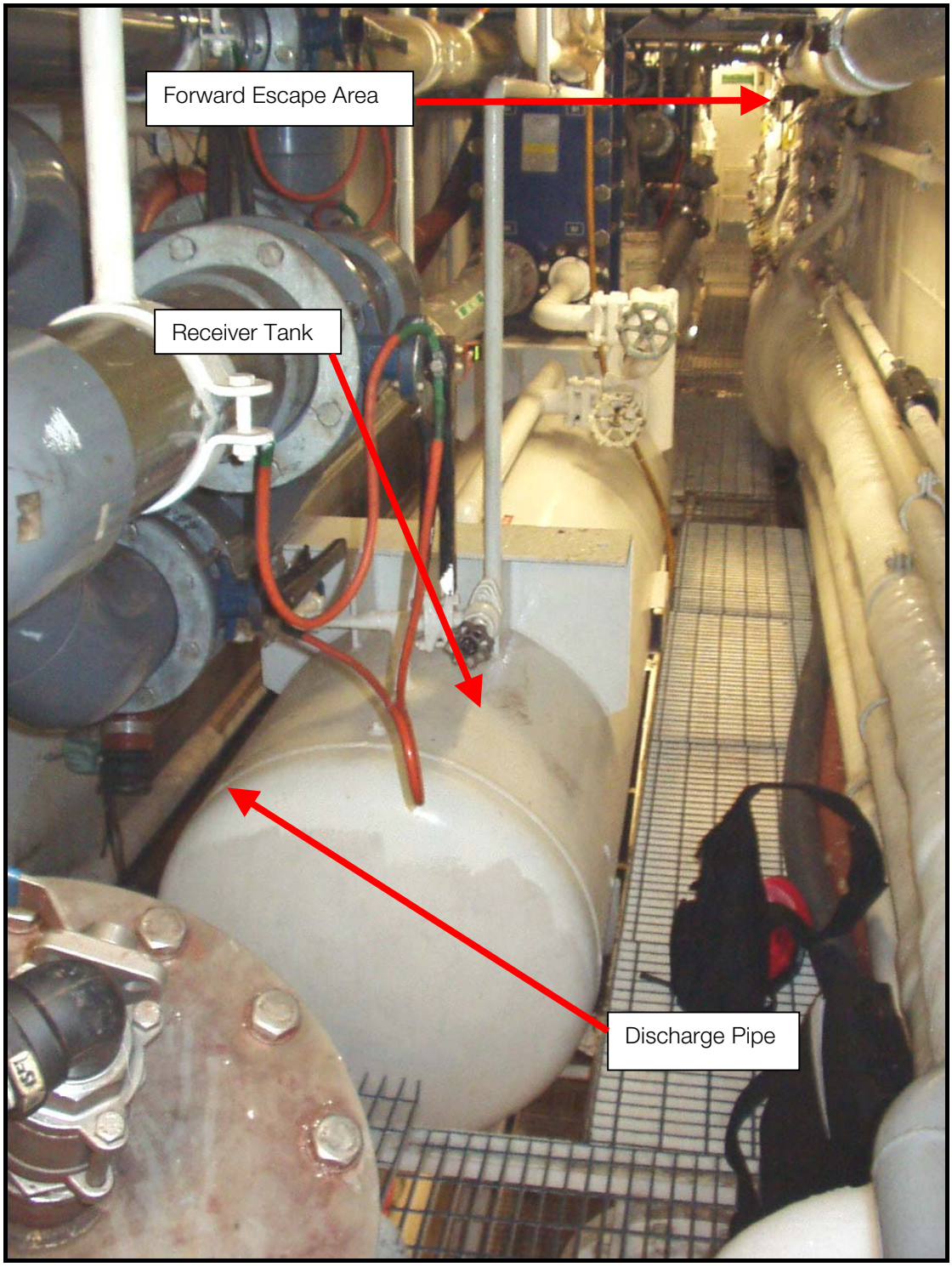


Figure 2

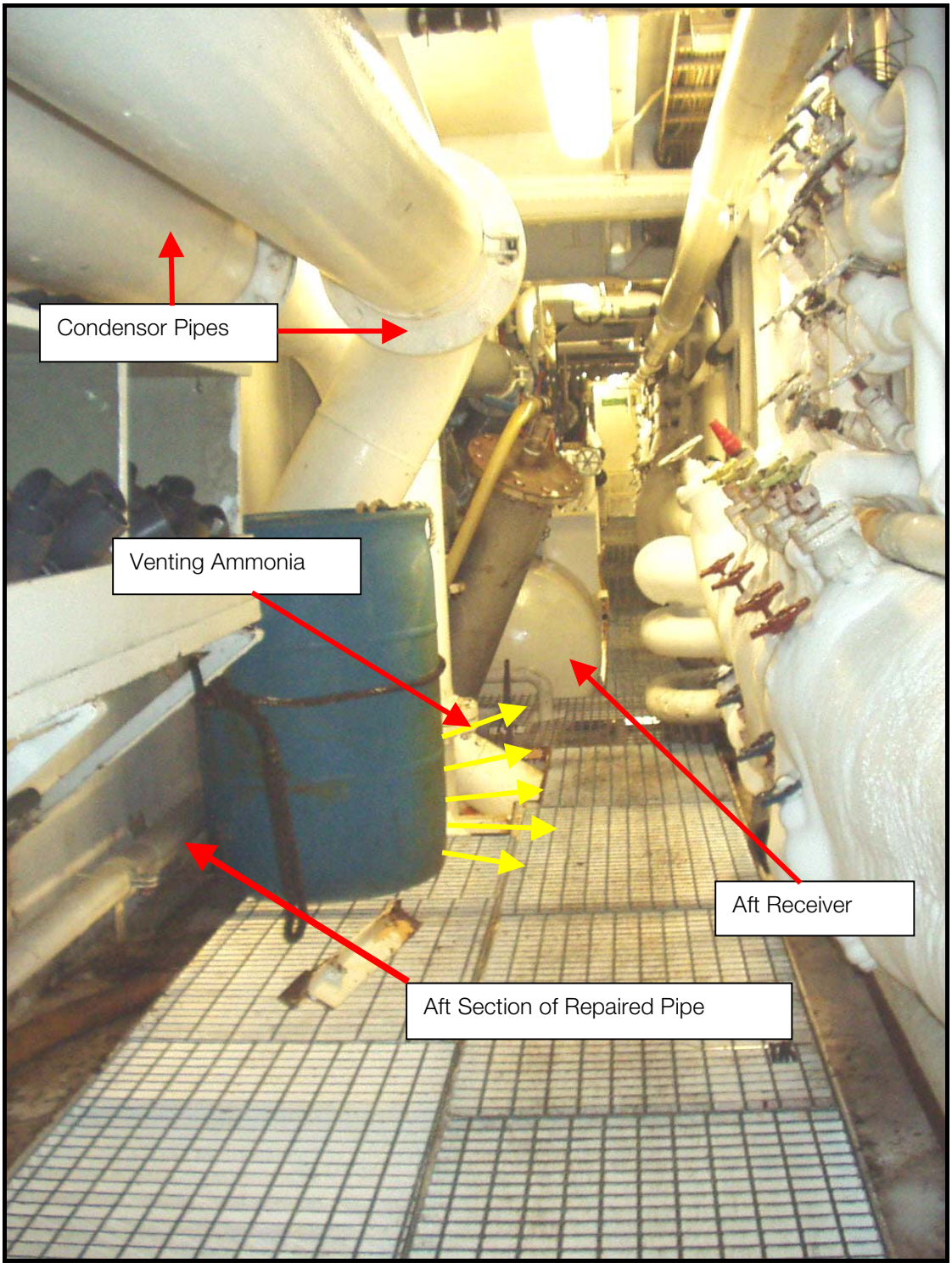
Section of Pipe Alley where Ammonia was vented

(not to scale)

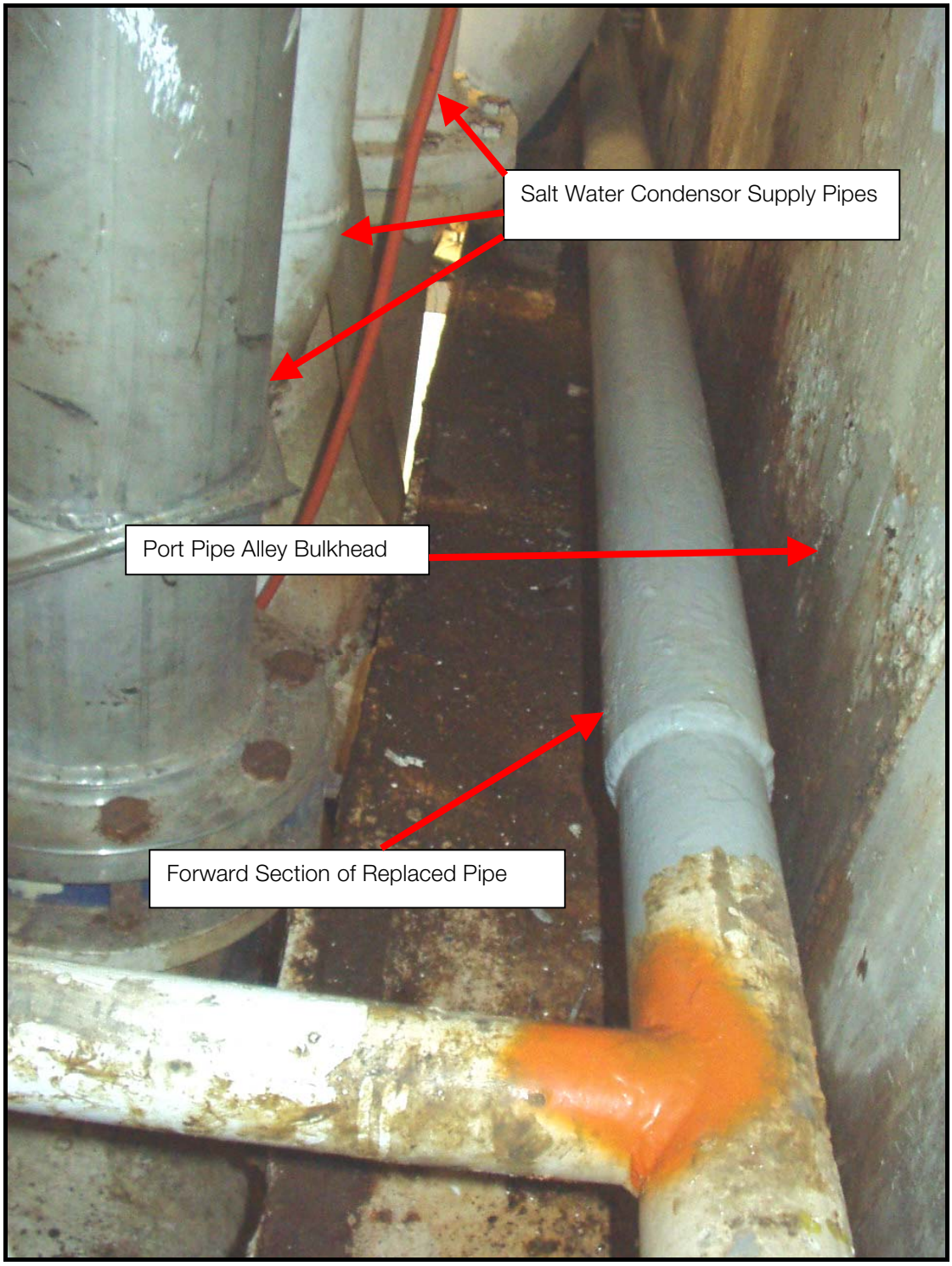


Photograph 1

The pipe that failed was the discharge line from the receiver. It was under continual pressure of 12 atmospheres (12 bar). It can only be closed down when the entire system is shut down *(See Photographs 2 & 3 - Replaced section of pipe viewed from aft and forward)*.

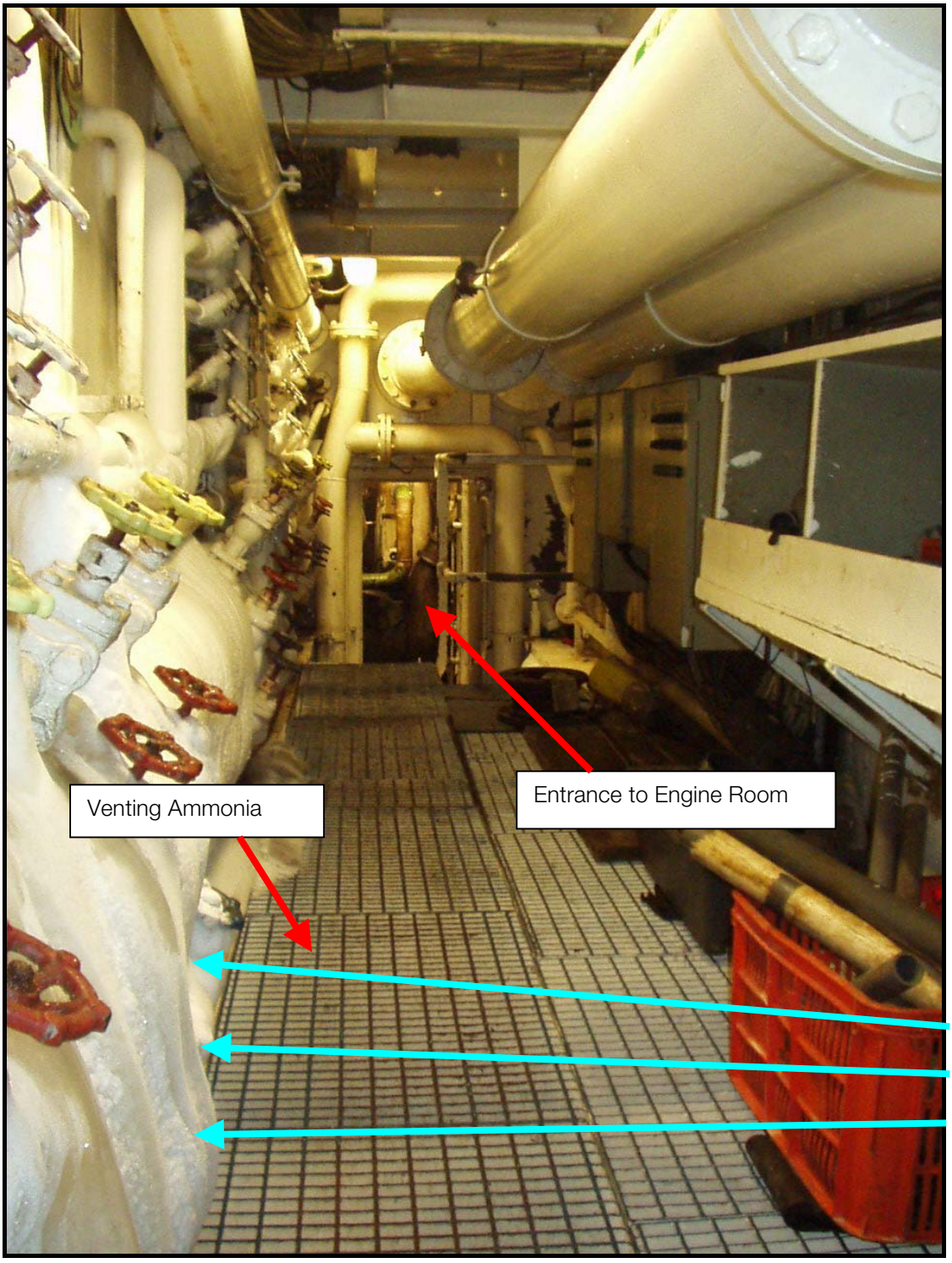


Photograph 2



Photograph 3

The three crew exited the pipe alley by running aft to the engine room *(See Photograph 4)*.



Photograph 4

The pipe alley has two ammonia masks and general quarters alarms in the catwalk section on the starboard bulkhead of the alley *(See Photograph 5 - Photograph of mask & Figure 1 showing location)*.

Photograph 5

The pipe alley is ventilated from positive pressure exerted by the engine room blowers. This forces air into the alley from the engine room *(See Photograph 4 - Engine room entrance viewed from position of leak)*.

Due to the positive pressure from the aft section of the alley, the ammonia expanded forward from the venting point. For this reason the crew escaped via the engine room. They knew that after passing through the venting ammonia they could breathe safely. The other option was to run forward, hopefully in advance of the expanding ammonia, and escape up the ladder at the forward end of the pipe alley *(See Photograph 6 - Emergency exit and escape rungs)*.

Photograph 6

Ammonia Safety Equipment

- 2 x BA equipment
- 2 x Chemical protection suits
- 6 x ammonia masks (2 in the pipe alley)
- Litmus testing units
- Sulphur stick-testing units

Refrigeration System Maintenance

When *San Nikunau* was purchased in 2001 the refrigeration system was inspected and all pipes pressure tested. The system was tested to 21 bar (300psi) with dry nitrogen. Leaks found were rectified. The system was then re-tested and found secure *(See Figure 3 - Tightness Certificate from Company Service Division)*. No further pressure testing had been carried out since that time.

The vessel's engine room log gave a thorough record of all engineering maintenance. This included maintenance on the refrigeration system. Entries referring to maintenance on the system appear regularly throughout the log. On 21 March 2004, the log sheet refers to a liquid ammonia line blow out. The trip record sheet for 21 March states that 1500 lbs of ammonia was lost from the number 10-bottom bank at the stop valve on the main liquid line. The Pacific Tuna Manager stated he was not specifically made aware of this accident and was not aware of any significant leaks during Sanford's ownership prior to 7 December. In the days prior to the 7 December leak work was carried out on the expansion valves. The log refers to an ammonia leakage on 9 December 2004. However, when questioned on this, the company advised this was an error and that the entry related to the accident of the 7th December 2004 *(See Figure 4 - Excerpt of log 17 November to 12 December 2004)*

Drills

San Nikunau's deck log had no entries for emergency drills. Ship's computer readout records indicated fire and man overboard drills had been carried out on a regular basis. The last drills were on 6 October 2004 (fire) and 7 October 2004 (abandon ship). No specific drills for ammonia leaks had taken place since the vessel's purchase by the company.

Weather

At the time of the leak, winds were northwest force 4 with a 1.5 metre northwest swell.

SANFORD SERVICE DIVISION
SUSTAINABLE SEAFOOD

TIGHTNESS CERTIFICATE

VESSEL	: San Nikunau
Date tested	: 02 January 2002
Location	: Auckland
Test medium / pressure	: Dry nitrogen / 21 bar (300psi)

To Whom It May Concern:

A survey of the NH3 refrigeration system for the above vessel has been completed and a thorough leak test was conducted.
All leaks found were rectified and the system has been re-tested and found secure.

Regards,

Frank Kleinherenbrink Ch.Eng.
Marine and Refrigeration Engineer.
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Figure 3

Date	Denomination	Work
17-Nov-2004	Generator Eng #1	Rferigeration water inlet to Turbocharger fixed by leak
17-Nov-2004	Ammonia Comp #1	Mechanical Seal Replaced
17-Nov-2004	# 5 Fishwell Stdb	Fuel oil to d. bottoms and cleaned
17-Nov-2004	# 5 Fishwell Stdb	fissure on floor of tank - oil leak - welded and checked
18-Nov-2004	Generator Eng #1	Basement of Turbocharger repaired and bolts replaced
18-Nov-2004	Fresh water tank # 14 P	plate on ceiling welded - to cover a hole
19-Nov-2004	Bowtrusther	Reducing air press valve to control system replaced
20-Nov-2004	Hyd System	Hydraulic oil coolers cleaned and Zinc replaced
21-Nov-2004	Ammonia Comp #3	20 lts of lub oil added
21-Nov-2004	Bowtrusther	System parts regreased
21-Nov-2004	Watermaker	Brass Nipples hoses replaced - broken
22-Nov-2004	Wet deck	Aft Conveyor - 3 ball bearing with housing replaced on fore and aft shafts to hydraulic motor
22-Nov-2004	Exhaust stack	chipping and painting
23-Nov-2004	Pipealley	Jointing replaced on brine pipe 4" Portside
24-Nov-2004	Rudder Room	chipping and painting
25-Nov-2004	Main Winch	Bow purse drum roller replaced and rebuilded
26-Nov-2004	Main Winch	Main purse drum , roller replaced and rebuilded
26-Nov-2004	# 10 Stbd circ pump	Mechanical Seal Replaced
27-Nov-2004	Exhaust stack	chipping and painting
29-Nov-2004	Ammonia Comp #2	Pressure Transmitter suction ammonia compressor replaced
29-Nov-2004	Hyd System	Gypsy winch - Port speedboat deck. Hydraulic motor replaced - Leak of oil by seal
30-Nov-2004	#4 Fishwell Stbd	Cage and Power Head on upper coil replaced
1-Dec-2004	Emergency air compressor	Chip & painted
2-Dec-2004	# 5 Stbd Fishwell	Cleaned and bottom welded by fissures
3-Dec-2004	Hydr Caterpillar Stbd	Replaced fitting on discharge of Vickers Hydraulic pump - Aft side gearbox
3-Dec-2004	Air Condition	1 Gallon of Glycol added
4-Dec-2004	Stern Tube	Stern Tube tank 20 lts lub oil added
5-Dec-2004	#8 Stbd Fishwell	Manual expansion ammonia valve disassembled and fixed
6-Dec-2004	Rudder	Rudder Stack regreased
6-Dec-2004	Hydr Caterpillar Stbd	Hydraulic oil leakeage fixed on main
6-Dec-2004	Freezer	Orifice on expansion valve replaced
7-Dec-2004	Refrigeration System	Main leakeage of ammonia - hole on discharge from receiver tank - All system stopped
8-Dec-2004	Refrigeration System	discharge Line from Receiver Tank emergency repaired and start the refrigeration plant again -
9-Dec-2004	Refrigeration System	Ammonia leakege detected on discharge line from ammonia receiver - 2500 pounds lose - we made emergency repair with Marine text and clamps
10-Dec-2004	Skiff	Cleaned
10-Dec-2004	Bowtrusther	Lub Oil and filters F.O& Lub Oil replaced
10-Dec-2004	Hydr Caterpillar Port	Lub Oil and filters F.O& Lub Oil replaced
10-Dec-2004	Hydr Caterpillar Stbd	Lub Oil and filters F.O& Lub Oil replaced
11-Dec-2004	Generator Eng #1	Service - Oil lub replaced - Lub oil filter replaced - Lub oil purifiers cleaned - turbochargers lub oil replaced
12-Dec-2004	Rudder Pump #2 Stbd	Start Motor circuit braker replaced

Figure 4

COMMENT & ANALYSIS

Ammonia

Ammonia condenses to a colourless liquid when kept at elevated pressures of approximately 900 kPa (8.88 atmospheres). On *San Nikunau*, the pressure in the pipe that failed was 12 atmospheres. A characteristic of ammonia is its low corrosivity to iron, steel, tin, aluminum and their alloys. For this reason internal sections of piping and receiver units remain relatively free of corrosion. Ammonia is lighter than air and will accumulate at head level in limited entry areas such as freezer holds and pipe alleys. When ammonia escapes from a pipe, where it is in a liquid state it expands rapidly when it enters the atmosphere. This rapid expansion poses considerable danger to persons in confined spaces when a leak occurs.

Ammonia is an extremely dangerous substance that has long been recognized as a hazard to mariners. Skin contact can cause first or second degree burns. Eyes are especially vulnerable with potential to seriously damage the cornea. Inhalation in higher concentrations can cause severe breathing difficulty. In serious cases lung damage can occur causing pulmonary oedema that can be fatal. Ammonia is explosive in air at gas concentrations greater than 15-28%. The presence of oil or other combustible materials will increase the fire hazard. Ammonia is easily distinguished by odour although exposure to dangerous levels can occur before it can be smelled. It is detectable by smell at concentrations as low as 0.6 ppm (parts per million). At 500 ppp it is classed as being immediately dangerous to life and health. At 1700 ppm it can be fatal after 30 minutes. At 5 000 to 10 000 ppm it can be fatal within minutes. In 2002, a leak in a purse seiner in Pago Pago closed the main dock. In 2004, an explosion of a 1 000 litre tank on a vessel in Montevideo caused 67 crew to be hospitalized.

Treatment

Application of large quantities of water is recommended for areas of the body exposed to ammonia. When eyes are affected in the absence of medical advice water irrigation should be continued for 30 minutes followed by 2 or 3 drops of 0.5 percent pontocaine solution or an equally effective aqueous topical anesthetic. After irrigation of the nose and throat 0.5 percent citric acid solution or lemonade should be consumed.

Detection

There are a number of methods for detecting ammonia. By far the most common is by smell. Ammonia is easy to test for with relatively inexpensive detector tubes or hand-held gas meters anyone can use. In addition, sulphur sticks and litmus paper can be used. In Australia, in the workplace, the Time Weighted Average (TWA) concentration of the work atmosphere for a normal 8 – hour day and a 40 hour work week is to achieve concentrations of not more than 25 ppm *(Australian National Health & Safety Commission)*. Fixed ammonia gas detection systems are available to monitor ammonia levels. Multipoint fixed alarm systems can monitor different sections of a vessel where there is a danger of an ammonia leak and activate an alarm on the bridge. Non-dispersive infra red technology, that is refrigerant specific, is used in many of these systems, making them suitable for vessels.

Industry Standards

In 2002, the New Zealand Seafood Industry Training Organization published a 130-page document in association with the Accident Compensation Commission and the Department of Labor on ammonia. This was intended as a base reference for the development of individual training resources relating to safety and training for ammonia emergencies primarily for factory/freezer vessels. This document gives a detailed description of the properties of ammonia together with safety standards and the procedures required for safe operation.

Reporting

The company failed to notify Maritime New Zealand of the accident despite the fact that the Pacific Tuna Manager stated he knew he had an obligation to report. The Master advised the company of the accident approximately 20 minutes after the alarm. The vessel sent a detailed report on 8 December. The Master stated it was procedure to report accidents to the company. He was relying on the company to report the matter to Maritime New Zealand. When questioned, the Pacific Tuna Manager stated his failure to instruct the vessel to send the original report via post for submission to Maritime NZ was an oversight. Under the Maritime Transport Act (MTA), masters have an obligation to report accidents that involve the loss of any substance or thing that may result in serious harm to any person. There are no Maritime Rules in force that require any persons other than the master to notify Maritime New Zealand of an accident. Under section 410 of the MTA there is however vicarious liability of a principal where an agent or employee breaches the MTA. In this case as there existed an internal company procedure whereby the master was required to report accidents to the company, the failure of the Master to report would make the company liable for his breach of the Act under section 410 MTA. Both Master and company had obligations either to report or ensure the accident was reported.

Maritime Transport Act 1994

S 31 Obligation to notify all accidents, incidents, etc.

(1) The master of—
- *(a) Any New Zealand ship; or*
- *(b) Any foreign ship in New Zealand waters—*

that is involved in a mishap that results in serious harm to a person, an accident, or an incident, shall notify the mishap, accident, or incident to the Authority as soon as practicable.

(2) If, due to injuries or death or for other good reason, the master of a ship referred to in subsection (1) of this section is unable to give the necessary notice under that subsection, the operator of the ship shall provide the necessary notice.

S. 410 Liability of principal for acts of agents

(1) Where an offence is committed against this Act by any person acting as the agent or employee of another person, that other person shall, without prejudice to the liability of the first-mentioned person, be liable under this Act in the same manner and to the same extent as if he, she, or it had personally committed the offence.

(2) Notwithstanding anything in subsection (1) of this section, where any proceedings are brought by virtue of that subsection, it shall be a good defence if the defendant proves,—

- *(a) In the case of a natural person (including a partner in a firm), that—*
  - *(i) He or she did not know nor could reasonably be expected to have known that the offence was to be or was being committed; or*
  - *(ii) He or she took all reasonable steps to prevent the commission of the offence:*
- *(b) In the case of a body corporate, that—*
  - *(i) Neither the directors nor any person involved in the management of the body corporate knew or could reasonably be expected to have known that the offence was to be or was being committed; or*
  - *(ii) The body corporate took all reasonable steps to prevent the commission of the offence:*

(c) In all cases, that the defendant took all reasonable steps to remedy any effects of the act or omission giving rise to the offence.

(3) Where any body corporate is convicted of an offence against this Act, every director and every person concerned in the management of the body corporate shall be guilty of the like offence if it is proved—

(a) That the act that constituted the offence took place with his or her authority, permission, or consent; and
(b) That he or she knew or could reasonably be expected to have known that the offence was to be or was being committed and failed to take all reasonable steps to prevent or stop it.

Health & Safety in Employment Act

Under section 3B of the Act the Health & Safety in Employment Act applies to New Zealand ships outside New Zealand.

[3B Application of Act to ships

(1) This Act applies—

(a) to a person—
(i) employed or engaged under an employment agreement or contract for services governed by New Zealand law to work on board a New Zealand ship or on board a foreign ship carrying coastal cargo while the foreign ship is on demise charter to a New Zealand-based operator; or
(ii) performing work on a foreign ship while it is carrying out petroleum operations in New Zealand continental waters (as defined in section 222(1) of the Maritime Transport Act 1994); and

(b) to the person who employs or engages the person described in paragraph (a); and
(c) to the ship as a place of work.

(2) Where this Act applies in respect of a New Zealand ship, it applies whether the ship is operating inside or outside New Zealand.

(3) Section 16 does not apply to a ship while it is at sea.

(4) To avoid doubt, where this Act applies outside New Zealand, the provisions relating to offences apply even though an act or omission that constitutes an offence occurred in respect of a ship outside New Zealand.

Part 2 of the Act places an obligation on employers relating to health and safety in employment:

6 Employers to ensure safety of employees
Every employer shall take all practicable steps to ensure the safety of employees while at work; and in particular shall take all practicable steps to—

(a) Provide and maintain for employees a safe working environment; and

(b) Provide and maintain for employees while they are at work facilities for their safety and health; and

(b) Ensure that plant used by any employee at work is so arranged, designed, made, and maintained that it is safe for the employee to use; and

(d) Ensure that while at work employees are not exposed to hazards arising out of the arrangement, disposal, manipulation, organisation, processing, storage, transport, working, or use of things—
(i) In their place of work; or
(ii) Near their place of work and under the employer's control; and

(e) Develop procedures for dealing with emergencies that may arise while employees are at work.

In addition sections 7, 8, 9 & 10 place an obligation on employers to identify hazards and take all practicable steps to eliminate, isolate and minimize hazards to employees.

The injuries suffered by the crew did not fall within the definition of serious harm under the Health & Safety in Employment Act. Accordingly there was no obligation for the master or company to report to Maritime New Zealand under the health and safety legislation.

Life Saving Appliances

The Mate expressed surprise that the BA bottles lost pressure as soon as they did. Two of the four BA bottles were fully pressurized at 200 bar. The other two were at approximately 160 to 170 bar due to being used in drills. The Mate was of the opinion that the positive pressure required for the chemical suits may have been a factor that contributed to the rapid depletion.

The sudden failure of the discharge pipe allowing a large quantity of ammonia to vent may have been caused by the rapid drop in temperature in the area of the initial leak. When the leak first occurred the effect of expanding gas might have chilled the adjacent material thus altering its physical properties causing the failure to occur over a larger area.

CONCLUSIONS

N.B. These are not listed in order of importance

- The ammonia leak placed the three crew working in the pipe alley of *San Nikunau* in serious danger. The Chief Engineer succinctly expounded the danger in relation to the crew who are close to the ruptured pipe by stating “one metre you live, one metre you die”.

- Given the serious danger ammonia poses, specific drills for ammonia leaks should be mandatory on fishing vessels carrying ammonia.

- The section of pipe that failed was heavily rusted.

- The pipe that failed was not readily visible due to it being behind large condenser pipes. It is likely that the line was not visually inspected on a regular basis because of its situation.

- As *San Nikunau* was at sea, the expectation of the Master that the company would report the ammonia leak to Maritime New Zealand was reasonable, given company procedures required him to report directly to the company. He was nevertheless in breach of the Maritime Transport Act, by failing to report the accident to Maritime New Zealand.

- In the course of this investigation a previous ammonia leak and a subsequent serious harm injury were found to have occurred on *San Nikunau.* Neither of these was reported to Maritime New Zealand as required under the Maritime Transport Act and the Health & Safety in Employment Act.

- The fact that the Pacific Tuna Manger was unaware of the 21 March 2004 ammonia leak, suggests that company procedures for reporting accident to management were not followed in this instance.

- Whilst the responsibility to report accident lies on the Master, the company is vicariously liable for the failure of the Master to report the accident.

SAFETY RECOMMENDATIONS

1. A compressor be carried on board to ensure BA bottles can be refilled.

2. The company put in place a scheduled inspection system to ensure all ammonia pipes are inspected every 6 months and replaced if required. *At the time this report was being compiled sections of piping had been marked for replacement.*

3. Ammonia leak drills be carried out on a regular basis and be documented in the vessel's deck log.

4. The company ensures that accidents, incidents or mishaps required to be reported under the Maritime Transport Act or the Health & Safety in Employment Act are reported to Maritime New Zealand as soon as practicable.

5. The Company ensures all crew on ammonia refrigerant vessels view the New Zealand Seafood video "It Happens" that deals in part with ammonia leaks on fishing vessels.

6. The company, in consultation with the vessel's SSM company, put in place a specific section in the vessel's SSM manual relating to safety and emergency procedures for ammonia leaks.

7. It is recommended the company refer to the New Zealand Seafood Industry Training Organization (2002) and the Tuna Handling and Refrigeration on Purse Seiners publications *(See References)* in relation to procedures to be taken in the event of an ammonia leak.

8. The company considers installing fixed ammonia detection units.

9. The company purchase additional ammonia masks and ensure that within confined spaces, where ammonia is likely to vent, there are masks present for the maximum number of crew likely to be in the space in question.

10. The company considers purchasing additional chemical protection suits and B/A equipment.

11. The company is censured for failing to ensure the Master reported both ammonia leaks to Maritime New Zealand.

12. The Master is censured for failing to report both ammonia leaks to Maritime New Zealand.

13. The company is censured for failing to have in place procedures to ensure ammonia pipes were properly inspected.

References:

Ammonia Toxicity — *Institute of Chemical Engineers*
Tuna Handling & Refrigeration on Purse Seiners — *Dept. of Commerce, USA*
Ammonia Refigerant Gas & Safety Training Resource — *New Zealand Seafood Industry Training Organisation (SITO)*
Ammonia Handbook — *Orica Australia Pty Ltd.*