Final report MO-2017-205: Multipurpose container vessel *Kokopo Chief*, cargo hold fire, 23 September 2017

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Final Report

Marine inquiry MO-2017-205
Multipurpose container vessel *Kokopo Chief*

Cargo hold fire

23 September 2017

Approved for publication: September 2018

Transport Accident Investigation Commission

About the Transport Accident Investigation Commission

The Transport Accident Investigation Commission (Commission) is a standing commission of inquiry and an independent Crown entity responsible for inquiring into maritime, aviation and rail accidents and incidents for New Zealand, and co-ordinating and co-operating with other accident investigation organisations overseas. The principal purpose of its inquiries is to determine the circumstances and causes of occurrences with a view to avoiding similar occurrences in the future. Its purpose is not to ascribe blame to any person or agency or to pursue (or to assist an agency to pursue) criminal, civil or regulatory action against a person or agency. The Commission carries out its purpose by informing members of the transport sector and the public, both domestically and internationally, of the lessons that can be learnt from transport accidents and incidents.

Commissioners

Chief Commissioner	Jane Meares
Deputy Chief Commissioner	Peter McKenzie, QC
Commissioner	Stephen Davies Howard
Commissioner	Richard Marchant
Commissioner	Paula Rose, QSO

Key Commission personnel

Chief Executive	Lois Hutchinson
Chief Investigator of Accidents	Captain Tim Burfoot
Investigator in Charge	Captain Jennifer Cuttriss
General Counsel	Cathryn Bridge

Email	inquiries@taic.org.nz
Web	www.taic.org.nz
Telephone	+ 64 4 473 3112 (24 hrs) or 0800 188 926
Fax	+ 64 4 499 1510
Address	Level 16, 80 The Terrace, PO Box 10 323, Wellington 6143, New Zealand

Important notes

Nature of the final report

This final report has not been prepared for the purpose of supporting any criminal, civil or regulatory action against any person or agency. The Transport Accident Investigation Commission Act 1990 makes this final report inadmissible as evidence in any proceedings with the exception of a Coroner's inquest.

Ownership of report

Citations and referencing

Information derived from interviews during the Commission's inquiry into the occurrence is not cited in this final report. Documents that would normally be accessible to industry participants only and not discoverable under the Official Information Act 1982 have been referenced as footnotes only. Other documents referred to during the Commission's inquiry that are publicly available are cited.

Photographs, diagrams, pictures

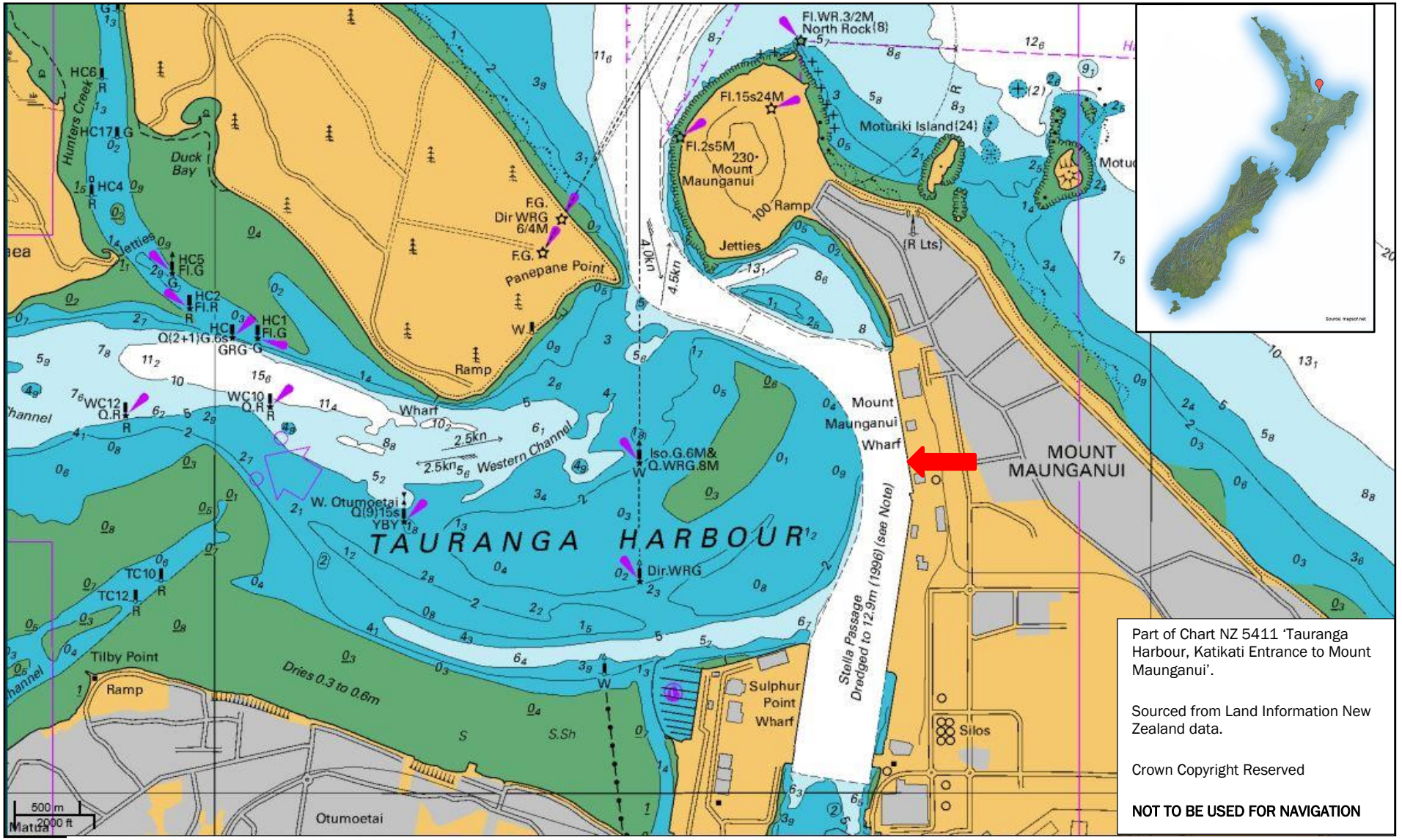
Unless otherwise specified, photographs, diagrams and pictures included in this final report are provided by, and owned by, the Commission.

Verbal probability expressions

The expressions listed in the following table are used in this report to describe the degree of probability (or likelihood) that an event happened or a condition existed in support of a hypothesis.

Terminology (Adopted from the Intergovernmental Panel on Climate Change)	Likelihood of the occurrence/outcome	Equivalent terms
Virtually certain	> 99% probability of occurrence	Almost certain
Very likely	> 90% probability	Highly likely, very probable
Likely	> 66% probability	Probable
About as likely as not	33% to 66% probability	More or less likely
Unlikely	< 33% probability	Improbable
Very unlikely	< 10% probability	Highly unlikely
Exceptionally unlikely	< 1% probability	

The *Kokopo Chief* at Napier



Part of Chart NZ 5411 'Tauranga Harbour, Katikati Entrance to Mount Maunganui'.

Sourced from Land Information New Zealand data.

NOT TO BE USED FOR NAVIGATION

Location of the incident

Contents

Figures

Abbreviations

°C	degree(s) Celsius
CIMS	Coordinated Incident Management System
CO_2	carbon dioxide
Commission	Transport Accident Investigation Commission
FENZ	Fire and Emergency New Zealand
FSS Code	International Code for Fire Safety Systems
ISM Code	International Safety Management Code
mm	millimetre(s)
SOLAS	International Convention for the Safety of Life at Sea, 1974
W	watt

Glossary

boundary cooling	a firefighting method where the areas surrounding a burning compartment are cooled with water to remove heat and slow the spread of the fire
bulkhead	a vertical partition in a vessel that divides the interior into compartments
hatch cleats	steel locking devices for securing a hatch lid
incandescent	(of an electric light) containing a filament that glows white-hot when heated by an electric current
LED lamp	a lamp that produces light using a light-emitting diode (LED)
MIHO class	refers to the *Kokopo Chief* and sister ships built at the Miho Zosen shipyard in Japan
P&I club	a protection and indemnity insurance organisation
smoulder	a burning process that normally includes a thermal decomposition step to create a char, followed by self-sustained burning of the char itself
starboard	the right-hand side of the ship when facing forward
stevedore	a person employed in the loading and unloading of ships

Data summary

Vehicle particulars

Name:	*Kokopo Chief*
Type:	multipurpose/container
Class:	Lloyd's Register
Limits:	unlimited
Classification:	Lloyd's ✠100A1 LMC UMS Containership (No. 2 and No. 3 holds are suitable for general cargoes)
Length:	158.06 metres
Breadth:	22.20 metres
Gross tonnage:	10,352
Built:	Miho Zosen, Shimizu, Japan, May 1991
Propulsion:	Mitsui B&W type 7L42MC MK3 diesel 8120 BHP @ 168 RPM
Service speed:	16 knots
Owner/Operator:	The China Navigation Company Limited
Port of registry:	Hong Kong
Crew:	21

Date and time (NZST)[1]	23 September 2017 11:55 p.m.
Location	Tauranga
Persons involved	all crew
Injuries	nil
Damage	paint damage to number 4 cargo hold, fire damage to timber cargo

[1] The clocks went forward from New Zealand standard time (NZST), UTC (Coordinated Universal Time) + 12 hours, to New Zealand daylight savings time (NZDT), UTC + 13 hours, at 0200 on 24 September.

1. Executive summary

1.1. On 23 September 2017, the multipurpose/container vessel *Kokopo Chief* was loading a cargo of containers and general cargo at Port of Tauranga.

1.2. Number 4 cargo hold was completed with tiers of packaged timber, after which the hatch lid was closed and containers loaded on top. Cargo operations were completed by about 2230 and the crew stood down to rest before the vessel's departure, which was scheduled for early the next morning.

1.3. Shortly before midnight the ship's smoke-detection system alarmed, alerting the crew to a fire that had broken out in number 4 cargo hold. The crew response to the fire included activating the ship's fixed carbon dioxide (CO_2) fire-extinguishing system, which involved sealing the cargo hold and releasing liquid CO_2 into the cargo hold.

1.4. The master alerted harbour control, which called the local fire service, responded and combined with the ship's crew to form a joint fire command team and a fire control team. The fire control team monitored the temperatures of the steel surfaces around the cargo hold, which indicated that the fire was being suppressed by the CO_2 gas in the hold.

1.5. A decision was made to unload the containers on top of the hatch and partially open one of the lids. However, smoke was emitted from under the hatch lid, so it was replaced and any remaining bottles of liquid CO_2 were released into the cargo hold.

1.6. After several hours the temperatures had decreased, so the hatch lid was removed. There were no obvious signs of fire, so the timber packs were unloaded and any remaining hot spots attended to.

1.7. The Transport Accident Investigation Commission (Commission) found that the fire was caused by heat radiating from an incandescent reflector lamp that set fire to packs of timber that had been stowed close to the lamp. The cargo hold lights had not been switched off on completion of loading.

1.8. The Commission also found that the ship's fixed CO_2 fire-extinguishing system was effective, but that the fire could have been extinguished sooner if the hatch had not been opened earlier.

1.9. The Commission also found that the response to the fire was well co-ordinated, but identified the following safety issues:

- the operator's safety management system had not fully mitigated the risk of fire caused by cargo hold lighting, in spite of an earlier incident involving similar circumstances
- the responsibilities of the various authorities involved in responding to the fire were not clearly documented and understood by all parties
- the Fire and Emergency New Zealand training standards did not fully cover the special considerations for responding to shipboard fires.

1.10. The operator took a number of safety actions to address the first safety issue. The Commission made two recommendations to Fire and Emergency New Zealand to address the other safety issues. The Commission also made recommendations to the International Association of Classification Societies and the International Group of P&I Clubs to disseminate the lessons learned from this accident to the global shipping fleet.

1.11. Key lessons arising from this inquiry included:

- safety procedures such as switching off cargo hold lights should be documented and include systems for checking that they have been carried out

- some lamp types generate a substantial amount of heat that can be a fire hazard. Ship owners and operators should consider using other types of lamp that do not generate high heat in locations where the risk of fire is present
- the required firefighting systems on board ships are unique to the special design and construction of the ships. When possible, they should be fully utilised in accordance with the operating instructions.

2. Conduct of the inquiry

2.1. Maritime New Zealand notified the Transport Accident Investigation Commission (Commission) of the fire at about 0400[2] on 24 September 2017. The Commission opened an inquiry the same day under section 13(1)b of the Transport Accident Investigation Commission Act 1990, and appointed an investigator in charge.

2.2. On 24 September the Commission notified the flag state, Hong Kong[3], and informed it that the Commission had opened an inquiry.

2.3. Later that day two investigators travelled to Tauranga and met with the master and the deputy designated person ashore[4]. The investigators spent the following two days collecting evidence and interviewing crew members.

2.4. On 25 September the Commission requested the assistance of a specialist fire investigator from Fire and Emergency New Zealand (FENZ)[5] to inspect the scene and report on the cause of the fire. The investigators also met with the FENZ area commander, Bay of Plenty Coast Area.

2.5. On 27 September the investigators met with the harbourmaster and the Port of Tauranga operations manager.

2.6. On 2 October the Hong Kong Maritime Authority confirmed that it did not intend to carry out its own investigation, but as a substantially interested state requested a copy of the draft report for comment.

2.7. On 29 January 2018 further evidence was received from The China Navigation Company Limited (the operator), including a near-miss report on a potential fire on board one of its other vessels in 2014.

2.8. On 16 February 2018 the investigator in charge conducted a telephone interview with the FENZ area commander to gather more information about FENZ ship firefighting procedures.

2.9. On 21 February 2018 further information was received from the harbourmaster about ship firefighting procedures from the harbourmaster's perspective.

2.10. On 24 April 2018 the Commission conducted a simulation to establish the temperatures generated by the reflector lamp and test whether these would have been sufficient to ignite the timber cargo.

2.11. On 20 June 2018 the Commission approved the draft report to be circulated to interested persons for comment.

2.12. The draft report was circulated to 12 interested persons. Nine responses, including four submissions, were received.

2.13. The Commission considered the submissions in detail and any changes as a result have been included in the final report.

2.14. The Commission approved the report for publication on 19 September 2018.

---

[2] At 0200 on 24 September, clocks were advanced one hour to New Zealand daylight saving time (NZDT), UTC + 13 hours. All times in this report after 0200 on 24 September are referred to in NZDT.
[3] The flag state is a 'substantially interested state' under the International Maritime Organization Casualty Investigation Code, and as such had rights to participate in the New Zealand inquiry.
[4] An appropriately qualified person with direct access to the highest level of management to ensure the safe operation of a ship and to provide a link between the operator and those on board.
[5] Fire and Emergency New Zealand was established on 1 July 2017 through the unification of New Zealand's urban and rural fire services under the Fire and Emergency New Zealand Act 2017.

3. Factual information

3.1. Background

3.1.1. The *Kokopo Chief* is a geared[6], multipurpose container ship with four cargo holds serviced by three deck cranes.

3.1.2. The ship is owned and operated by The China Navigation Company Limited and runs a regular trans-Tasman service between Australia and New Zealand.

3.1.3. The ship is registered in Hong Kong and classed by Lloyd's Register. There was a multinational crew on board and the working language of the ship was English.

3.2. Narrative

3.2.1. On 23 September 2017 the *Kokopo Chief* was working cargo alongside at Port of Tauranga, loading timber packs, machinery and containers.

3.2.2. The fourth officer took over the deck watch at 1800, when number 4 cargo hold had been loaded but the cargo had yet to be lashed by the shore-based stevedores[7].

3.2.3. Once the cargo inside the hold was lashed to the satisfaction of the fourth officer, the hatch cover was closed.

3.2.4. The stevedores then loaded some machinery on the main deck and, finally, loaded dangerous goods containers on top of number 4 hatch cover. The stevedores then lashed the deck cargo. Cargo and lashing operations were logged as complete at 2224.

3.2.5. After the completion of cargo operations, the ship went to a 'single watch', which meant that one crew member was stationed at the top of the ship's gangway while the remaining crew rested before the expected departure time of 0400 the following day. The fourth officer went to take some rest, but remained contactable by radio.

3.2.6. The ship was fitted with a Safetec SDS-48 sample-extraction smoke-detection system. This system continuously drew air samples from the cargo holds. These air samples passed through a smoke sensor located on the navigating bridge. If the density of the smoke reached defined criteria, the smoke alarm would be activated.

3.2.7. Shortly before midnight a cargo hold smoke-detection alarm sounded throughout the crew accommodation. The master went to the bridge and saw that the smoke-detector panel was indicating the presence of smoke at the forward end of number 4 cargo hold. The master checked the cargo hold light panel and saw that the lights were switched on in all of the cargo holds, so switched them off immediately.

3.2.8. The chief officer and the fourth officer went to the starboard-side under-deck passageway, where there was an access hatch to number 4 cargo hold (see Figure 1). They lifted the lid of the access hatch and smelled burning, so immediately closed the lid. They reported to the bridge that there was a fire and that it was not a false alarm.

3.2.9. The chief officer and the fourth officer returned to their designated emergency muster point, the ship's emergency headquarters. The general alarm was activated to summon any crew who had not already mustered on first hearing the smoke alarm.

3.2.10. The ship's crew began to prepare the firefighting equipment. A first fire team of two men donned fire suits and self-contained breathing apparatus. The fire team, together with the chief officer and the fourth officer, returned to the access hatch and prepared for the fire team to enter number 4 cargo hold. This time when the access hatch was opened, smoke could

[6] A geared ship carries her own cranes.
[7] People employed in the loading and unloading of ships.

clearly be seen coming from the cargo hold. The first fire team then entered the cargo hold with the intention of locating and fighting the fire.

3.2.11. A second fire team was sent to check the bulkhead[8] temperatures on the outside of number 4 cargo hold. They reported that the temperature of the starboard forward corner of number 4 cargo hold was five degrees higher than anywhere else.

3.2.12. The first fire team soon found that their access was blocked by containers and that visibility was limited due to heavy smoke. The chief officer told them to stop and get out of the hold.

3.2.13. At 0016 the master advised Port of Tauranga Radio that there was smoke in the cargo hold, but no fire had been seen.

3.2.14. When the fire team was clear of number 4 cargo hold, the access hatch was closed and the crew evacuated from the starboard-side under-deck passageway. They returned to the emergency headquarters, after which the master ordered a head count to be carried out.

3.2.15. At 0049 the master contacted Port of Tauranga Radio to report that the ship had a cargo hold fire and required assistance from the local fire service. The master also advised of the intention to activate the ship's carbon dioxide (CO_2) fire-extinguishing system.

3.2.16. Once all crew members were accounted for, the master ordered the chief engineer to prepare to activate the CO_2 fire-extinguishing system in number 4 cargo hold. The crew were sent to ensure that all ventilation openings to the cargo hold were closed and that it was fully sealed. At 0058 the master ordered the chief engineer to release 48 bottles of CO_2 into number 4 cargo hold, the required number of bottles for the initial release according to the CO_2 system operating procedure.

3.2.17. Following the activation of the CO_2 system, the chief engineer reported to the master that there was a small leak on the CO_2 system manifold. The master ordered the chief engineer to leave the CO_2 room and to return wearing breathing apparatus to repair the manifold. The chief engineer carried out this order.

3.2.18. At about 0103 the first FENZ unit from Mount Maunganui arrived alongside the ship. Shortly afterwards a unit from Tauranga fire station arrived. The senior station officer from Tauranga fire station went on board and was briefed by the ship's crew. The station officer from Mount Maunganui remained on the quay to supervise the FENZ staff ashore.

3.2.19. The master appointed the chief officer and the fourth officer to liaise with FENZ personnel. At this stage the CO_2 had just been released and the master was waiting for it to take effect. The ship's crew had started using fire hoses to boundary cool[9] the hatch cover and hatch coaming[10]. They were also monitoring the temperature on the bulkheads of number 4 cargo hold from the starboard-side under-deck passageway. These actions continued for some time using a combination of ship and FENZ personnel.

3.2.20. The master spoke with the company's designated person ashore on the phone. They considered the risks presented by dangerous goods and fuel oil stowage and agreed that the dangerous goods containers needed to be unloaded from the ship. The master phoned the ship's planner and asked the planner to arrange for stevedores to unload these containers. Heavy fuel oil was transferred out of a fuel tank near number 4 cargo hold and sea water was pumped into a ballast tank underneath the cargo hold for a boundary cooling effect.

[8] A vertical partition in a vessel that divides the interior into compartments.
[9] A firefighting method where the areas surrounding a burning compartment are cooled with water to remove heat and slow the spread of the fire.
[10] A vertical barrier around a hatch to prevent water passing into the opening.

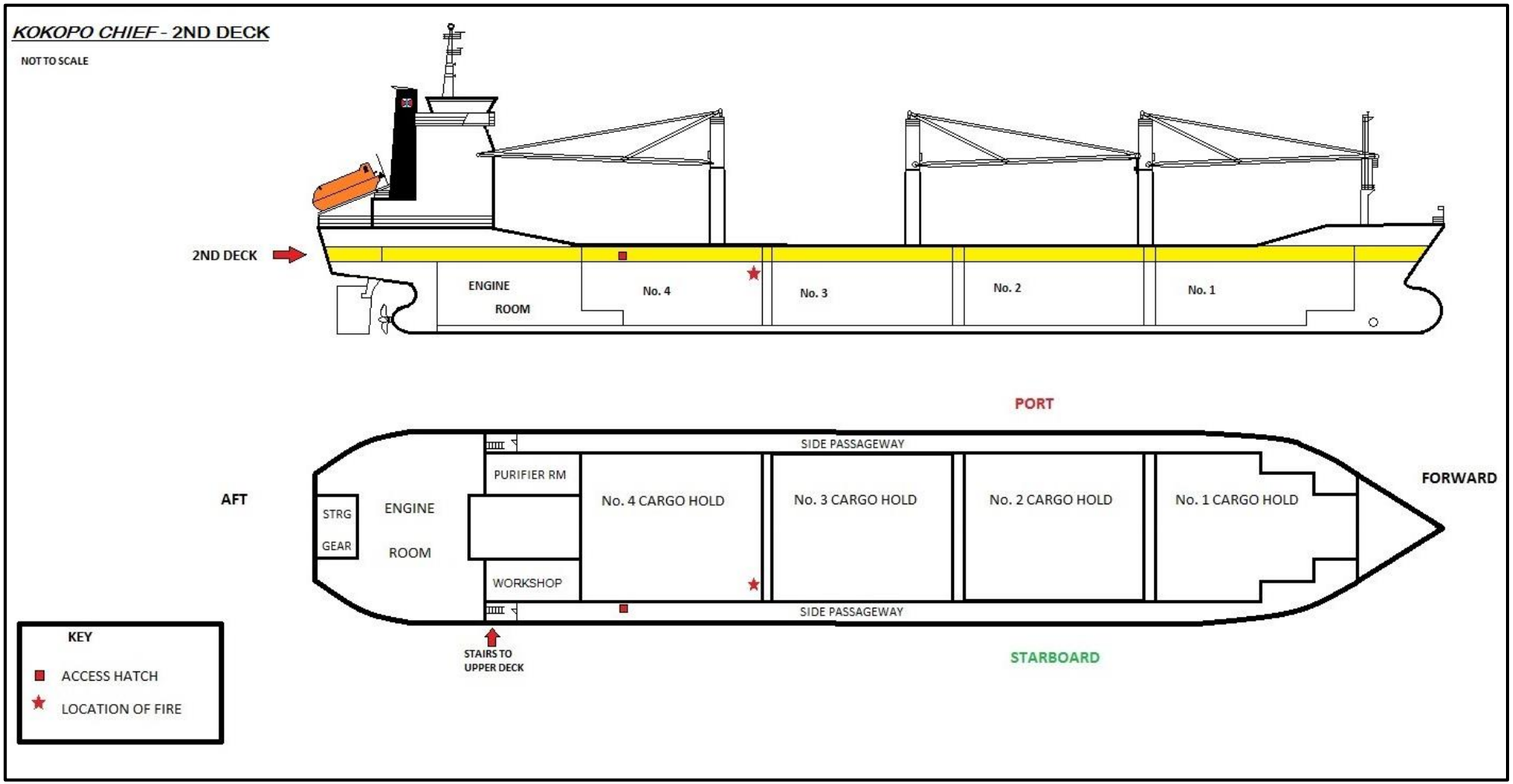


Figure 1
Location of fire and access hatch

3.2.21. The FENZ area commander arrived at 0149 and assessed that FENZ senior officers and the ship's crew had the firefighting response under control. As there were no outward signs of the fire, the area commander did not take control of the FENZ response at that time.

3.2.22. At about 0155 the cargo hold bulkhead temperatures were reported to have decreased. Volunteer stevedores soon arrived and unloaded the dangerous goods containers. At this stage there were still no external signs of the fire in the hold. The master, the chief officer and fire officers agreed to open the hatch lid as soon as the remaining containers were discharged.

3.2.23. At 0320 (now NZDT) the ship's crew removed the hatch cleats[11] and opened a hatch lid slightly. Heavy smoke emitted from the cargo hold, so the lid was replaced and the cleats re-secured. The master then decided to release the remaining 24 bottles of CO_2 into the hold.

3.2.24. The area commander saw that the fire was more serious than first thought, and assumed the position of incident controller, with FENZ as the lead agency. The status of the FENZ response was upgraded so that extra assets were sent to assist. An incident management team was established to discuss and formulate an action plan to minimise the effects of the fire. The master was part of the incident management team and retained command and control of the ship and its systems and crew.

3.2.25. At 0448 the hatch cleats were opened again and the boundary cooling teams withdrew in preparation for another attempt at opening the hatch and making a direct attack on the fire using water. However, a compliance officer from the Bay of Plenty Regional Council advised that the ship would not be able to discharge any soiled firefighting water into the harbour. Stability checks were carried out to establish how much water could be used and retained on board without compromising the ship's stability.

3.2.26. At 0540 the incident management team noted a one-degree drop in temperature on the cargo hold bulkheads. Taking this as an indication that the CO_2 was having an effect, they decided to leave the hatch sealed for several hours to allow the CO_2 to continue working. During this time temperature monitoring continued on the cargo hold bulkheads.

3.2.27. About four hours later the incident management team agreed that another attempt would be made to open the hold. Fire teams were ready to fight any fire using a direct attack with water. The ship's stability condition was confirmed as adequate. However, the harbourmaster overruled the earlier decision made by the compliance officer and allowed firefighting water to be discharged overboard if necessary to maintain adequate ship stability. They planned to place a containment boom to restrict any potential pollution. The port's fire tug *Tai Pari* was put on standby.

3.2.28. At 0945 a briefing was held to prepare all parties for opening the hatch cover. As a precaution, containers from the after end of number 3 hatch were also unloaded. A hatch lid was lifted at about 1110. No smoke was present in the hold and the fire appeared to have been extinguished.

[11] Steel locking devices for securing a hatch lid.

3.3. Post-fire examination and testing

3.3.1. The timber loaded into number 4 cargo hold consisted of 43 packs of sawn radiata pine[12]. The timber packs at the origin of the fire contained individually wrapped, kiln-dried, H4[13] treated posts, 90 millimetres (mm) by 90mm. Each pack had an outer wrapping of woven plastic sheeting.

3.3.2. Safety data sheets were reviewed for several brands of treated radiata pine. They all recommended avoiding heat and ignition sources when storing and handling treated pine and its products.

3.3.3. The damaged timber was removed to the extent necessary to confirm the fire was out. Figure 2 shows the state of the cargo hold once the timber packs had been removed. The worst of the smoke and heat damage on the forward bulkhead of the cargo hold indicated that the seat of the fire was in the vicinity of the recessed cargo hold light.

Figure 2
Remaining timber stowed in number 4 cargo hold after damaged timber had been removed

[12] Radiata pine (*Pinus radiata*), formerly known as Monterey pine or insignus pine.
[13] H4 is an annotation to indicate that the timber has been chemically treated to be suitable for in-ground applications.

3.3.4. The cargo hold lights were fitted with Matsuda 500-watt (W) reflector lamps. They were each housed in a protective cage and recessed into the cargo hold bulkhead so that they would not be damaged during cargo operations (see Figure 3).

Figure 3
Cargo hold light in recess (inset, the reflector lamp)

3.3.5. The face of the lamp was 40 mm away from the inside of the protective cage and the protective cage was set in 5 mm from the edge of the recess.

3.3.6. The Lloyd's Register requirements for ships' lighting equipment stated that "lamp holders are to be constructed of flame retarding non-hygroscopic materials" and that "lighting fittings are to be so arranged as to prevent temperature rises which overheat or damage surrounding materials"[14]. Technically, the lighting installations on board the *Kokopo Chief* complied with these rules. However, the choice of lamp and cargo stowage are beyond the scope of these rules.

3.3.7. The timber packs had been tightly stowed to minimise the risk of the cargo shifting at sea. The ends of the timber packs were loaded up against the side of the hold and across the light recesses and would have been about 45-50 mm from the face of the lamps.

3.3.8. Wood is a commonly used solid fuel. When it is exposed to high temperatures, wood undergoes a chemical decomposition process that releases gases, water vapour and various products as smoke. The combustion characteristics of wood products vary according to factors such as the nature of heat exposure, the size of the sample and the type of wood involved[15].

[14] Rules and Regulations for the Classification of Ships, July 2017, Lloyd's Register. Part 6, Chapter 2, 13.2.1-13.2.2.
[15] NFPA 921, 2011 edition, National Fire Protection Association 921-33.

3.3.9. Incandescent[16] reflector lamps are known to produce high temperatures. However, there is little data available on the temperatures they can reach or the intensity of any radiated heat.

3.3.10. Because there was no data available for a 500 W reflector lamp, the Commission carried out tests[17] to measure the temperature of a Matsuda 500 W reflector lamp when operated under conditions similar to those on board. A steel box was fabricated with dimensions matching those of the light recess in the cargo hold (600 mm x 700 mm x 525 mm). Thermocouples[18] were used to measure the temperatures at the centre of the lamp's face and at the surface of the timber opposite the lamp. A stack of H4 treated, dry radiata pine was placed 50 mm from the opening to the box and the lamp was switched on (see Figure 4).

3.3.11. Before the lamp reached a maximum temperature, the test had to be stopped because the timber had already started to smoulder[19] (see Figures 4 and 5). At the time that smoke was first seen the temperature of the lamp was 155 °C (degrees Celsius) and the temperature at the surface of the timber was 114 °C. The temperature of the lamp continued to rise and was 208 °C when the test was stopped (see Figure 6).

Figure 4
Lamp test set-up

[16] (Of an electric light) containing a filament that glows white-hot when heated by an electric current.
[17] Tested under non-laboratory conditions.
[18] Devices for measuring temperature.
[19] A burning process that normally includes a thermal decomposition step to create a char, followed by self-sustained burning of the char itself.

Figure 5
Photograph taken after three minutes' exposure to the lamp

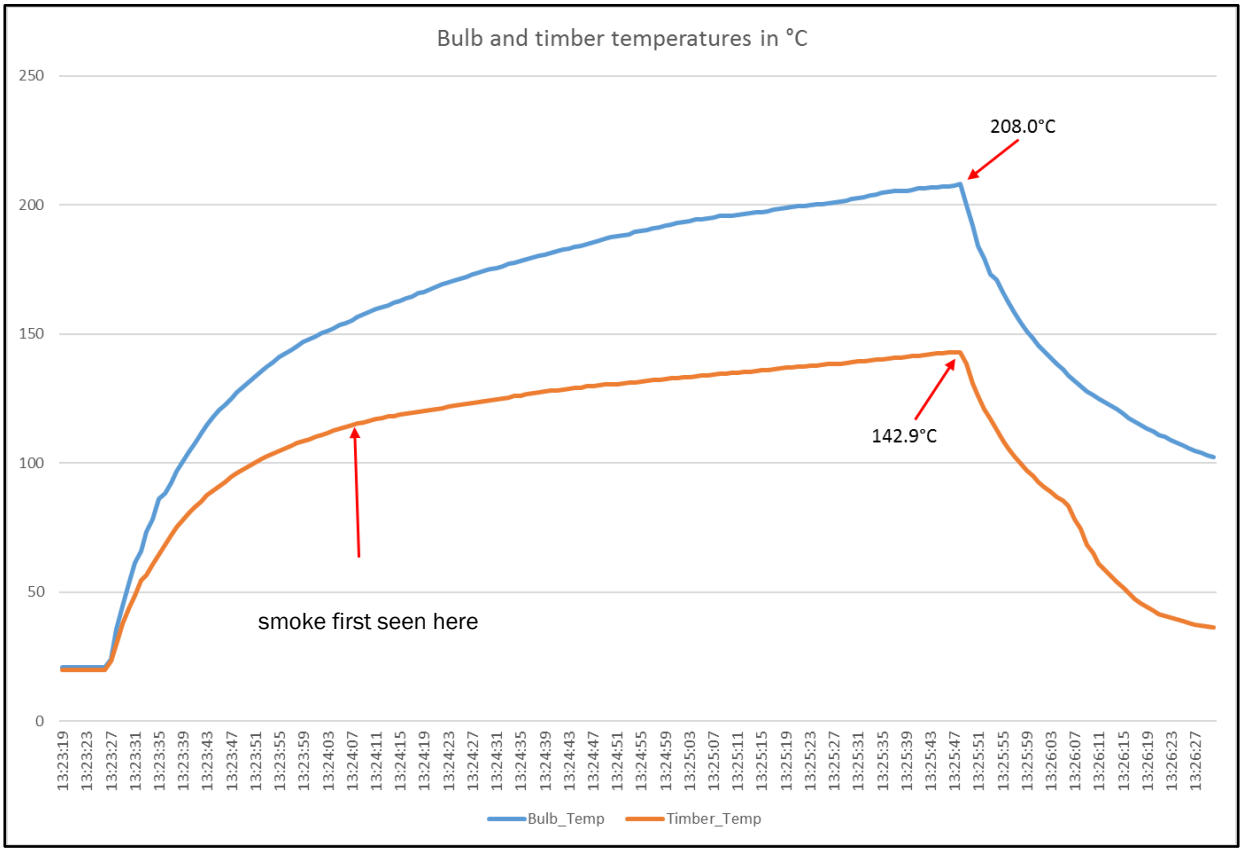


Figure 6
Graph showing temperatures recorded by test thermocouples

3.3.12. With no obstruction across the opening to the box, the lamp reached a maximum temperature of 191°C and remained at 188-190°C. It was found that placing the timber across the opening restricted the airflow around the lamp and prevented heat dissipation. The lamp reached a higher temperature and the heat was concentrated onto a focused point on the timber, where the smouldering commenced.

3.3.13. Several tests were run. However, when timber was placed at the opening to the steel box the tests had to be ceased after three to four minutes for safety reasons. Consequently, the maximum temperature the lamp would have reached could not be determined. The maximum temperature recorded was 216°C and rising.

3.3.14. Samples of the plastic used by the sawmill[20] to wrap its timber products were secured over the test timber. The plastic was found to melt, but not ignite, and left the timber exposed to the hot lamp (see Figure 7). The plastic wrapping was not considered an accelerant. In fact, in the tests the wrapping delayed the start of the timber combustion for about 30 seconds.

Figure 7
Plastic wrapping after two minutes, 20 seconds of exposure to the ship's lamp

3.4. The CO_2 fire-extinguishing system

3.4.1. CO_2 fire-extinguishing systems are the most common found on board ships for fighting fires in large enclosed spaces such as ships' engine rooms and cargo holds. They are favoured because they are easy to use, cause little or no damage to cargo, and avoid the use of large quantities of water, which can cause cargo damage and have stability implications for ships.

3.4.2. On the *Kokopo Chief*, the CO_2 fire-extinguishing system shared common lines with the sample-extraction smoke-detection system. The lines through which the smoke-detection air samples were drawn were used to deliver the fire-extinguishing medium to the holds by reversing the position of the system valves.

3.4.3. For combustion to take place there must be sufficient oxygen, heat and fuel, as portrayed by the fire triangle (see Figure 8). The CO_2 fire-extinguishing system works on the principle that

[20] The sawmill whose timber was directly opposite the light that was identified as the heat source of the fire.

enough CO_2 can be introduced to a compartment to reduce the oxygen content below that required to support combustion.

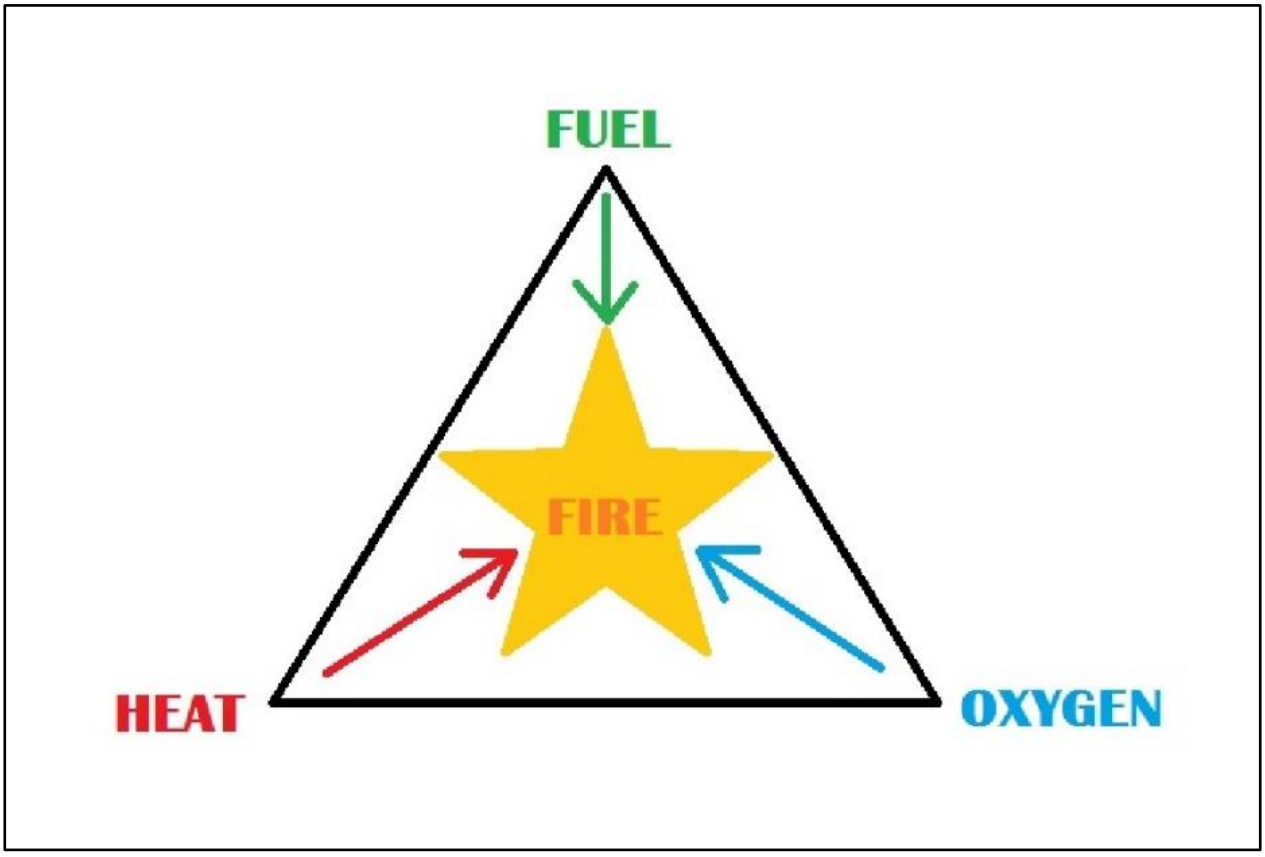


Figure 8
The fire triangle

3.4.4. To maintain the concentrations of CO_2 and oxygen required to extinguish the fire, the compartment must be closed and sealed to prevent the escape of CO_2 and the ingress of oxygen. Because CO_2 provides very little cooling effect, the fire can reignite if oxygen is readmitted to the space too soon.

3.4.5. Chapter II-2 of the International Convention for the Safety of Life at Sea, 1974 (SOLAS) sets the requirements for fire-protection, fire-detection and fire-extinguishing systems on ships. The International Code for Fire Safety Systems (FSS Code) defines the specifications of fire safety equipment and systems required by SOLAS.

3.4.6. Under the FSS Code, the *Kokopo Chief* was required to carry enough CO_2 to achieve and maintain 30% concentration in its largest protected cargo compartment, or 45% concentration in the engine room. There were 72 CO_2 bottles on board, each holding 45 kilograms of liquid CO_2. Any one of the cargo holds required an initial release of 48 bottles followed by one bottle every 15 minutes until all 72 cylinders were released. There was sufficient CO_2 carried on board to comply with the FSS Code.

4. Analysis

4.1. Introduction

4.1.1. Shipboard fires can be very destructive, and if left unchecked can easily result in the total loss of a vessel, with a high potential for loss of life. Because fires can occur while ships are at sea, away from any shore-based assistance, the SOLAS requirements are aimed at making them fully self-sufficient in their firefighting capability, and at ensuring that crews are fully trained in shipboard firefighting techniques.

4.1.2. Due to their design and construction, and the potential risk of capsize due to loss of stability, there are a number of unique aspects to fighting fires on board ships. The *Kokopo Chief* being in port when the fire occurred required the merging of two disciplines: ship and shore-based firefighting techniques.

4.1.3. The following analysis discusses the circumstances leading up to the fire, and some of the challenges the incident management team had to overcome while fighting the fire. It also discusses the following safety issues:

- the operator's safety management system had not fully mitigated the risk of fire caused by cargo hold lighting, in spite of an earlier incident involving similar circumstances
- the responsibilities of the various authorities involved in responding to the fire were not clearly documented and understood by all parties
- the FENZ training standards did not fully cover the special considerations for responding to shipboard fires.

4.2. What happened

Safety issue – The operator's safety management system had not fully mitigated the risk of fire caused by cargo hold lighting, in spite of an earlier incident involving similar circumstances.

4.2.1. The burn pattern on the timber cargo adjacent to the cargo hold light was a strong indication that the heat generated by the reflector lamp was the cause of the fire. The only other potential sources of heat found in the cargo hold were two old cigarette butts found in the hold. However, both were found at the opposite end of the hold to the fire location. One had been well stubbed out and the other had been discarded behind a cell guide[21] and could not have come into contact with any cargo.

4.2.2. The FENZ specialist fire investigator reported that a 200 W lamp would have been capable of radiating enough heat to cause the timber to burn. There was no data available for the 500 W bulb that was installed in the cargo hold. The obvious conclusion is that it would have been capable of radiating more heat than a 200 W bulb, but how much was not known.

4.2.3. The FENZ report found that thermal decomposition of the timber would have likely started at anywhere from 100 °C and reached a maximum rate by 180 °C. Ignition would have been expected to occur at around 300 °C[22].

4.2.4. The deep scorching of the timber that was stowed directly opposite the 500 W lamp showed that enough heat was radiated from the light to melt the plastic wrapping and cause the exposed timber to smoulder (see Figures 9 and 10). This timber was estimated to have been loaded as close as 45-50 mm from the face of the lamp. Over time the plastic wrap melted to expose the timber ends, which became hot enough to start a smouldering fire.

[21] A right-angled, vertical guide rail that helps to keep shipping containers straight in a container ship's hold.
[22] Figures from Kirk's Fire Investigation Manual as quoted in the specialist fire investigator's report.

Figure 9
Timber packet showing origin of fire

Figure 10
Charred timber at origin of fire

4.2.5. Because the use of high-powered incandescent reflector lamps in ships' cargo holds is commonplace in the worldwide fleet, the Commission considered that the hypothesis of the cargo lamp being the source of the fire was worth testing under simulated conditions.

4.2.6. The tests confirmed that it was virtually certain that the cargo lamp produced sufficient heat to ignite the timber cargo. The proximity of the cargo to the lamp would have restricted any airflow and its cooling effect on the lamp, and facilitated rapid heat transfer by radiation between the lamp and the timber.

4.2.7. While it is widely known that incandescent lamps produce heat, these findings offer valuable information to ship designers, owners and operators to consider when selecting the means of lighting in their ships' cargo holds. There are equivalent lighting options, such as LED lamps[23], that do not produce the same high temperatures.

4.2.8. Another measure that can be taken to mitigate the risk of similar fires is having procedures in place for ensuring that cargo hold lighting systems are turned off (and, if necessary, isolated) at an appropriate time before a loading operation creates the hazard. In this case, the lights could have been switched off and/or isolated as soon as the timber packs were placed over the lighting recess.

4.2.9. Normally the cargo hold lights were checked and switched off when the crew prepared the ship for leaving port. However, this was not included in any written procedure or checklist.

4.2.10. In 2014 a near-miss report was circulated to the operator's fleet after timber cargo on one of its vessels had scorched when the cargo hold lights were left on (see Appendix 1).

4.2.11. Despite the previous incident the operator had not included the risk of fire caused by hot cargo lamps in its fleet safety management system.

4.2.12. The operator has since addressed this safety issue (see section 7).

4.2.13. In order to promote the lessons from this accident, the Commission has made recommendations to the International Association of Classification Societies and the International Group of P&I Clubs[24] to alert ship designers, owners and operators, and surveyors and auditors of safety management systems, to the risks posed by lamps that produce high heat, such as incandescent reflector lamps.

4.3. Emergency response – responsibilities

Safety issue – The responsibilities of the various authorities involved in responding to the fire were not clearly documented and understood by all parties.

4.3.1. Chapter III, regulation 8 of SOLAS requires every crew member on a ship to be provided with clear instructions to be followed in the event of an emergency. The instructions are to be exhibited in conspicuous places throughout the ship, such as the bridge and the engine control room.

4.3.2. SOLAS Chapter IX, regulation 3 requires ship operators to comply with the requirements of the International Safety Management Code (ISM Code). The ISM Code states that a ship operator should identify potential emergency shipboard situations and establish procedures to respond to them.

4.3.3. Operators are also obliged to exercise emergency procedures and prepare for emergency actions. Specifically, the SOLAS requirements include at least one abandon-ship drill and one fire drill each month for every crew member.

4.3.4. The ISM Code requires an operator to define clearly a master's responsibility and overriding authority to make decisions with respect to the safety of their ship and its crew, and the

[23] A lamp that produces light using a light-emitting diode (LED).
[24] Protection and indemnity insurance organisations.

prevention of pollution. These requirements are reflected in New Zealand's Maritime Transport Act 1994, which states that the master has "final authority to control the ship while in command" and is "responsible for compliance with all relevant requirements except in an emergency when immediate action in breach of this Act may be necessary"[25].

4.3.5. The fire procedure contained in the *Kokopo Chief's* Emergency Preparedness and Emergency Response Plan stated, "if there is immediate risk to life or the safety of the ship, summon necessary assistance". Once the master had established that the fire risk was too great for the ship's crew to make a direct attack on the fire, the decisions to use the ship's CO_2 fire-extinguishing system and request the assistance of the local fire service were in accordance with the procedure.

4.3.6. One of the main functions of FENZ is to provide fire prevention, response and suppression services[26]. An additional function is to respond to maritime incidents to the extent of their capacity and capability[27].

4.3.7. FENZ has five regions covering mainland New Zealand, and each region has its own planning and procedures. Tauranga is part of region 2 – Hamilton, Thames, Tauranga, Rotorua and Gisborne. The Region 2 Ship Fires Operating Procedure requires FENZ to provide an initial response of two firefighting units and to manage any shipboard fire response with the Coordinated Incident Management System (CIMS).

4.3.8. The purpose of CIMS is to achieve effective incident management during a multi-agency response. Common structures, functions and terminology have been established across incident response and management agencies throughout New Zealand. CIMS has a flexible framework so that a response can be tailored to specific circumstances, yet still allows agencies to develop their own processes.

4.3.9. When more than one agency has a mandate to manage an incident, CIMS advises the establishment of 'unified control', where the agencies form a combined decision-making body and formulate a single action plan.

4.3.10. Port of Tauranga also has a procedure for responding to ship fires in its Emergency Procedures Manual. This document details the actions and communications required to allow relevant agencies access to a vessel and lists the firefighting resources that the port can provide. Port of Tauranga has the firefighting capability of its tug boats and a portable firefighting pump available.

4.3.11. The harbourmaster represents the relevant regional council by ensuring maritime safety in the ports harbours and waters of their region. The harbourmaster has powers of direction and duties under the Maritime Transport Act for the purpose of ensuring maritime safety[28].

4.3.12. As described above, when there is a ship fire in a port there will be several agencies involved in the response, and each agency will have its own procedures to follow with perhaps different purposes in mind. However, it is important that there be a clearly defined and understood position of responsibility for the emergency response, including a way to resolve any procedural conflicts between the responding agencies.

4.3.13. The FENZ Ship Fire Procedure indicates that the harbourmaster is responsible for firefighting during a ship fire in port, which is not always the case. Although the harbourmaster has the mandate to intervene to ensure that maritime safety is maintained in their region's waters, the master remains responsible for the safety of the ship, its crew and its cargo. The Port of Tauranga Emergency Procedures Manual acknowledges that the responsibility for firefighting on board a ship in port remains with the master and that the fire service will render whatever assistance is required.

[25] Maritime Transport Act 1994, section 19.
[26] Fire and Emergency New Zealand Act 2017, section 11.
[27] Fire and Emergency New Zealand Act 2017, section 12.
[28] Maritime Transport Act 1994, sections 33D, E and F.

4.3.14. When FENZ responded to the fire on board the *Kokopo Chief*, it was responding under its Ship Fire Procedure, which prescribed that the response be managed using the CIMS model. In accordance with the CIMS model, FENZ formed an incident management team that included members of the ship's crew and the harbourmaster. From this perspective the response worked well.

4.3.15. The crew of the *Kokopo Chief* had a good command of English and had a thorough understanding of their ship's fire emergency procedure, and thus were able quickly to establish a good working rapport with FENZ. When the area commander arrived the first-responding station officers were already working well with the ship's crew.

4.3.16. However, the FENZ Ship Fire Procedure did not accurately reflect the obligations of the master and the harbourmaster, which under different circumstances with different people involved could have been problematic. The Commission has made a recommendation to FENZ to address this safety issue.

4.4. Method of firefighting

Safety issue – The FENZ training standards did not fully cover the special considerations for responding to shipboard fires.

4.4.1. As already mentioned, there are a number of unique aspects to fighting fires on board ships. Although the incident management team was functioning well, in this case the inclination of the FENZ staff involved was to attack the fire directly, whereas the design of the ship's firefighting systems required a 'stand back, boundary cool, monitor and wait' approach.

4.4.2. The ship's crew had already released the first 48 bottles of CO_2 into the hold when the first FENZ units arrived. The ship's CO_2 system operating procedure then instructed the release of one bottle every 15 minutes until all bottles were used. The hold should ideally have been left sealed for as long as possible to allow the CO_2 to take effect and prevent oxygen entering. The master's options were either to follow the ship's procedure exactly or to make a departure from the procedure for a more direct attack.

4.4.3. Ultimately the decision was made to break the seal on one of the hatch lids. Straightaway, heavy smoke was observed emitting from under the hatch lid. It is very likely that some of the CO_2 gas escaped and some oxygen was introduced to the cargo hold at that time.

4.4.4. The hatch lid was then re-sealed and a good decision made for the remaining 24 bottles to be released into the hold all at once to replenish any CO_2 potentially lost.

4.4.5. The decision was then made to stand back, monitor and wait. This action resulted in the fire being extinguished with the sole use of the on-board systems.

4.4.6. There would be some benefit in FENZ including more information and training for its crews on fighting fires on board ships in port or near coastal situations. This would go some way to achieving a more common approach when ship and shore-based crews are jointly involved in shipboard firefighting operations. This would also help when responding to ship fires in situations where the crew are not as familiar and practised at firefighting as the crew on board the *Kokopo Chief* were, or other situations where the crew might not be involved at all.

4.4.7. A recommendation has been made to FENZ to address this safety issue.

5. Findings

5.1. The fire was caused by heat radiating from an incandescent cargo hold lamp that set fire to packs of timber that had been stowed within 45-50 mm of the lamp.

5.2. The ship had no written procedure or checklist for ensuring the cargo hold lights were switched off before flammable cargo was loaded against cargo light recesses, or when loading was complete and hatch lids were closed.

5.3. The CO_2 firefighting system and the on-board firefighting procedures on board the *Kokopo Chief* were effective in suppressing the fire to a point where the hatch lid could be removed with little risk of the fire re-igniting.

5.4. Although the co-ordinated response to the fire was eventually effective, the responsibilities of command were not clearly documented and understood by the various authorities involved in responding to the fire.

5.5. There is a need for shore-based responders to be more familiar with the unique aspects of fighting fires on board ships, so that they can provide effective responses to fires regardless of the circumstances.

6. Safety issues

6.1. The operator's safety management system had not fully mitigated the risk of fire caused by cargo hold lighting, in spite of an earlier incident involving similar circumstances.

6.2. The responsibilities of the various authorities involved in responding to the fire were not clearly documented and understood by all parties.

6.3. The FENZ training standards did not fully cover the special considerations for responding to shipboard fires.

7. Safety actions

7.1. General

7.1.1. The Commission classifies safety actions by two types:

(a) safety actions taken by the regulator or an operator to address safety issues identified by the Commission during an inquiry that would otherwise result in the Commission issuing a recommendation

(b) safety actions taken by the regulator or an operator to address other safety issues that would not normally result in the Commission issuing a recommendation.

7.2. Safety actions addressing safety issues identified during an inquiry

7.2.1. The safety actions taken by the operator included an internal investigation carried out by the deputy designated person ashore. A report was produced that included recommendations and led to the following actions.

7.2.2. The operator initiated a programme to change the cargo hold lights to LED lamps on all MIHO class[29] multipurpose/container ships in the fleet. At the time of publication, the changes had been completed on three of the five MIHO class ships, including the *Kokopo Chief*, and had been started on the other two sister ships.

7.2.3. All other ships in The China Navigation Company fleet were checked for high-temperature lamps. The operator has confirmed that they either had their cargo hold lights changed to use LED lamps or were delivered new with LED lighting already fitted.

7.2.4. Procedures have been written into the safety management system that require the lights to be switched off and entries made in the ships' log books to record when the lights have been turned off.

7.2.5. Internal messaging and subsequent follow-up with ship managers have been improved to ensure that fleet safety alerts are used effectively to learn from near misses.

7.3. Safety actions addressing other safety issues

7.3.1. None identified.

[29] MIHO class refers to the *Kokopo Chief* and sister ships built at the Miho Zosen shipyard in Japan.

8. Recommendations

8.1. General

8.1.1. The Commission may issue, or give notice of, recommendations to any person or organisation that it considers the most appropriate to address the identified safety issues, depending on whether these safety issues are applicable to a single operator only or to the wider transport sector. In this case, recommendations have been issued to FENZ, Lloyd's Register International and the International Group of P&I Clubs.

8.1.2. In the interests of transport safety, it is important that these recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

8.2. Recommendations to Fire and Emergency New Zealand

8.2.1. It is advisable that the responsibilities of the various authorities involved in responding to a shipboard fire are clearly documented and understood by all parties involved.

The FENZ Ship Fire Procedure did not accurately reflect the obligations of the master and the harbourmaster, which under different circumstances with different people involved could be problematic.

On 19 September 2018, the Commission recommended to the Chief Executive Officer of FENZ that he review its procedures for firefighting on board ships to ensure that they accurately reflect the mandated responsibilities of the ship's master, the harbourmaster and any other person or organisation that could be involved. (023/18)

On 4 October 2018, Fire and Emergency New Zealand replied:

> Fire and Emergency is reviewing its Operational Instruction S8 (Ships) to ensure that it accurately reflects the respective responsibilities of ships' masters, harbourmasters, and other agencies or persons who may be involved in emergency response activities.
>
> Fire and Emergency will ensure that similar reviews of local operating procedures (required by Operational Instruction S8) occur and that any necessary adjustments are made to those procedures.
>
> Fire and Emergency is also a member of the Australasian Fire and Rescue Associations Council (AFAC). AFAC's Urban Operations Group has recognised that fire services in Australasia would benefit from additional guidance on ship firefighting.
>
> The development of an AFAC guideline on this topic has been added to its work programme. Fire and Emergency will consider the guideline once it is available with the intent of incorporating relevant content into Operational Instruction S8.
>
> It is expected that this procedure will be in place by the first quarter of 2019 and Fire and Emergency would welcome input for the Commission when developing the procedure.

8.2.2. There is a need for shore-based responders to be more familiar with the unique aspects of fighting fires on board ships, so that they can provide effective responses regardless of the circumstances.

The FENZ training standards did not cover fully the special considerations for responding to shipboard fires.

On 19 September 2018 the Commission recommended to the Chief Executive Officer of FENZ that he review the FENZ training standards to ensure that they contain sufficient training in the unique aspects of fighting fires on board ships. (024/18)

On 4 October 2018, Fire and Emergency New Zealand replied:

> Fire and Emergency is currently reviewing its training modules for maritime incidents. This is part of Fire and Emergency's response to its newly articulated function in

relation to maritime incidents, which is set out in section 12 of the Fire and Emergency New Zealand Act 2017 (FENZ Act).

This includes the revision of an associated reference guide, which will be amended to better reflect the various fire extinguishment options and any existing emergency plan for a vessel.

We anticipate this work will be completed by the end of August 2019, with publication in September 2019 after final consultation and review.

Notwithstanding the above, all Fire and Emergency Officers are trained in incident command systems, dynamic risk assessments of incidents and undergo regular simulation training for incident management. These skills are applicable and utilised at a wide range of incident types.

8.3. Recommendations to Lloyd's Register International (New Zealand)

8.3.1. The fire on board the *Kokopo Chief* was caused by radiated heat from an incandescent reflector lamp fitted in a cargo light igniting the timber cargo.

While it is widely known that incandescent reflector lamps produce heat, the findings of this investigation offer valuable information to ship designers, owners and operators to consider when selecting the means of lighting in cargo holds and other parts of their ships. There are equivalent lighting options, such as LED lamps, that do not produce the same high temperatures.

On 19 September 2018 the Commission recommended, through Lloyd's Register International, that the International Association of Classification Societies alert members to the potential risk posed by lights that emit high heat, such as ones fitted with incandescent reflector lamps, for them to consider when approving designs or auditing safe ship management systems on board ships. (025/18)

On 20 September 2018, Lloyds Register International (New Zealand) replied in part:

> LRI agrees with the investigator's conclusion that this incident should be communicated to IACS for consideration; therefore our formal request for work on this matter was submitted to the IACS Machinery Panel.

8.4. Recommendation to the International Group of P&I Clubs

8.4.1. The fire on board the *Kokopo Chief* was caused by radiated heat from an incandescent reflector lamp fitted in a cargo light igniting the timber cargo.

While it is widely known that incandescent reflector lamps produce heat, the findings of this investigation offer valuable information to ship designers, owners and operators to consider when selecting the means of lighting in cargo holds and other parts of their ships. There are equivalent lighting options, such as LED lamps, that do not produce the same high temperatures.

On 19 September 2018 the Commission recommended that the Executive Officer of the International Group of P&I Clubs disseminate the lessons learned from this accident to all of its members and advise them of the potential risk to ship safety posed by lights that radiate high levels of heat. (026/18)

On 4 October 2018, International Group of P&I Clubs replied:

> [International Group of P&I Clubs] confirm that [we] will notify the relevant Group committees of the Final recommendation 026/18 and provide them with a copy of this so that this can be brought to the attention of the club's loss prevention departments and in turn their shipowner memberships if this has not already been done.

9. Key lessons

9.1. Safety procedures such as switching off cargo hold lights should be documented and include systems for checking that they have been carried out.

9.2. Some lamp types generate a substantial amount of heat that can be a fire hazard. Ship owners and operators should consider using other types of lamp that do not generate high heat in locations where the risk of fire is present.

9.3. The required firefighting systems on board ships are unique to the special design and construction of ships. When possible, they should be fully utilised in accordance with the operating instructions.

Appendix 1: Near-miss incident report from 2014

NEAR MISS – Timber pack got burnt under fixed cargo light.

Report Number: [redacted]

Date of Incident: February 25, 2014

Ship:

Place of Incident: [redacted]

Incident Type: Moderate

Nature of Injury: Nil

Description of Incident

While lashing some timber packs on #4(S)Tween Deck, stevedore noticed one timber pack, being close to halogen lamp emitting some smoke, and a smell of burnt timber was felt . A plastic cover of a timber pack shrunk & burnt due to its proximity to the cargo hold lamp. Two sawn timber planks sustained about 35 cm burn spot on their sides. Affected area was immediately flushed with water and observed for several minutes. Burn spot was removed. All lights were switched off in cargo holds and tween decks which contained timber.

Root Cause(s):

1. Close proximity of timber to cargo hold fixed light.
2. High temperature generated by fixed cargo hold light is apparently enough to smoulder a timber.
3. Cargo hold light was left switched on during overnight although the cargo operations were seized and a hold was closed due to beetle season.

Preventative Corrective Action

1) Take a note of proximity of fixed lighting in cargo holds to stowed timber.
2) All deck officers to keep cargo lights off in holds contained timber when cargo operations are seized.
3) Circulate 4 box to share the near miss with other fleet.

The China Navigation Company Pte. Ltd

Recent Marine Occurrence Reports published by the Transport Accident Investigation Commission

MO-2017-202	Passenger vessel *L'Austral*, grounding, Milford Sound, Fiordland, 9 February 2017
MO-2016-206	Capsize and foundering of the charter fishing vessel *Francie*, with the loss of eight lives, Kaipara Harbour bar, 26 November 2016
MO-2016-202	Passenger ship, *Azamara Quest*, contact with Wheki Rock, Tory Channel, 27 January 2016
MO-2017-201	Passenger vessel *L'Austral* contact with rock Snares Islands, 9 January 2017
MO-2016-201	Restricted-limits passenger vessel the *PeeJay V*, Fire and sinking , 18 January 2016
MO-2016-204	Bulk carrier, *Molly Manx*, grounding, Otago Harbour, 19 August 2016
MO-2016-205	Fatal fall from height on bulk carrier, *New Legend Pearl*, 3 November 2016
MO-2015-201	Passenger ferry *Kea*, collision with Victoria Wharf, Devonport, 17 February 2015
Interim Report MO-2017-203	Burst nitrogen cylinder causing fatality on board the passenger cruise ship *Emerald Princess*, 9 February 2017
MO-2012-203	Fire on board *Amaltal Columbia*, 12 September 2012
MO-2016-203	Bulk log carrier Mount Hikurangi, Crew fatality, during cargo securing operation, 27 February 2016
MO-2014-203	Fatal injury, Purse seine fishing vessel, *Captain M. J. Souza*, 24 August 2014
MO-2015-202	Containership *Madinah*, loss of person overboard, Lyttelton Harbour entrance, 2 July 2015
MO-2016-202	Urgent recommendation: Cruise ship *Azamara Quest*, contact with Wheki Rock, Tory Channel, 27 January 2016
MO-2011-202	Roll-on-roll-off passenger ferry *Monte Stello*, contact with rock, Tory Channel, Marlborough Sounds, 4 May 2011
MO-2014-201	*Dream Weaver*, flooding due to structural failure of the hull, Hauraki Gulf, 23 February 2014
MO-2010-206	Coastal container ship *Spirit of Resolution*, grounding on Manukau Bar, Auckland, 18 September 2010
MO-2014-202	Lifting sling failure on freefall lifeboat, general cargo ship *Da Dan Xia*, Wellington, 14 April 2014
11-204	Container ship MV *Rena* grounding, on Astrolabe Reef, 5 October 2011
13-201	Accommodation fire on board the log-carrier, *Taokas Wisdom*, Nelson, 11 July 2013
13-202	Bulk carrier, *IDAS Bulker*, pilotage incident Napier, Hawke's Bay, 8 August 2013

Price $15.00

ISSN 1173-5597 (Print)
ISSN 1179-9072 (Online)