



A U S T R A L I A N T R A N S P O R T S A F E T Y B U R E A U

MARINE SAFETY INVESTIGATION

REPORT 165

Independent investigation into the fire and
muster of the passengers aboard the
Australian flag passenger ferry

Spirit of Tasmania



in Bass Strait
on 24 February 2001



**Department of Transport and Regional Services
Australian Transport Safety Bureau**

Navigation Act 1912
Navigation (Marine Casualty) Regulations
investigation into the fire and muster
of the passengers aboard the Australian flag passenger ferry
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FIGURE 1:
Spirit of Tasmania at Station Pier in Melbourne



Summary

At 1800 on 23 February 2001, the Australian flag roll on-roll off passenger ferry *Spirit of Tasmania* departed Station Pier in Melbourne bound for Devonport in Tasmania. On board the ship were 967 passengers, 112 crew and 10 staff from licensed businesses. The weather was good with wind from the south-south-west at 17-21 knots and a low swell. The ship was averaging a speed of approximately 17 knots.

At 0114 the second mate on the bridge received a fire 'pre-warning' from a detector he identified as being in 'The Ship's Photographer' shop on 'E' deck. Approximately one minute later the detector initiated a fire alarm followed shortly after by the second detector located in the shop. He immediately contacted the two night security stewards and asked them to investigate the alarms. The stewards called back a short time later confirming that there was a fire, which appeared to be in the store at the rear of the photography shop. The two men could see into the shop through the locked glass front door but could not enter as they did not have the key. The second mate then called the master and started the muster signal in the crew accommodation.

The master arrived quickly on the bridge and, after assessing the situation including further confirmation that the fire was serious, initiated the muster signal throughout the passenger accommodation. The time was 0120.

By this time members of the attack and back-up emergency parties had started to arrive outside the photography shop with fire fighting equipment. The mate who was leading the attack party, nominated two integrated ratings to don breathing apparatus to enter the shop and extinguish the fire.

As smoke was spreading from the shop throughout the ship's accommodation, the mate called the bridge and requested that the fire doors throughout the ship be closed remotely. The time was 0125.

The shop door key was obtained from the shop manager and the two nominated IRs entered the photography shop, initially with hand held extinguishers. Although the smoke was very thick, they located the fire in the store area at the rear. They attempted to extinguish the fire with the hand held extinguishers but found that the fire kept re-igniting. The lead IR realised that the only option was to cool the area with a fire hose. Both men retreated from the shop. A fire hose was quickly charged, both men re-entered the shop and, after five minutes, the fire was extinguished using salt water. After the shop area was thoroughly checked, the fire was declared out at 0144.

While the fire was being extinguished, the passenger muster was proceeding relatively smoothly. By 0152 all passengers had been mustered at their designated muster areas by the ship's crew. The crew dealt with a number of problems during the muster including the need to move one group away from a smoke filled muster area, one passenger with a suspected heart attack and two others who had experienced asthma attacks. All passengers were kept at their muster areas for the next hour while the smoke in the accommodation was cleared and the area of the fire monitored for any signs of re-ignition.

At 0255 it was decided that the smoke in the accommodation had cleared sufficiently for the passengers to be escorted back to their cabins. The rest of the voyage was completed without incident with *Spirit of Tasmania* arriving at Devonport on schedule on the morning of 24 February.

Sources of Information

Master and crew of *Spirit of Tasmania*

The passengers aboard *Spirit of Tasmania*

TT-Line Company Pty Ltd

ASP Ship Management Pty Ltd

Tasmanian Fire Service

Australian Maritime Safety Authority

Mr Adam Brumley, AMOG Consulting Pty Ltd

References

Consolidated edition of the International Convention for the Safety of Life at Sea (SOLAS), 1997.

Australian/New Zealand Standard AS/NZS 3760:1996, 'In-service safety inspection and testing of electrical equipment'.

Narrative

Spirit of Tasmania

Spirit of Tasmania (figure 1) was an Australian flag roll on-roll off passenger ferry operated by TT-Line Company Pty Ltd (TT-Line), of Devonport. ASP Ship Management, based in Melbourne, was responsible for the technical, and some of the personnel management, of the ship.

TT-Line is wholly owned by the state of Tasmania and has terminals in Devonport in Northern Tasmania and Port Melbourne in Victoria. For most of the year, *Spirit of Tasmania* was the only vessel operated by TT-Line, with the ship carrying freight, passengers and vehicles across Bass Strait on a schedule of six crossings per week. Higher demand for the service during the summer period meant that *Spirit of Tasmania* completed eight crossings per week.

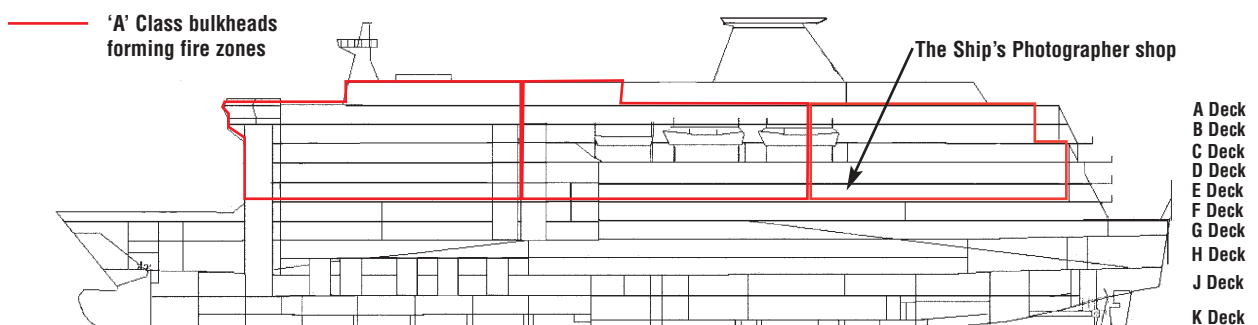
Spirit of Tasmania was built in 1986 at Seebeckwerft AF, Bremerhaven, Germany, and for seven years operated as *Peter Pan* on the Baltic Sea between Germany and Sweden. The vessel was purchased in 1993 by the Tasmanian government and entered service on Bass Strait in November 1993 after completing extensive modifications. In July 1995 *Spirit of Tasmania* underwent further modifications and refurbishment during a dry docking in Newcastle, New South Wales.

The ship was constructed under Germanischer Lloyd (GL) survey with a hull class of ∇ 100A5 M (Restricted International Service) E2, Ro-Ro-Ship, Ferry, Passenger Ship, IW and machinery class of ∇ MC E2 AUT-14h. The ship has been maintained continuously in class with GL since the time of building.

Spirit of Tasmania is 161.52 m in length overall, has a moulded depth of 18.52 m and a maximum breadth of 28.20 m. It has a gross tonnage of 31 356 and a maximum draught of 6.217 m. The ship has 10 decks above the tank top level alphabetically labelled from A deck at the top, to K the deck above the tank tops (figure 2). Machinery spaces containing accommodation ventilation fans and the emergency generator are located on an 11th deck above A deck. There are 1324 berths for passengers and crew in 468 cabins and hostel style accommodation.

Crew cabins are located on A deck aft of the bridge and on B deck forward of the crew mess areas. Passenger cabins are located forward of restaurant, shopping and entertainment areas on C, D and E decks. The reception area and purser's office is located on E deck with walk-on passengers accessing the area via gangways located midships, port and starboard, on F deck. Further passenger cabins are located outboard of the two upper vehicle decks on F and G decks with more passenger cabins at the forward end of J deck and the hostels located at the forward end of K deck. The engine room is located aft of the passenger accommodation on J and K decks.

FIGURE 2:
General arrangement of *Spirit of Tasmania*



The ship has the capacity to carry 35 semi-trailers and 360 standard sized cars on its three vehicle decks. The main vehicle deck is designated H deck and is a continuous deck running the full length of the ship. H deck is divided along its fore-aft centre line by a casing which contains the engine room exhaust uptakes, ventilation and other service trunking, five lift shafts, and stairways for accessing the engine room and lower accommodation spaces. Vehicle access to H deck is via the bow and stern doors and ramps. Semi-trailer cargo is usually loaded on the outboard sides of H deck with smaller vehicles being loaded along the centre line of H deck and via hydraulically actuated ramps onto the upper vehicle decks located either side of the centre casing on F and G decks. The main vehicle deck is divided by three sets of flood control doors, which protect the ship's stability in the event of H deck becoming flooded.

Spirit of Tasmania has watertight subdivision below H deck in accordance with the requirements of the International Convention for the Safety of Life at Sea. On *Spirit of Tasmania* this means that the ship has sufficient damage stability and subdivision to survive two adjacent watertight compartments being flooded. Hydraulically operated watertight doors, which are usually left open, seal the watertight bulkheads in the J and K deck passenger areas. The engine room is similarly divided into four compartments by watertight bulkheads fitted with watertight doors, which allow these spaces to be sealed in an emergency.

Spirit of Tasmania's propulsive power is provided by four, 8-cylinder, MAK 8M552AK, medium speed diesel engines, which provide a total of 19,600 kW. The four main engines are clutched into two reduction gearboxes, which in turn drive a pair of contra-rotating controllable pitch propellers to give the ship a service speed of 20 knots. Auxiliary power is provided by four 1795 kW diesel generator sets, which supply the main switchboard with 660 V, 60 Hz, 3-phase alternating current. Transformers are used to step the voltage down to 440 V 3-phase and

220 V single phase power for use throughout the ship.

On the night of the incident, *Spirit of Tasmania's* crew complement was 112. The crew consisted of:

- the master;
- four mates (including the ship's security officer who is designated 1st mate);
- the chief engineer and eight engineers (including a chief electrician and a hotel services electrician);
- two shipwrights;
- chief and 12 integrated ratings (IRs); and
- two pursers, the hotel manager, four executive and 62 other stewards, the executive chef, 12 other cooks and one supernumerary.

The master on board *Spirit of Tasmania* at the time of the incident held a Master Class 1 certificate of competency issued by the Australian Maritime Safety Authority and had been at sea for 30 years. He had been appointed master nine years previously and had spent the last two years as one of the three permanent masters on *Spirit of Tasmania*. All other ships staff were appropriately qualified.

Emergency equipment and procedures

Spirit of Tasmania held current certificates for all ship's safety equipment, including the fire fighting equipment. The ship was subject to a weekly inspection by the master and senior officers to ensure that the vessel was well maintained and the principles of good ship husbandry were observed.

Spirit of Tasmania has a sophisticated fire detection system with every space in the vessel, where required, fitted with a detector. The fire detection panel is located on the bridge and monitors the fire zones within the ship, identifying any space in which a smoke detector is activated. A fire plan is also displayed on the bridge showing the layout of the ship and the

fire detection and fire fighting resources. There are 1256 detectors located in three zones throughout the ship. The majority of the detectors fitted in the system are of ionisation type. Optical and heat detectors are fitted in areas such as galleys and engine room. Each detector has an individual address. When activated the system will indicate on the consoles, both on the bridge and in the engine room, which detector has activated.

Structurally, the passenger areas above F deck on *Spirit of Tasmania* are divided into three main vertical zones. The bulkheads dividing these zones are 'A' class, constructed of steel or an equivalent material and are insulated to resist the passage of heat and smoke for a minimum of one hour. Each vertical zone has a number of fire-protected escape routes from the accommodation areas to the muster areas and the boat deck. Passages which cross from one vertical zone to another are equipped with automatic fire doors. These fire doors may be operated from the bridge, or locally, in the event of a fire.

Evacuation procedures

Spirit of Tasmania had a planned passenger evacuation procedure. There were seven designated areas located on B, C, and D decks for mustering passengers. Each passenger was allocated a specific muster area depending on his/her berth. Passengers were provided with a number of sources of information detailing the evacuation procedures. A safety pamphlet was provided when boarding the ship and there was further written information located on the inside of each cabin or hostel dormitory door. A safety briefing, including information on how the passengers would be notified of an emergency and what action they should take, was played over the ship's public address system shortly after leaving port.

During an evacuation, individual crew members were detailed to clear a specific section of cabins and escort the occupants to their allocated muster area. In the event of

abandonment of the ship, passengers were to be issued with life jackets at the muster areas and then led to lifeboats or life rafts by ship's staff.

The evacuation system was reliant on crew training and participation, passenger awareness and the safe design and construction of the ship. New crew members underwent safety training in addition to a mentoring process. Their individual responsibilities in the event of an emergency were clearly defined and practiced. Fire and abandon ship drills for the crew were conducted each week.

The Ship's Photographer shop

Five licensed enterprises operated on *Spirit of Tasmania*: Admirals Casino; Galactica amusement arcade; Allder's on Board gift shop; Kingford Promotions travel agency and The Ship's Photographer shop. These businesses were owned by private companies and operated on *Spirit of Tasmania* under a license agreement with TT-Line. The Ship's Photographer shop was owned and operated by Sundisk Pty Ltd. The staff who operated the license areas were employed directly by the owners of the businesses. They were accommodated in passenger cabins on the ship but participated as part of the ship's crew in safety drills and were included on the crew muster lists.

The Ship's Photographer shop (photography shop) was located on the port side of E deck (figure 3). The Promenade restaurant was adjacent to the after end of the photography shop and a lavatory block was located forward of it. The photography shop fronted onto the port side promenade, which was a passage that connected the ship's reception area to the Promenade restaurant. The inboard bulkhead of the shop was bounded by an internal stairwell and the engine room casing. Access to the shop was from the promenade via a plate glass door. The space was originally used as a children's playroom when the ship operated in Europe.

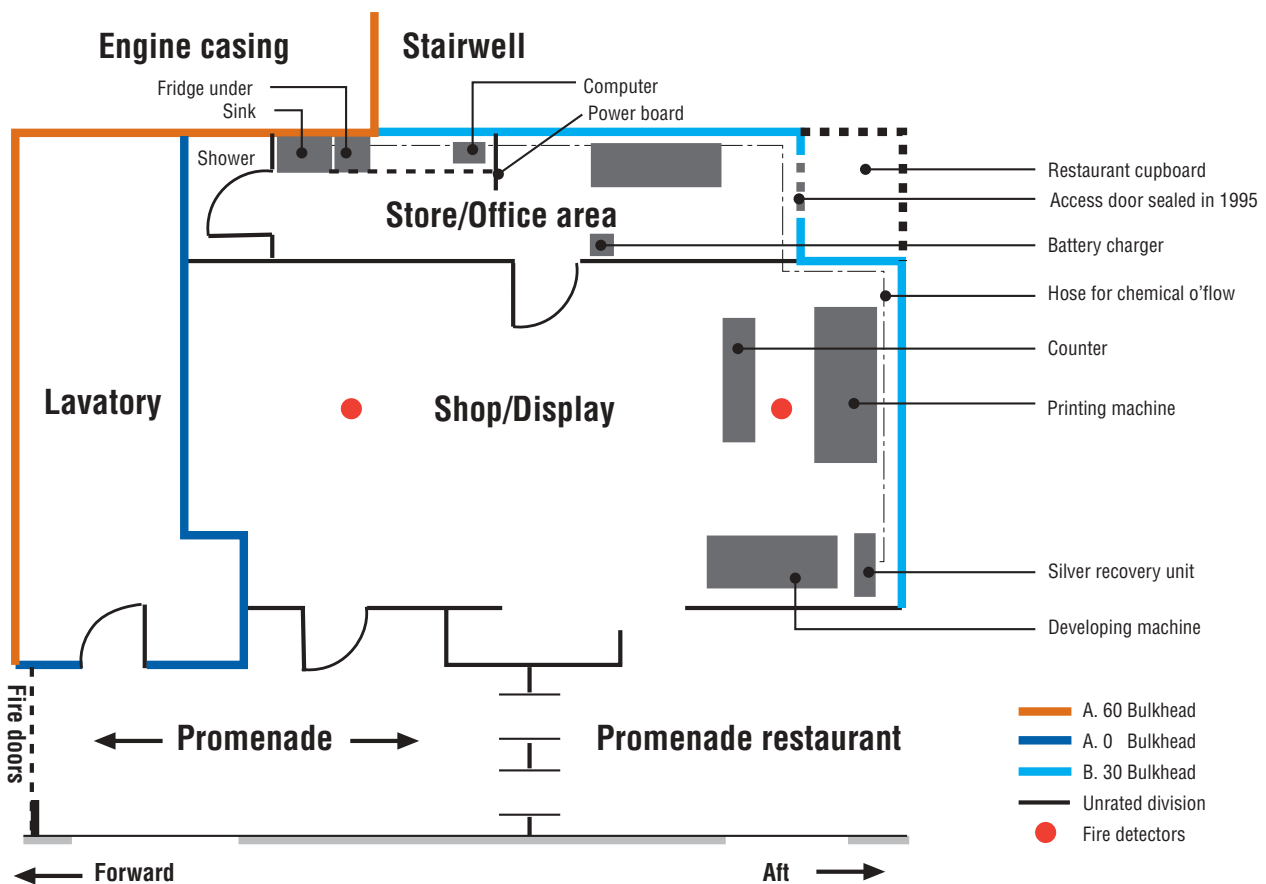
Both the forward and inboard bulkheads of the shop space, together with the deck and deckhead are rated as 'A.60' divisions.¹

Prior to the ship entering service on Bass Strait, the licensed business areas, passenger amenities and entertainment areas on C, D, and E decks were extensively modified. The photography shop on E deck was constructed in 1993 with

the photography shop into the restaurant. A small locker for the new restaurant was constructed in its place.

At the time of the fire the photography shop consisted of a display space with a floor area approximately 4.2 m athwartships and 6.4 m fore and aft. The forward area of the shop was occupied by display racks and the after end contained the sales desk, a film developing

FIGURE 3:
Plan of The Ship's Photographer shop on E deck



some further modifications performed while the ship was in dry dock in 1995.

During the 1995 dry-docking the Promenade restaurant was constructed in place of an existing cafeteria. Part of the refurbishing involved sealing an access door and short passage from the after end of the store area of

machine and a print processing machine. There were two smoke detectors fitted to the deckhead of the shop display space, as part of the ship's fire detection system.

Inboard of the shop display area were storage and office areas which were accessed via a door leading from the display area. The office and

¹ 'A' class bulkheads are of steel construction, 'B' Class bulkheads are of alternative non-combustible material, able to prevent the passage of flame. The qualifying number indicates the insulation property in minutes in terms of standards required under the Safety of Life at Sea Convention 1974, Ch.II-2 Regulation 3.

storage area was approximately 1.2 m wide by 5.5 m fore and aft. The most forward section of the store area (about 1.2 m x 1m), originally a bathroom including a shower recess, was used to store spare film processing chemicals.

At the time of the fire the photography shop had a stock of photographic chemicals as well as a large stock of paper products. The chemicals were of either Dangerous Goods Class-8 (Corrosives) or were of unspecified class. Most of the chemicals were noted to cause possible eye or skin irritation but were not combustible. However one of the chemicals was liable to decompose and give off hazardous fumes in the event of a severe fire. The ship's staff maintained a register of material safety data sheets for all the chemicals.

Immediately aft of the chemical storage area was an office space approximately 2.2 m in length. A bench was fitted along the inboard bulkhead with an in-built sink at its forward end and a computer work-station at the after end. A series of shelves above the desk were used to house a printer and compact disk writer and, above these, documents and some smaller items of stock were stored. A small fridge was located under part of the bench forward of the computer work-station, with the space immediately under the work-station used to store boxes full of photograph envelopes. There were also a number of boxes of picture frames stored against the bulkhead opposite the bench.

Aft of the office space in the shop store was a small area with equipment lockers adjacent to the inboard bulkhead and a small dark room at its after end. Two battery chargers were located on a shelf adjacent to, and just aft of, the door from the shop space.

Power for the fridge, printer, compact disk writer, and the two camera battery chargers in the after store area was supplied from a power board fixed to the bulkhead adjacent to the computer work-station. Power to the battery chargers was provided by a flexible electrical cable run through the door frame into the office area and over the door from the shop, to the

shelf where the chargers were located. A short extension lead had been used to connect the fridge power lead to the power board. This extension lead was run along the deck under the computer work-station with the connection between the fridge plug and the extension lead socket located on the deck in the corner under the bench.

A reinforced plastic hose was led from the machines in the sales/display area to the sink in the store area. The hose was run through the bulkhead dividing the display and store areas to the inboard bulkhead, then forward through the bulkhead between the forward and after store areas. The hose ran along the deck beneath the office desk before rising to terminate at the sink. The hose was rigged to drain any overflow of a chemical used in the film developing and printing processes.

No automatic ship fire detection or suppression system was fitted within the store/office area.

The incident

At 1800 on 23 February 2001, *Spirit of Tasmania* sailed from Station Pier in Port Melbourne with 967 passengers, 112 crew and 10 staff employed by the licensed businesses on board. The ship's destination was the northern Tasmanian port of Devonport some 232 miles to the south-south-east. Shortly after leaving the berth, the standard safety briefing was played over the ship's public address system in all the passenger areas.

By 2042, *Spirit of Tasmania* had cleared point Lonsdale, at the entrance of Port Phillip Bay, to be running clear en route to Devonport. The weather was good, with wind from the south-south-west at 17-21 knots and a moderate sea on a low swell.

At 2145 the manager closed the photography shop for the evening. Prior to closing the shop the manager propped open the door into the store area at the rear of the shop to help dispel some chemical fumes resulting from a spill of chemical the previous evening. The spill had

emanated from the drain hose for the silver recovery unit. Usually the manager ensured that the door into the store area was locked when the shop was closed.

At 0100 the ship's two night security stewards conducted rounds of the ship's accommodation. They passed the photography shop at approximately 0103 and did not notice anything unusual.

At 0114 the second mate on watch on the bridge, received a fire 'prewarning', on the fire detection panel on the bridge, from detector 0460 'Child.Pl.Room Deck-E'. He identified the detector on the ship's fire plan as one of two detectors in the photography shop on E deck. Approximately one minute after the prewarning, detector 0460 initiated a fire alarm on the detection panel, followed shortly after by a prewarning from detector 0459, the other detector in the shop. At 0116 detector 0459 also initiated a fire alarm. The second mate immediately contacted the night security stewards by 2-way radio and instructed them to investigate the alarms.

Initially, one night security steward walked around the corner from the catering office in the reception area on E deck to The Ship's Photographer shop. He looked through the plate glass entrance door into the shop to see smoke coming out of the store area at the back of the shop. He could also see some light at the back of the shop and, while he was looking, he saw a piece of paper float out of the store area on fire. He immediately called the bridge to confirm the existence of the fire. The first night security steward was quickly joined by the second night security steward who had been on a coffee break. Both men tried their keys in the locked door of the shop to find that none would fit. They stayed at the front of the shop and gathered the portable fire extinguishers located around the area. They also ran out the fire hose located at the closest fire point² at the forward end of the Promenade restaurant. The shop

filled quickly with smoke as the two men were assembling the fire fighting equipment.

After being notified by the night security steward that the fire alarm in the photography shop was not a false alarm, the second mate called the master and started the muster signal in the crew accommodation on A and B decks. The master arrived very quickly on the bridge and took the watch from the second mate and instructed him to go down to the photography shop and report on the situation. The master also instructed the 12-4 IR to go through the crew accommodation and rouse the crew.

The second mate proceeded quickly to the shop rousing the mate and security officer on his way. Once he arrived at the shop, he found that it was full of smoke and that smoke was starting to fill the promenade outside the shop. He contacted the master, reported the situation and made his way back to the E deck reception area.

On the bridge, the master was joined by the third mate, the chief purser and an IR. Once the second mate had reported the situation in the photography shop, the master instructed the chief purser to initiate the muster signal throughout the whole of the ship's accommodation. The mustering of the passengers commenced and the chief purser started a running log to record the timing of events. The time was 0120.

The mate had dressed quickly after being roused by the second mate, and proceeded directly to the photography shop. There he met the second mate and the night security stewards who left shortly afterwards to perform their respective muster duties.

By this time the IRs in the attack and back-up fire teams had started to arrive at the photography shop. After leaving their cabins on A deck on hearing the muster signal and being informed of the situation by the 12-4 IR, they had proceeded to their muster area on the port side of B deck. Once there, the word was passed on the location of the fire. They had moved quickly down and opened the equipment locker

² Cupboard containing a portable extinguisher, a fire main connection, with a fire hose and nozzle.

at the fire station, adjacent to the port gangway on F deck, where they collected breathing apparatus (BA), torches, extinguishers an axe and a lifeline. Three of the IRs who had donned BA then proceeded to the photography shop on E deck via the promenade.

The security officer also arrived outside the photography shop during this time and, seeing that the shop doors were locked, he went immediately to the shop manager's cabin in the passenger accommodation on G deck and obtained the key from the shop manager. He moved quickly back to the shop and unlocked the doors.

The chief steward and two other stewards had been closing the 'Tiger' bar on C deck when they heard the muster signal over the ship's public address system. The chief steward rang the bridge and was informed that there was a fire in the photography shop and that the passengers were to be mustered. The three stewards went immediately to the crew accommodation and started knocking on doors to ensure that all the crew were awake and moving and had been informed that there was to be a full evacuation of the passenger accommodation.

At approximately 0125, the master made the decision to slow the ship to five knots. This was a precaution in case the situation became rapidly worse and the ship had to be abandoned.

At this time, the mate saw that there was smoke issuing from cracks around the closed front door of the photography shop. He was concerned about the spread of the smoke into the rest of the accommodation and so he used the local tripping switch to close the fire doors forward of the shop on the promenade. He also contacted the bridge to request that all fire doors throughout the accommodation be remotely closed to slow the spread of the smoke. The time recorded on the bridge for closing the fire doors was 0125. Later, at 0135, the watertight doors were remotely closed from the bridge and the ventilation to the shop area was shutdown by the engineers.

Once the attack party had assembled outside the shop, the mate nominated two of the IRs to go into the shop to extinguish the fire. A lifeline was attached to the leading IR, their BA was checked, and they moved to enter the shop, each man equipped with a dry powder extinguisher. One of the shipwrights kept a time board to monitor the two men in BA.

As the door was opened and the two men entered the photography shop, smoke billowed out to fill the corridor outside, forcing most of the crew to move back to the reception area. The mate and the chief IR, who was handling the lifeline, lay on the deck outside the shop. As more smoke filled the corridor, the mate and chief IR were forced to move back behind the fire doors forward of the shop, with one of the doors open just enough to feed the lifeline.

The smoke inside the shop was very thick and even with torches the IRs could not see more than a metre ahead. The two men initially made their way to the developing machine at the after end of the shop. Finding nothing, they moved towards the rear of the shop and then saw flames in the store area. As they got closer, the men saw two areas burning in the forward part of the store, one on the left adjacent to the bulkhead dividing the store from the display area, and another to the right around the computer work-station. They used the dry powder extinguishers on both areas to extinguish the fires momentarily but, as the area was extremely hot, flames flared up again almost immediately. The lead IR realised that the only option was to use water to cool the area and so the men withdrew from the shop. A fire hose was charged. The two men re-entered the shop with the hose and within five minutes had extinguished the fire.

While the fire was being extinguished, areas adjacent to the photography shop were being checked for hot spots by members of the backup party led by the security officer and the second mate. No hot spots were found in any of the adjacent spaces although the second mate noted that there was water dripping through to the

vehicle deck below. The backup party also noted that smoke was leaking into an adjacent locker at the forward end of the Promenade restaurant and the deck above.

After ensuring that the fire was out, the two integrated ratings came out of the photography shop to report to the mate. They changed the air bottles on their BA sets and then went back into the shop with the fire hose to cool the area of the fire by spraying water on the bulkheads and deckhead in the store area. At 0144 the chief IR notified the bridge that the fire was out.

The engine room was also notified that the fire had been extinguished and engine room staff were sent to check the funnel casing adjoining the shop.

At 0150, the hotel services electrician was instructed to isolate the power to the photography shop at the local electrical distribution board. When he inspected the distribution board he found that one of the circuit breakers supplying the power outlets in the shop was in a tripped condition.

Evacuation of the passengers by the hotel staff was proceeding smoothly while the fire was being fought. By 0130 all muster areas had been manned. At 0151 the chief purser announced over the ship's public address system that the fire had been extinguished but that passengers were to continue to muster and remain at their muster stations until the smoke had been cleared from the accommodation. At 0152 the second mate reported to the bridge that everyone was at their muster stations. The chief purser recorded that final reports were received on the bridge from all muster stations by 0211.

The crew had been presented with a number of problems during the evacuation, including excessive smoke in muster area six, in the Nauticals restaurant on D deck, which necessitated moving the passengers into muster area seven in the Huon Room restaurant also on

D deck. One passenger suffered a suspected heart attack and two other passengers experienced asthma attacks. These passengers were eventually stabilised after being moved to the ship's hospital and attended by the ship's nurse and two doctors, who were travelling as passengers.

During the next hour or so the photography shop was continuously monitored for any sign of the fire reigniting. A deckhead panel within the shop was taken down to see if there was any fire as a result of the heat transmitted into the ceiling cavity, but no signs of damage due to heat or smoke were found. Both fire detector heads were also isolated in the shop so that the detection system could be reset.

At 0205 fire doors on C, D, and E deck were opened to help clear the smoke from the accommodation.

At 0212, the engineering staff started to re-establish the accommodation ventilation by opening the fan dampers and restarting the ventilation fans. Passengers were made as comfortable as possible at the muster areas by the hotel services staff and kept informed of the situation regularly by the chief purser over the public address system.

The master was concerned about the passenger with a heart problem and so, at 0235, he rang the engine room to indicate that he would be working the ship up to full speed to get to Devonport as quickly as possible. By 0255 the smoke had cleared sufficiently for the passengers to be escorted back to their cabins by the hotel services staff.

After the passengers had returned to their cabins and the ship was on passage at full speed, the master inspected the photography shop and then contacted AusSAR to report the fire. A continuous watch was maintained on the shop and the surrounding areas for the remainder of the voyage.

Comment and analysis

Evidence

Two investigators from the Australian Transport Safety Bureau (ATSB) attended *Spirit of Tasmania* in Devonport on the afternoon of 24 February 2001 and continued the investigation on board until the vessel arrived in Melbourne on the morning of 25 February 2001. The primary aim of the investigation was to establish the cause and circumstances of the fire, its initiation, detection, and extinction. In addition, given the current international regulatory focus on the safe evacuation of passenger vessels, measuring the effectiveness of the 'real' passenger evacuation, which occurred on board *Spirit of Tasmania* as a result of the fire, was seen to be a high priority of the investigation.

Evidence relating to the cause of the fire was gathered at the fire scene in the photography shop.

Evidence regarding the circumstances of the incident and the sequence of events was obtained by interviewing various members of the crew in addition to various documentary evidence in the form of logs etc. Those interviewed included: the master, mate, security officer, second mate, electrician, hotel manager, chief steward, night security stewards, chief IR, the photography shop manager and the IRs in the attack party who fought the fire.

Various other documentary evidence relating to the investigation was obtained from the ship and from TT-Line including: official log books, vessel certification, fire plans, crew training plans, procedures relating to emergency and evacuation, crew and passenger manifests and information relating to chemicals used in the

photography shop. TT-Line also provided some information on the history of the modifications made to the photography shop in 1993 and 1995.

An extract from the events and causal factors chart for the incident is reproduced in figure 11.

Passengers

To establish the effectiveness of the emergency evacuation procedures and the effectiveness of the crew, a survey in the form of a questionnaire comprising 28 questions relating to the fire and evacuation was developed jointly by ATSB and TT-Line.

The questionnaire was designed to elicit information on:

- the effectiveness of safety information;
- the effectiveness of the alerting/alarm system;
- reaction to the emergency alarm;
- barriers to effective movement under alarm conditions; and
- the effectiveness of the passenger and crew mustering system.

Of the 967 passengers on board *Spirit of Tasmania* on the night of 24 February, TT-Line had contact details for 291 who had made bookings directly through their reservation system. These passengers were posted a copy of the questionnaire, which ultimately resulted in 123 completed questionnaires returned. The information contained in the completed questionnaires was collated and analysed by the ATSB to produce the report contained in appendix 1.

The fire scene

The fire scene in the photographic shop was examined by the two investigators from the ATSB in the company of a fire scene examiner from the Tasmanian Fire Service. The primary aim of the examination was to determine the source of ignition of the fire.

The retail/display area of the shop showed extensive smoke and water damage throughout with some heat damage in the upper part of the shop, particularly the deckhead adjacent to the door into the store area where some mounted plastic fittings had melted. There was no evidence of flame damage within the display area apart from in the doorway leading into the store area at the rear (figure 4).

FIGURE 4:
Doorway to store area



Inside the store area, all the bulkheads and deckhead panels showed extensive fire and smoke damage. The examination revealed that the fire had started in the forward end of the store/office area and had been mainly confined to this area. In many areas plastic laminate facing of the bulkhead and deckhead panels had either been burnt away or delaminated from the backing particle board. In all of these areas the fire resistant particle board had remained wholly intact (figure 5).

In the forward section of the store, the deck was covered in fire debris (figure 6). The debris consisted mainly of charred paper, broken glass and melted plastic. Most of the debris was lying in the area of the computer desk and adjacent to

FIGURE 5:
Heat damage to deckhead panelling



the opposite bulkhead. Among the debris were the remnants of the electrical power-board, which had been fixed to the bulkhead adjacent to the computer work-station. Examination of the remnants of the power board showed that the plastic components of the board and of the plugs to the extension lead supplying the fridge, CD writer, printer and battery chargers had been destroyed, to leave only the conductors within the board relatively intact. Of the electrical leads plugged into the power board only the copper conductors remained. The position and condition of the power board presented one possible source of ignition for the fire.

FIGURE 6:
Fire debris in the forward section of the store



FIGURE 7:
Fire damage to computer workstation



FIGURE 8:
Fire damage under computer workstation showing 'V' pattern in corner



On closer inspection, the seat of the fire appeared to be centred low in the area around the bench where the computer was located. The computer monitor and keyboard both showed extensive fire damage (figure 7). The compact disc writer and printer on the shelf above the computer, and a stock of manuals on the shelf above that, had been destroyed. Systematic clearance of the debris from the deck under the computer work-station (mostly partially burned cardboard boxes containing photograph envelopes), revealed a characteristic fire ‘V’ pattern low in the corner between the engine casing bulkhead and the part bulkhead between the forward and after sections of the store (figure 8). The pattern of the burn damage in the surrounding boxes of photograph envelopes indicated that the flame had travelled from a point close to the deck in an upwards direction, partially consuming the boxes of envelopes in its path.

Adjacent to the burn pattern under the computer work-station lay a section of a short extension lead, which had connected the power board to the power lead from the fridge (figure 9). The plastic hose used to drain chemical from the silver recovery unit in the shop to the sink in the store lay alongside the connection between the extension lead and the fridge lead. This hose had been partially damaged by the fire and had a charred hole in it adjacent to the extension lead connection.

It was concluded from the fire scene examination that the likely sources of ignition for the fire were the electrical power board or the short extension lead supplying power to the fridge. To positively establish the source of ignition, the remnants of the power board, short extension lead, fridge power lead and a short section of the chemical drain hose, which had fused to the extension lead, were taken for further examination by the technical analysis unit of the ATSB.

ATSB technical analysis

The technical analysis unit of the ATSB examined the remnants of the power board and found that there was no evidence of shorting/fusing between any of the conductors within the power board or on the pins of the plugs, which had been plugged into it. It was concluded that the damage to the board was most likely to be the result of the fire, not the cause.

After examining the section of extension lead, fridge power lead and chemical hose, the ATSB’s technical analysis unit provided the following report:

A section of electrical extension lead located at the seat of the fire was recovered for detailed examination. The extension lead supplied power to a fridge. It was apparent that the section of the lead had been looped and trapped between the lead connection plug and a reinforced plastic drain hose (waste photographic processing chemicals). The plastic material on the side of the plug in contact with the lead and drain hose had been affected by melting and charring (see fig 9).

The trapped section of lead (plastic insulation and copper conductor strands) had been destroyed. The features of the ends of the conductor strands protruding from the intact section of the lead were consistent with melting and resolidification (see fig 10).

The plastic drain hose had also been affected by localised melting and charring to a degree that created leaks. The blue coloured compounds on the plug pins are consistent with a reaction between the copper alloy of the pins and waste photographic processing chemicals.

ANALYSIS

It is likely that the complete destruction of the copper conductor wires in the section of the electrical lead trapped between the plug fitting and drain hose was caused by electrical arcing between the conductor wires.

In normal use, electrical arcing between conductor wires is prevented by the dielectric properties of the polymeric materials used in electrical lead construction. Dielectric strength depends on material properties and the distance between the conductors. A significant factor in the electrical breakdown of polymeric (plastic) dielectric materials is the loss of dielectric thickness by deformation. Because plastics are visco-elastic materials they will deform if a mechanical load is imposed on the material for a period of time. Electrical heating effects will exacerbate the process of deformation.

CONCLUSIONS

It is evident that electrical arcing occurred between the copper conductor wires of the section of lead trapped between the plug and drain hose. There was no evidence of arcing between the pins of the plug fitting.

It is likely that the significant factor in the development of arcing between the lead wires was the imposition of a mechanical load on the trapped section of the lead.

Based on the technical analysis unit's findings, it is probable that the fire in the photography shop was caused by arcing/heating as a result of the breakdown of the insulation between the conductors in the section of extension lead trapped between the chemical drain hose and the plug. It is likely that the poly vinyl chloride insulation in the lead had 'flowed' until thin enough to allow heating/arcing (a short circuit) between the conductors after being subjected to the weight of the boxes of photograph envelopes. These boxes had been stored under the computer work-station, resting on the plug/lead/hose, for a considerable period of time (approximately three months according to the shop manager).

Neither moisture, from a spill of water/chemical from the sink or the fridge, nor a leak from the chemical drain hose contributed to the fire. It is probable that the hole in the chemical drain hose adjacent to the plug was the result of the fire. There was no evidence of any accelerant at the fire scene which may have increased the speed of flame propagation.

FIGURE 9:
The features of the recovered section of the electrical lead and drain hose (two views)



FIGURE 10:
A remnant of a copper conductor wire (arrowed) exposed by cutting the remaining intact insulation



The electrical system

Short circuit and earth leakage protection

Analysis of the remains of the electrical extension lead indicated that the initial short circuit may have occurred between the active conductor and either the neutral or earth conductor in the lead. It was not possible to identify which of these two leads was the first to complete the short circuit. In either case, if the short circuit protection within the electrical system had isolated the power to the lead at an early stage, the fire may have been prevented. In the case of a current flow to the earth conductor in the lead, the ship's earth leakage

detection system may also have alerted engineering personnel to the short circuit. There was no evidence to indicate that there was such an earth fault detected prior to the fire.

Like all ships, *Spirit of Tasmania* was protected at multiple levels against short circuits in its electrical distribution system. In the case of the short circuit in the extension lead in the photography shop, the first level of protection was the circuit breaker within the power board itself, rated at 10 amps. The next level of short circuit protection was provided by a circuit breaker in the local distribution board for the whole power circuit, into which the power board was plugged, this was rated at 16 amps. There are further circuit breakers in the distribution system, progressively higher rated, which are designed to protect against short circuits at progressively higher levels. The fire in the photographic shop occurred despite these multiple levels of short circuit protection.

The circuit breaker in the power board was found after the fire in a tripped condition. Similarly when the hotel services electrician opened the local distribution board at approximately 0150 after the fire had been extinguished, he found that the circuit breaker supplying the power board in the photography shop had tripped. The tripped condition of these circuit breakers requires explanation.

Considering the sequence of events, it is likely that the initial rate of insulation breakdown between the conductors in the extension lead was slow. Eventually the insulation thinned to the point where a current was established from the 220 volt active to the, nominally zero volt, neutral or earth conductors. Once the current was established, the resultant heating would have been rapid even for a relatively small current (but less than required to trip the circuit breaker) flowing across the high resistance of the remaining insulation. With the rapid heating, the remaining insulation would have broken down quickly with a progressively higher short circuit current flowing between the conductors

until the 10 amp circuit breaker tripped on the power board. By this time the insulation on the extension lead must have started to burn with a ready source of fuel for the fire in the cardboard boxes sitting on top of it.

The distribution board circuit breaker may have tripped at the same time as the power board circuit breaker, (depending on the amount of current at that instant). The other possibility is that this breaker tripped sometime later due to a second short circuit, perhaps when the fire had consumed the insulation on the power board or when water had been sprayed into the store to fight the fire.

Inspections of electrical equipment

As a vessel managed by ASP Ship Management, *Spirit of Tasmania* was subject to the technical procedures and policies applicable to all vessels managed by the company. These included a policy and associated procedure (QPRO-8.17, 'Testing of Portable Electrical Equipment') relating to the periodic testing and inspection of portable electrical equipment.

Procedure QPRO-8.17, contains instructions for ship's personnel regarding the type of portable electrical equipment to be tested and the frequency and method by which such equipment should be tested. The procedure does not refer specifically to the testing of extension leads but states: 'This procedure must be read in conjunction with AS/NZS 3760:1996 "in-service safety inspection and testing of electrical equipment".'

AS/NZS 3760:1996 states under section 1.1 'Scope':

This standard specifies procedures for the in-service safety inspection and testing of single and polyphase electrical equipment, other than fixed equipment, which is designed for connection by a flexible power supply cord and plug to a low voltage supply. It applies also to **cord extension sets**, (author's emphasis), electrical portable outlet devices, cord-connected residual current devices and portable isolation transformers.

The standard stipulates that all equipment must be inspected prior to initial introduction to service. QPRO-8.17 states:

It is the responsibility of the chief engineer of each vessel to ensure that portable electrical equipment which has not been tested by a qualified electrician, shall be tested according to this procedure.

QPRO-8.17 also stipulates that portable electrical equipment used in areas like cabins and offices must be re-tested every 12 months. Neither the extension lead, nor the power board, in the store of the photography shop had ever been tested or inspected by a suitably qualified member of the ship's engineering staff. Had the lead been tested and its conditions of service been inspected at some time in the three months before the incident, the failure of the lead and resultant fire may have been prevented.

The hotel services electrician on board *Spirit of Tasmania* stated that standard AS/NZS 3760:1996 was, indeed, used for guidance when testing of the portable appliances on the vessel, however he indicated that it was not usual practice to test either extension leads or power boards. In this regard there appears to be some discrepancy between the intent of QPRO-8.17 and its application on board *Spirit of Tasmania*. In submission TT-Line's Chief Executive Officer stated:

As you have correctly noted the inspection and tagging standard set out in Procedure QPRO-8.17 as read in conjunction with AS/NZS 3760:1996 covers electrical extension leads and power boards. I am advised that extension leads were, in fact, inspected and tagged in accordance with the designated procedure at the time of the incident. Further, I am also advised within the last 2 years TT-Line supplied the entire ship's complement with power boards that incorporated the correctly rated circuit breaker. Accordingly, it is most likely that the extension lead and power box was brought on board by Sundisk's personnel without the knowledge or approval of the Chief Engineer and/or ship's engineering and electrical staff.

Shipboard risk management

The ASP Ship Management quality management system in use aboard *Spirit of Tasmania* included a number of procedures for ensuring the occupational health and safety of the crew and for preventing accidents on the vessel. These procedures included the formulation of a 'Health, Safety and Environment Committee' (QPRO-8.24), the use of 'Hazard Logs' for identifying workplace hazards, periodic 'Shipboard Safety Surveys' (QPRO-8.27) and 'Shipboard Risk Management' (QPRO-8.28). The stated purpose of these interlinked procedures was to proactively identify hazards in the form of 'unsafe acts and conditions associated with the crew and vessel' and 'to assist in the assessment of identified hazards in terms of their risk and then manage that risk.'

All regular crew members received training in identifying hazards and were encouraged to enter any hazards they may identify in one of the 'Hazard Logs' located in various places around the ship.

In addition to the 'Hazard Log' system, QPRO-8.27 stipulates that areas including store rooms must be regularly surveyed by designated members of the ship's crew to identify hazards such as hazardous materials, storage and electrical equipment. Like the entries in the 'Hazard Logs', safety survey results were presented at the monthly meetings of the Health, Safety and Environment Committee. This committee, which was made up of senior members of the crew, assessed the risks of any hazards identified, (guided by QPRO-8.28), and then made a decision about any required remedial action.

The photography shop store contained stocks of chemicals as well as an extensive range of paper products. It is not possible, after the fire, to assess how tidily and safely the paper and chemicals were kept. However such stores are a

potential, if low-level hazard, and should be stowed properly and inspected regularly. The stowage of the boxes of photograph envelopes on top of the electrical extension lead under the computer work-station was an identifiable fire hazard. A regular inspection of the photography shop by ship's crew or a safety survey may have identified such a hazard and thus prevented the fire. There were no records of any safety survey or inspection of this area at any time prior to the fire.

Access for regular ship's crew to the licensed business areas on *Spirit of Tasmania* was limited, even for normal ship's routines and procedures, including the weekly inspections by the master and senior officers. These inspections normally occurred when the ship is in port when the licensed business areas are closed and secure and their staff are off duty. The purpose of such inspections, however, is to ensure cleanliness and safety and hence no area in the ship should be restricted.

Indeed at the time of the fire, neither the mate nor the security officer had a key to the photography shop and had to obtain the key directly from the shop manager, although a spare key for the shop was located in the master's key locker. Valuable minutes may have been lost if the shop manager had not been readily available while the spare key was found or if another method of access to the shop had to be used.

Licensees' staff training

The staff working in the licensed businesses on *Spirit of Tasmania* sometimes worked on the vessel continuously for lengthy periods of time without leave as they did not work under the provisions of a maritime award. In many cases the staff in these areas spent considerably more time on the vessel than regular members of the crew.

Although the licensee's staff used the crew messing and other facilities on board and participated in the weekly fire and emergency drills, they did not receive the training that the regular

crew were required to undertake before commencing sea-going duties. The crew training included such things as the operation of the survival craft, firefighting, evacuation, and occupational health and safety including hazard identification. None of the photography shop staff had received training in these basic aspects of shipboard safety, the issue of hazard identification being of particular relevance. There was no requirement for such training under the arrangements existing between TT-Line and the business operator.

It is a matter for some conjecture whether the photography shop staff may have found a safer way of stowing the boxes of photograph envelopes, rather than on top of the extension lead, if they had received the training provided to the crew. Nevertheless, as staff regularly working on the ship, they should be trained in, and fully conversant with, the ship's fire and emergency evacuation plans and safety management strategy.

Fire protection and detection

The International Convention for the Safety of Life at Sea (SOLAS) contains specific requirements for structural fire protection, and fire detection and extinction on all ships. The requirements for passenger ships like *Spirit of Tasmania* are particularly rigorous.

In 1993 when many areas of the ship were modified, the Australian Maritime Safety Authority worked with TT-Line to ensure that all the materials used in the modifications complied with SOLAS requirements to minimise the spread of fire and the generation of smoke and toxic fumes. The store in the photography shop was subject to intense heat at, and just below, the deckhead level. Both the deckhead and the bulkhead material showed only superficial damage but remained structurally intact and thus effectively prevented the spread of the fire into adjacent spaces.

The photography shop was protected by two smoke detectors located approximately three

metres apart on the deckhead in the display area. The partitioning of the space to create the store at the rear of the shop meant that there was no detector in the area where the fire started. Regulation 41-2 of SOLAS (consolidated edition, 1997), 'Requirements for passenger ships carrying more than 36 passengers constructed before 1 October 1994' was applicable to *Spirit of Tasmania* and states in section 2:

All accommodation and service spaces, stairway enclosures and corridors shall be equipped with a smoke detection and alarm system of an approved type and complying with the requirements of regulation 13.

On the basis of regulation 41-2, it could be argued that the shop store should have been fitted with a smoke detector. Several original store/office areas of a similar size throughout the ship and used for similar purposes were fitted with a smoke detector.

The door into the shop store area was normally closed and locked, fortunately on this occasion the door had been left open to vent some chemical fumes. It is likely that the outcome of the fire would have been more serious if the detection and extinction of the fire had been delayed by a locked store door. A smoke detector fitted in the shop store would have allowed significantly faster detection and thus faster extinction of a fire in normal circumstances.

The response to the emergency

Fire fighting

The response to the fire, from the time of its first detection to the time it was extinguished, was effective and well executed. A matter of slight concern is the time taken to isolate the electrical power in the photography shop, which occurred at 0150, after the fire had been extinguished. The officers and crew involved in fighting the fire were familiar with the ship and, notwithstanding the delay in isolating the power, proper precautions were adopted with the fire

team's responses being proportionate and consistent with their training.

There were, however, two areas of concern that could have led to delays or an inappropriate response had any of the key staff been new to the ship or had outside support, such as shore firefighters, been involved.

The 'prewarning' provided by smoke detector 0460 was the first detection of the possibility of fire. The fire panel on the bridge indicated that there was smoke in 'Child.Pl.Room Deck-E' and the detector number. Since 1993 the detection system had not been modified to reflect the ship's Australian configuration and the conversion of the space from what was once a playroom for children to the photography shop. This may have been a source of confusion if the second mate had been new to the vessel although this issue has been partially addressed by a system of reference cards, kept adjacent to the fire detector panel, which indicated the location of individual detectors and their number.

All ships carry a fire plan approved by the flag State marine regulatory authority, in this case the Australian Maritime Safety Authority. The fire plan, which shows the location of fire fighting and detection equipment and means of access to spaces, may be used to plan an attack on a fire. A current copy of the fire plan must be kept at the gangway to provide shore services with a plan of the ship and its fire fighting resources.

With respect to the photography shop, the fire plan on board *Spirit of Tasmania* at the time of the fire, was not accurate. Despite being approved by AMSA in February 1996, the plan did not show the alterations to the shop that had been completed in July 1995. The plan showed an entrance to the store area of the photography shop from the forward end of the Promenade restaurant although this entrance had been blocked off and turned into a store for the restaurant in 1995. During the fire, some of the

crew had opened the cupboard, not aware of the modification, to try to gain alternative access to the area of the fire.

Neither the out-of-date space indicator on the fire detection system, nor the inaccurate fire plan were critical in this incident, but under different circumstances such deficiencies may lead to unnecessary delays in response or create critical situations.

Cabin evacuation and mustering the passengers

The master did not hesitate to order a muster of passengers. He knew there was a fire but could not predict what course the fire would take. In deciding to muster the passengers he ensured that the passengers had the maximum time available to evacuate their cabins and thus minimised the potential for the evacuation to be complicated by the spread of smoke or fire. His decision, although the fire was quickly brought under control, was, in the Inspector's opinion, totally appropriate. He received full support of TT-Line management for his actions.

Passenger survey

General

Of the questionnaires sent out, 123 individuals responded, of whom three were under the age of 12, 100 were between 19 and 60 years of age and 20 were over 61 years of age. Of all the passengers surveyed, only one specified a first language which was not English. Sixteen per cent of the passengers were embarked for their first crossing, 57 per cent had crossed between one and five times and 27 per cent had crossed on more than five occasions. At the time the fire alarm was raised, 91 per cent of the respondents were in their cabins, just under half of whom were asleep.

Safety Information

Three questions sought information on the effectiveness of safety information provided by TT-Line through announcements, notices on cabin/dormitory doors and in material provided with the passenger's ticket.

Eighty two per cent of respondents recalled the routine safety announcement made shortly after the ship sailed, however 13 per cent of those respondents stated that they did not understand the instructions given in the announcement. Two respondents commented that the announcement was hard to hear above the noise of other passengers. Sixty three per cent of passengers stated that they read the safety notice on their cabin door, of which 76 per cent stated that having read the instructions helped them during the emergency. Almost the same number 77, stated that they read the safety information with their ticket documentation.

Effectiveness of alerting/alarm system

The questionnaire asked the question, 'How were you first alerted to the emergency?' It is of concern that only seven per cent stated that the fire alarm by itself alerted them. A further eight per cent were alerted by the fire alarms combined with either the public address system or the warnings by crew or other passengers. It was also established that, even when alerted to the emergency, people within the dormitory did not hear the fire alarm. Thirty per cent of passengers were initially alerted by the public address system. Again a proportion reported that it was a combination of the public address and other warnings that first alerted them. Either crew (36 per cent), or other passengers (four per cent), or a combination of the two alerted a total of 43 per cent of the respondents.

Comments from respondents stated that the public address system was too muffled to understand inside the cabin. Other comments related to the fire alarm, public address system and crew instructions being given simultaneously, leading to some confusion.

Reaction to the alarm/emergency

About 45 per cent of respondents did not initially believe that the emergency was real. The majority of these were persuaded that there was indeed a fire when instructed by the crew or hearing other passengers. Sixty four per cent were convinced that the emergency was real in two minutes or less. Of concern was the fact

that nine per cent of respondents took over ten minutes to accept that the emergency was real.

The great majority of passengers (86 per cent) of respondents recalled that a crew member gave them instructions as they evacuated their cabins and 69 per cent recalled being guided to their muster station by a crew member or following other passengers under instruction from a crew member. Sixty per cent of respondents were evacuated leaving their personal belongings in their cabin/dormitory, while 36 per cent took small bags or items of luggage. Some ensured they took warm clothing.

Barriers to effective movement under alarm conditions

Some difficulty or delay in evacuating to the muster areas was reported by 23 per cent of respondents. These varied from the difficulty in waking passengers to their slowness in getting dressed and to the level of mobility of some passengers (generally older passengers) in climbing the stairs. One wheel chair had to be carried up stairs, while other passengers found it difficult to find doors and exit points. Six passengers reported that some passengers attempted to go down the stairs against the flow of the evacuation.

In commenting on the behaviour of other passengers, 17 per cent commented on fellow passengers being intoxicated, while a number of respondents noted other passengers being difficult, or displaying signs of panic, and some complained of jokes in 'poor taste', particularly 'Titanic' jokes. Yet other passengers remarked on how calm people were in general. Some passengers commented on the cold and the lack of warm clothing, while others were frustrated at not knowing the nature of the incident.

The passenger and crew mustering system

Respondents were asked to estimate how long it took them to reach their muster station. Seventy one per cent estimated that they took five minutes or less, while 15 per cent estimated

some time between five and ten minutes. Five per cent estimated that it took between 13 and 20 minutes, while six per cent did not supply an estimate.

Half the respondents recall, once at the muster station, being told of the nature of the emergency, the vast majority by the crew. The majority of the respondents 71 per cent recalled being kept informed of what was going on through the public address system or a combination of the address system and crew briefing.

The majority, 70 per cent, of the respondents were unaware of a head count by the crew at the muster station, while the vast majority, 89 per cent, were aware that there was a crew member with them at all times. Eighty six per cent of the respondents understood the announcements made while at the muster station.

The respondents were asked to rate the crew performance on a scale of five (excellent) to one (poor). Eighty three percent rated the crew performance as four or five, while 10 per cent rated the crew as average (three). Four per cent of respondents did not respond and three per cent rated the crew as scale one or two.

Passenger survey conclusions

The passenger survey results indicate that the evacuation procedures in use on board *Spirit of Tasmania* are generally effective. The vast majority of passengers surveyed had received and understood the emergency and evacuation information provided by TT-Line in the safety briefing, the safety information pamphlet provided when boarding and/or the information located on each cabin door. Response and evacuation times were satisfactory, with the majority of survey respondents reaching their designated muster point in less than 10 minutes. The vast majority of passengers also expressed a very high level of satisfaction with the performance of the crew. Of the 99 passengers who made written comments in the survey, 58 specifically commended the actions of the crew.

The passenger survey, however, did raise concerns about some aspects of the evacuation. The inaudibility of the alarms and public address system in some areas of the ship, two passengers not mustered and passenger ‘back flow’ are the predominant issues highlighted by the survey which need to be addressed.

A number of respondents commented that they had difficulty hearing and understanding the announcements made over the ship’s public address system. In addition, a very high proportion of respondents indicated that they were first alerted to the emergency by means other than the fire alarm (only seven per cent were first alerted by the fire alarm). Based on the evidence provided by the passengers surveyed, the audibility and clarity of the alarm and public address systems throughout the ship needs to be reviewed.

More concerning is the report that two passengers had slept through the emergency in one of the hostel areas. The ship’s evacuation plan requires the crew to systematically clear and check each berth to ensure that all passengers have been mustered. In this case it appears that the crew may have failed to clear, and then check, the area properly.

Spirit of Tasmania is required to carry a complete passenger manifest on each voyage. In

the event of an emergency, the manifest may allow a final check of the number of mustered passengers by conducting a systematic head count. The evacuation plan in use at the time of the fire did not include a final check of passenger numbers at the muster stations, although 30 of the passengers surveyed indicated that they were aware of a head count at their muster station. A final head count and reconciliation of the passenger numbers based on the manifest would have identified that there were passengers missing from the muster.

Passenger ‘back flow’ or unescorted passengers moving back down to their cabins during the evacuation was noted by several of the passengers surveyed. ‘Back flow’ during an evacuation must be strictly controlled by the crew. By returning to their cabins, the passengers may be placing themselves at risk by entering unsafe areas, or they may slow the flow of others moving in the opposite direction to the muster points. Three of the respondents who noted the passengers going back to their cabins indicated that their evacuation was slowed as a result. When dealing with passengers in an evacuation, the importance of staying in a single group while moving in one direction to the muster points, must be emphasised by the accompanying crew members. Passengers must never be allowed to return to their cabins unescorted.

Conclusions

These conclusions identify the different factors contributing to the incident and should not be read as apportioning blame or liability to any particular individual or organisation.

Based on the evidence available, the following factors are considered to have contributed to the incident:

1. The fire in The Ship's Photographer shop was caused by a short circuit in the extension lead under the sink in the store area supplying power to the fridge.
2. The short circuit in the extension lead was caused by the breakdown of the insulation between the conductors in the lead. The breakdown of insulation was the result of the imposition of a mechanical load on the lead, ie. the stowage for several months previously of boxed photograph envelopes on top of the lead.
3. Neither the short circuit protection nor the earth leakage detection in the electrical distribution system was effective in either detecting or limiting the damage caused by the short circuit in the extension lead.
4. The extension lead and its conditions of use had not been inspected by qualified ship's staff at any time prior to the fire.
5. The poor stowage of the boxes on top of the extension lead was a fire hazard which had not been identified by any crew inspection in the three months prior to the fire.

6. The photography shop staff were not aware of the dangers of stowing the boxes of photograph envelopes on top of the extension lead, nor had they received any training in recognising such a danger.
7. The limited access for ship's staff to the licensed business areas aboard *Spirit of Tasmania* for normal ship's routines and procedures impeded the inspection of the photography shop store area.

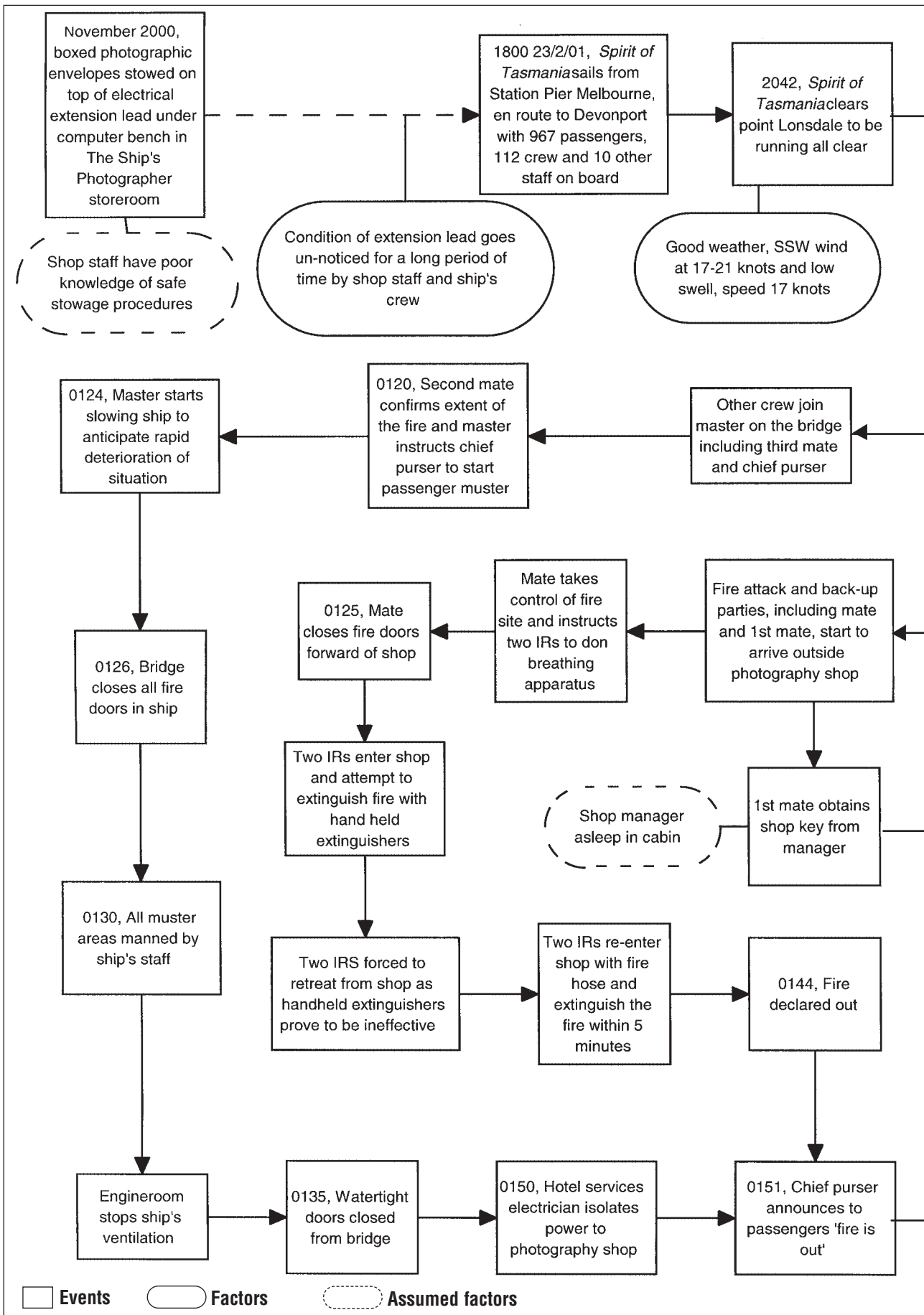
It is further considered:

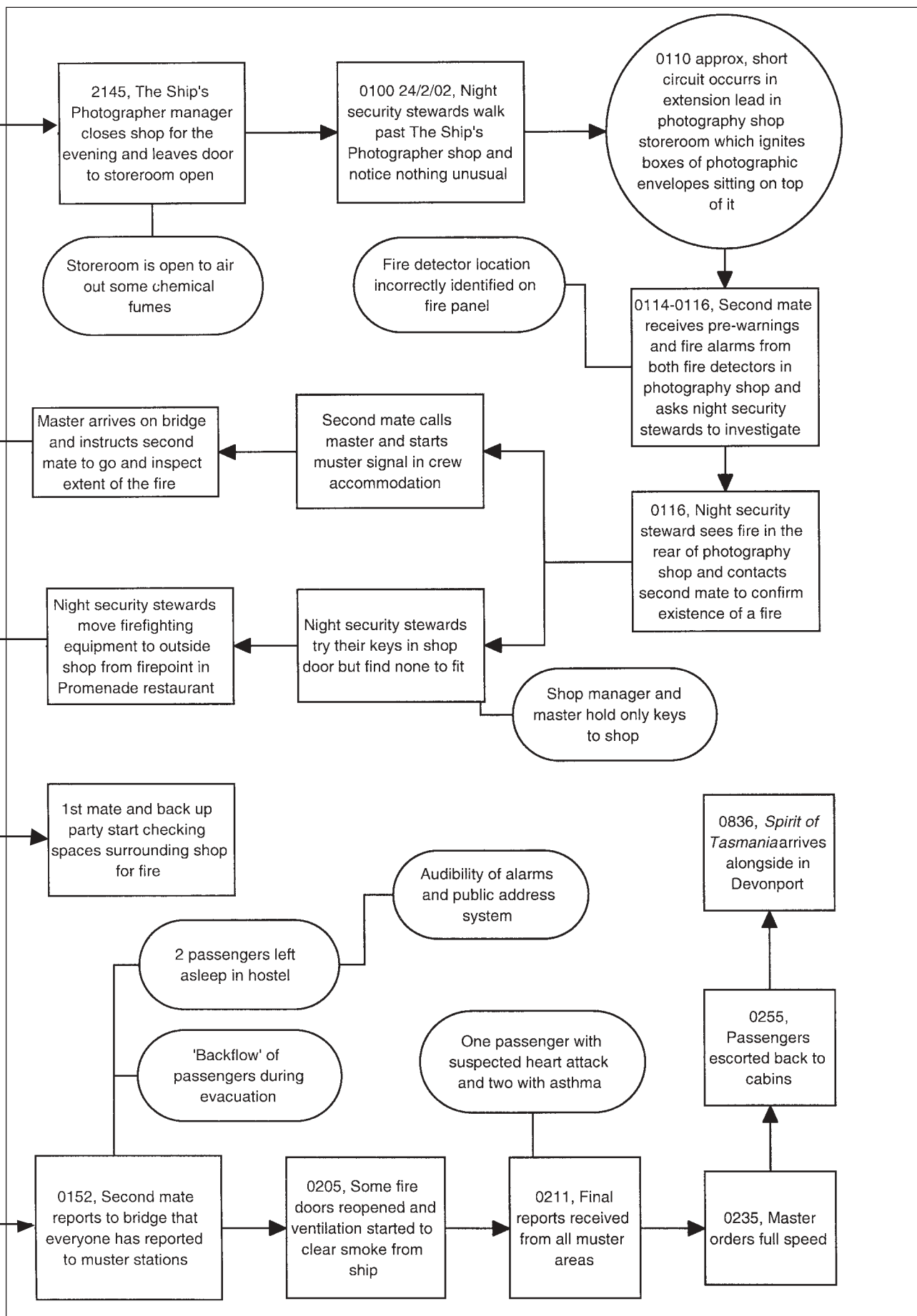
8. The fire plan in use at the time of the fire did not accurately depict the photography shop store space by not showing the blocked access door from the Promenade restaurant.
9. The fire detection panels were misleading as they did not accurately describe the location of the detectors which tripped initially in the photography shop display area.
10. The crew's response to the fire from the time that it was detected to the time it was extinguished was effective and well executed.

With regard to the passenger evacuation it is concluded:

11. The master's actions in ordering an evacuation of the passengers, immediately after the existence of the fire was confirmed, was totally appropriate.
12. The crew are to be commended on the passenger evacuation which was generally very effective.

FIGURE 10:
Fire: *Spirit of Tasmania* events and causal factors chart





Recommendations

1. The licensed business areas on board *Spirit of Tasmania* should be subject to the same safety management policy, procedures and routine inspections as any other part of the vessel.
2. Consideration should be given to providing the staff of the licensed businesses on the vessel with the same safety training as received by regular crew members.
3. A smoke detector fitted in the store would improve the speed of detection and extinction of a fire in the photography shop store.
4. The audibility of the alarm and public address systems in some areas of the ship needs to be reviewed.
5. Consideration should be given to the inclusion of a final head count of passengers in the evacuation plan.
6. Passenger evacuation 'back flow' issues need to be addressed in crew evacuation training.

Submissions

Under sub-regulation 16(3) of the Navigation (Marine Casualty) Regulations, if a report, or part of a report, relates to a person's affairs to a material extent, the Inspector must, if it is reasonable to do so, give that person a copy of the report or the relevant part of the report. Sub-regulation 16(4) provides that such a person may provide written comments or information relating to the report.

Copies of the draft report were sent to the manager and owner of The Ship's Photographer shop, the master and managers of *Spirit of Tasmania*, the Chief Executive Officer of TT-Line and the Australian Maritime Safety Authority.

Submissions were received from the Chief Executive Officer of TT-Line and the Australian Maritime Safety Authority. The report was amended and submissions included where appropriate. The following is an extract from the TT-Line Chief Executive Officer's submission which details the company's safety actions in response to the incident and investigation:

1. All fire detector addresses have been re-written to precisely identify the spaces in the ship's current configuration.
2. Safety drills include a weekly search procedure for a randomly "lost" person.
3. Masters have been instructed to notify AUSSAR as soon as passengers are mustered and place relevant authorities on standby.
4. Fire alarms and public address systems are constantly checked and rectified immediately when noted to be faulty (regrettably, the intentional rendering of this equipment as in operable makes this a full time task).
5. Back flow issues of passengers during musters have been highlighted to all crew.
6. Steps are being taken to require the compulsory attendance of all Licensees' personnel at Modified Sea Safety Training to ensure, amongst other things, that they can assist passengers in the same manner as any of the crew in times of emergency.
7. In order to avoid any access difficulties arising from availability of keys to Licensee's premises, break glass boxes are to be fitted adjacent to Licensee's premises.
8. The fire plan that was being updated at the time of the incident has now been completed and the new plan approved.
9. A fire detector has been fitted and included in the ship's system to the photography shop Licensee's storeroom. All other spaces have also been checked on board to ensure compliance.

Spirit of Tasmania

IMO Number	8502391
Flag	Australian
Classification Society	Germanischer Lloyd
Ship Type	Ro-Ro passenger ferry
Builder	Seebeckwerft AG, Bremerhaven
Year Built	1986
Owner	TT-Line Company Pty Ltd
Ship Managers	Technical management and officers supplied by ASP Ship Management
Gross Tonnage	31 356
Net Tonnage	14 129
Maximum draught	6.217 m
Length overall	161.53 m
Breadth	28.20 m
Moulded depth	18.52 m
Engine	4 x MAK 8M552AK 4 stroke, single acting
Total power	19 600 kW
Crew	112

APPENDIX 1: Passenger Survey Results

At 1800 on 23 February 2001, *Spirit of Tasmania* departed from Port Melbourne with 967 passengers, 112 crew and 10 other staff on board en route to Devonport, Tasmania. At approximately 0110 in the morning of 24 January, with the ship in Bass Strait, a fire broke out in the Ship's Photographer shop which led to a full evacuation and muster of the passengers.

To gain some insight into the effectiveness of the passenger evacuation system used on the ship and the responses of the passengers to the emergency, a passenger questionnaire comprised of 28 targeted questions was developed by the Australian Transport Safety Bureau in conjunction with the ferry operators TT-Line. TT-Line posted the questionnaire to 291 of the passengers who had provided contact details when booking their travel. Of the 291 passengers surveyed, 123 responded with completed questionnaires. The following is a summary of those responses.

Summary of Responses

Q.1 Age and gender of those who responded, as at 23 February 2001.

The majority of respondents (51%) were aged between 46 and 60 years

One child was aged less than six

Two children were aged 6-11

12 respondents were aged 19-30

25 respondents were aged 31-45

17 respondents were aged 61-75

3 respondents were aged over 76

No respondents were aged between 12-18

Total of Male respondents 69

Total of Female respondents 54

Q. 2 Is English your first language?

Out of the 123 respondents only one passenger answered 'No'. This person specified Hungarian was their first language.

Q. 3 How many times have you crossed Bass Strait by ferry?

0	16% of respondents
1-2	39%
3-5	18%
5-10	15%
10-20	7%
>20	5%

Q. 4 On 23/4 February did you read the safety information on the back of the cabin door? Part 2: If yes, did it help you?

Of the 123 respondents, 78 answered 'Yes', while 45 answered 'No'.

Of the 78 respondents who answered 'Yes', 60 stated that it did help.

Q.5 Did you read the safety information pamphlet provided with your boarding pass?
Part 2: If yes, did it help you?

Of the 123 respondents, 77 answered ‘Yes’, while 44 answered ‘No’.
One respondent could not recall and another did not answer.
Of the 77 who answered ‘Yes’, 59 stated that it did help.

Q. 6 Do you recall a safety announcement demonstrating the ship’s emergency alarm system just after the ship left from Melbourne? If yes, did you understand the instructions?

Of the 123 respondents, 101 answered ‘Yes’, 20 answered ‘No’ and 2 did not answer.
82 of the respondents understood the instructions.
13 respondents did not understand the instructions.
18 respondents did not necessarily tick the box but have answered ‘Yes’ to part one of the question.
One respondent wrote: ‘Don’t know’.

Some passengers commented:

‘...too much noise could not hear’ (respondent 66).

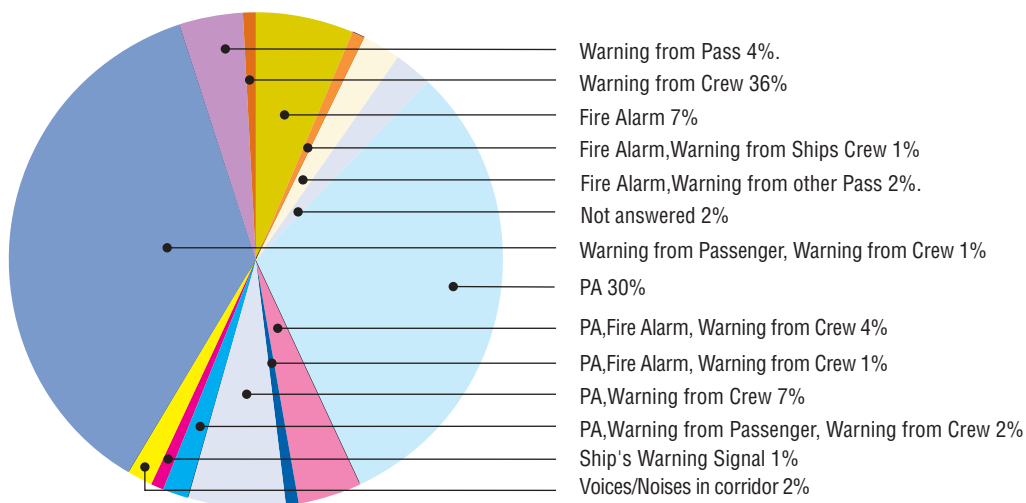
‘It was very hard to hear because of the level of noise in the dining room’ (respondent 77).

Q. 7 Where were you when you became aware of the emergency?

Of the 123 respondents, 54 stated that they were asleep in their cabins at the time.
A further 59 respondents stated that they were in their cabins,
8 respondents did not answer this question.
Two respondents said they were at the muster station.

Q. 8 How were you first alerted to the emergency?

PA, Fire Alarm, Smelled/saw smoke, Warning from other passenger, Warning from ship’s crew: Other, please describe?



Of the 123 respondents, 35% said that they were first alerted to the emergency by warnings from the ship’s crew and a further 30% by the ship’s PA announcement.

Some respondents commented on the clarity of the PA announcements:

'Too muffled to understand' (respondent 6).

'PA not functioning in cabin' (respondent 29).

'My husband and I filled out a passenger feedback form on the morning following the fire – because no fire alarm sounded in the dorm room' (respondent 40).

'Had to open our door to hear the announcement clearly' (respondent 83).

'PA announcement very difficult to hear inside cabin with door shut' (respondent 107).

Another passenger who had selected PA announcement, Fire alarm and the warning from ship's crew, stated in the comments section:

'Heard all at once!' (respondent 96).

Q. 9 Did you believe that there was a real emergency when first alerted? If no, describe what clues were required to convince you that there was a real emergency:

Of the 123 respondents, 65 replied 'Yes', 55 replied 'No' while 3 did not answer.

Of the 55 respondents that answered 'No', the table below identifies clues which convinced respondents that there was a real emergency:

Instructions from crew	19
Further PA announcements	9
Hearing noise/voices from other passengers outside cabin	5
Knocking on cabin door (by crew)	3
Smelled/saw smoke	3
When alarm was sounded	1
Convinced by travelling companion	1
Hearing noise/voices from other passengers and knocking on cabin door	1
Not until got outside cabin	1
Further PA announcements/Hearing noises/voices outside cabin	1
Further PA announcements/Smelled/saw smoke	1
Second calls	1
Smelled saw smoke/Hearing noises/voices outside cabin/Instruction from crew	1
Not answered	11
No comment	2

Some of the passengers added comments:

'A crew member came and assured us it was for real' (respondent 22).

'I thought it was just some sort of fire drill till we got outside' (respondent 21).

'Because I couldn't hear the alarm & PA, I wasn't sure that there was a problem, it wasn't until I heard other passengers jumping out of their bunks and a general sense of agitation did I bother to wake my wife...I lost what could have been valuable time if it had been more serious' (respondent 105).

Q. 10 Estimate how long it took for you to be convinced that there was a real emergency?
(mins/secs)

The following table summarises the time it took for the respondents to be convinced the emergency was 'real' with 47% indicating that they were convinced in one minute or less.

10 seconds	13
Less than a minute	28
1 minute	19
1.5 minutes	3
2 minutes	16
3 minutes	8
5 minutes	11
5.5 minutes	1
10 minutes	6
20 minutes	1
15 minutes	2
30 minutes	1
50 minutes	1
Not answered	13

Q. 11 Describe your very first actions when you realised that the emergency was real.

Of the 123 respondents, 42% answered that they dressed, with 20% stating that they dressing in warm clothing.

Respondent's answers were wide-ranging from real actions undertaken to identifying emotional feelings such as annoyance, fear or confusion.

Annoyance	1
Grabbed blanket & dressed warmly	1
Concerned	2
Concerned & followed instructions from crew	1
Calmed others & got wallet	1
Fearful	1
Fearful & followed instructions from crew	1
Thought it was a fire drill	3
Thought it was a fire drill & remained calm	1
Followed others	3
Dressed	27
Dressed & followed instructions from crew	2
Dressed & left cabin	2
Dressed & proceeded to muster station	7
Dressed, went to toilet, read instructions on back of cabin door & proceeded to muster station	1
Dressed, got wallet	2
Dressed, got wallet and followed instructions	1
Dressed & waited at the door	1
Dressed and wondered where to go	1
Dressed and waited in hallway with others	4

Dressed and woke others in cabin (kids)	1
Dressed in warm clothing	14
Dressed in warm clothing & proceeded to muster station	8
Dressed in warm clothing & got wallet	1
Got out of bed	1
Left cabin	1
No answer given	5
Wondered what to do	1
Wondered what to do & felt annoyed	1
Offered assistance & proceeded to muster station	1
Panicked	1
Felt panic & annoyance	1
Proceeded to muster station	4
Remained calm	6
Remained calm & concern	1
Remained calm & followed instructions from crew	1
Worried about the kids	1
Woke others in cabin	1
Woke others in cabin & dressed	6
Woke others in cabin and dressed in warm clothing	1
Woke others in cabin and left cabin	1
Wondered what to do	1

Q. 12 Estimate how long it took you to start evacuating after first being alerted to the emergency. (mins/secs)

10 seconds	1%
Less than a minute	10%
1minute	11%
1.5 minutes	5%
2 minutes	18%
2.5 minutes	2%
3 minutes	16%
4 minutes	3%
4.5 minutes	1%
5 minutes	16%
6 minutes	2%
7 minutes	2%
8 minutes	4%
10 minutes	2%
20 minutes	1%
30 minutes	2%
Don't know	2%
Not answered	2%

Q. 13 Was your muster station the first place you decided to go when evacuating? Yes/No, Other, please describe

Of the 123 respondents, 103 answered ‘Yes’, 16 answered ‘No’, while 4 did not answer the question. Some of the respondents who answered ‘No’, commented:

‘Waited for advice from ship’s crew member who directed us to muster station’ (respondent 6).

‘To wait with other passengers in the passage-way’ (respondent 4).

‘We were asked to wait 5 minutes in a corridor which was closed off from stairs’ (respondent 15).

Q. 14 Did a ship’s crew member instruct you on what to do when evacuating your cabin? Yes/No

Of the 123 respondents, 106 answered ‘Yes’, 13 answered ‘No’, while 4 did not answer.

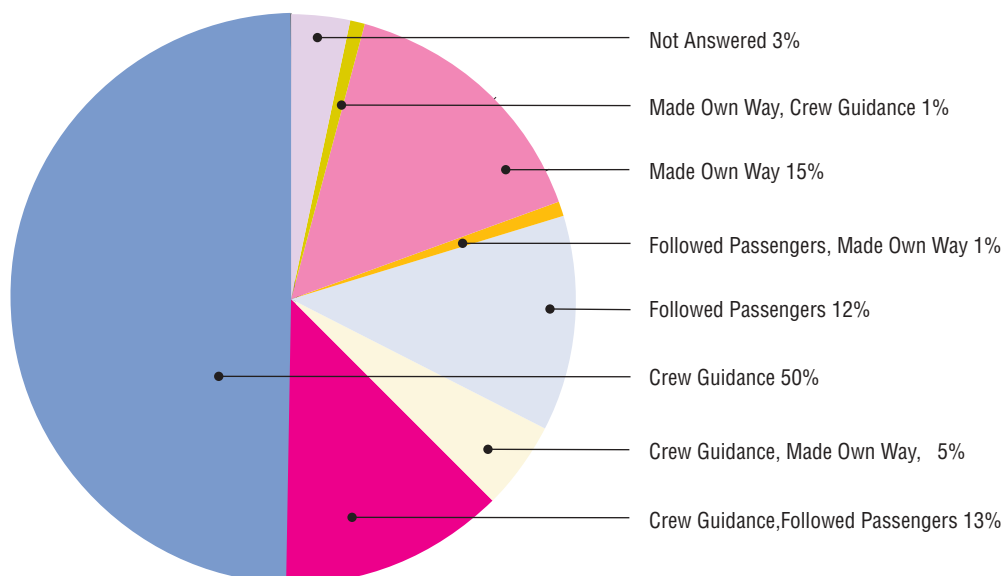
Q. 15 Did you take any personal effects or luggage with you when evacuating your cabin? Yes/No If yes, please describe

Of the 123 respondents, 60% answered ‘No’, 36% ‘Yes’ and 4% did not answer.

Of those passengers who did take personal effects or luggage when evacuating their cabin, the descriptions included; bags/wallets/backpacks (32 respondents), warm clothes (6 respondents). Other items included; cameras, mobile phones, cabin keys, car keys, medication, jewellery, knives, cigarettes.

Q. 16 How did you get to your muster station? – ship’s crew guided you, followed other passengers or made own way.

How passengers reached their muster stations



Q.17 Did you experience any difficulty or delays in reaching your muster station? No/Yes. If yes, please describe why

Of the 123 respondents, 74% of answered 'No', 23% answered 'Yes', with 4 respondents not answering.

For those that answered that they did experience difficulty or delays in reaching muster stations some of the reasons were stated as:

Unsure of correct muster station (2).

Commented they went to the wrong muster station (1).

Became tired climbing stairs (4).

Commented they were confused as to which way to go (2).

Passenger movement being too slow (1).

Passengers suffering medical conditions & concerns over the elderly (5).

Door not open (2).

Unable to locate exit door from hostel (1).

Crowding on stairs (4).

Waiting in passage (3).

Difficulty waking passengers (1).

Delays in evacuating passengers from cabins (1).

Some passengers commented:

'...it took rather long to get all passengers out of cabins' (respondent 8).

'...waited in passageway with other passengers until crew told us to move' (respondent 10).

'...waiting in corridor for crew to alert elderly couple' (respondent 15).

'My wife's fitness level is very poor and she had trouble getting up stairs – I thought she was going to collapse' (respondent 21).

'Couldn't find exit out of dorm passage to muster station stairway (respondent 28).

'...delay due to passenger on oxygen' (respondent 68).

'Bunch of older women panicking. They took a long time to get ready-Ship's crew made us stay together' (respondent 69).

'...we were behind a distressed woman in a wheel chair being carried up stairs – only short delay' (respondent 92).

Q. 18 On your way to the muster station did you see any passengers going back down to the cabins? No/Yes, If yes, did this cause congestion or slow the evacuation?

Of the 123 respondents, 89% answered 'No', 5% answered 'Yes', 2% did not know while 4% did not answer this question.

Three respondents who had answered 'Yes', stated that passengers going back down to the cabins did cause congestion or slowed the evacuation.

One commented:

'Passengers who didn't know their muster station were confused and slowed the process of finding their correct deck' (respondent 49).

Q. 19 Were there any specific examples of passenger behaviour you would like to comment on? Describe:

Of the 123 respondents, 48 did not answer this question, 21 people commented that intoxicated passenger(s) were annoying and frustrating to both crew and fellow passengers.

Examples of those comments were:

'A gentleman who had too much to drink, was making jokes and being silly about the situation' (respondent 33).

'One gentleman had too much to drink, giving the crew a hard time' (respondent 2).

Other comments included:

Passengers displaying behaviour of panic or anxiety (9).

Respondents stated some passengers were being difficult/annoying (7).

Respondents stated that passengers remained calm and in control (13).

Respondents stated that passengers were not adequately dressed for the cold conditions at muster station (7).

Confusion - as to which way to go to muster station (3).

Concerns expressed that children did not give up seats for the elderly (2).

Distressed woman in wheel chair (2).

Crew kept together in tight bunch (1).

Concerns that life jackets were not handed out (1).

Respondents felt things went well (1).

Frustration – in not knowing the nature of the incident (3).

Passengers suffering medical conditions (3).

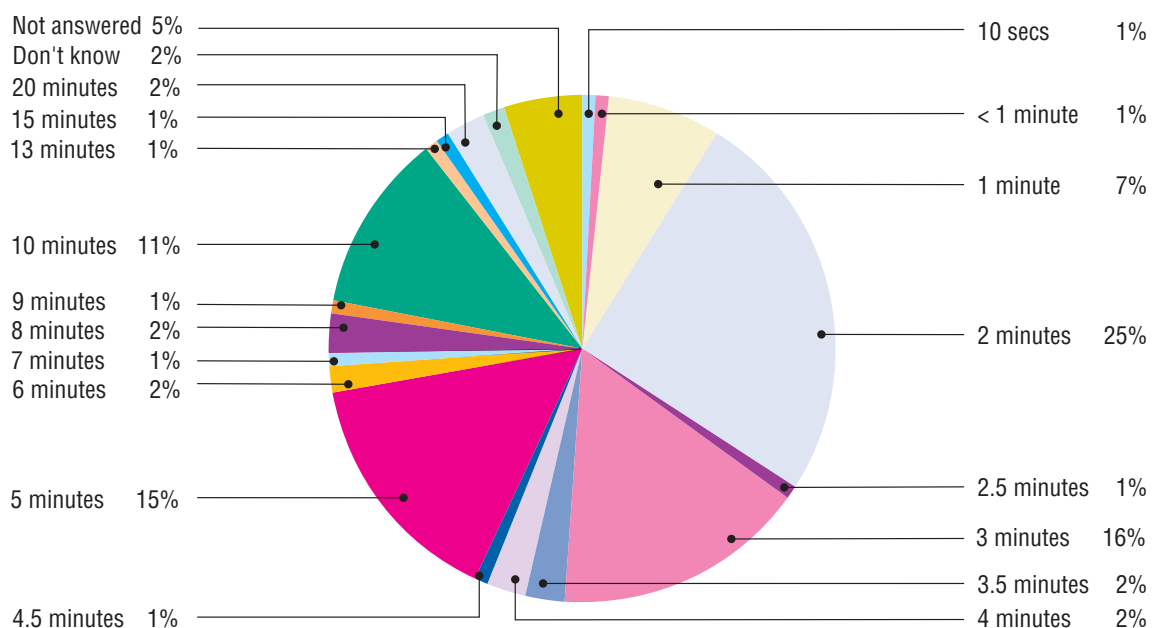
Respondents felt that passengers obeyed instructions (6).

Respondent felt that reference to 'Titanic' not funny (2).

Respondent noted that children were upset (1).

Q. 20 How long did it take to reach your muster station once you started from the place you were first alerted to the emergency?

Time taken to reach muster station



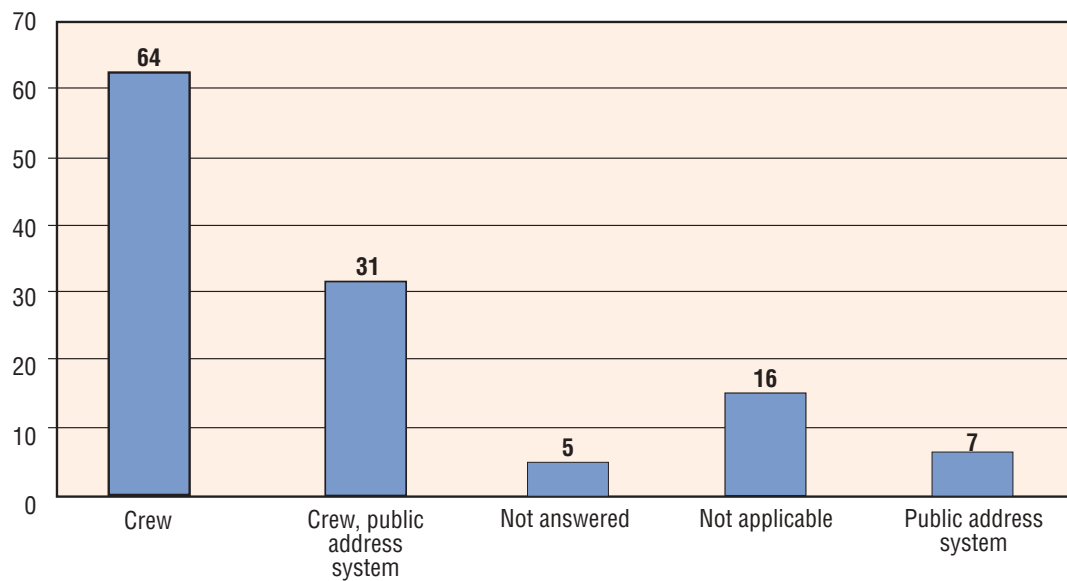
Q. 21 At the muster station, were you told what the emergency was? Yes/No: If yes, by whom? Crew/other passenger

Of the 123 respondents, 60 answered 'Yes', 58 answered 'No', 4 respondents did not answer, and 1 respondent could not remember.

Of the respondents that answered 'Yes', 50 respondents answered Crew, 1 respondent said crew and other passengers, 5 said other passengers while 4 respondents did not specify.

Q. 22 While at the muster station were you kept informed of what was going on? By the crew (yes/no) or Public address system (yes/no)

How were you kept informed



Q. 23 Were you aware if a head count was conducted by the ship's crew at your muster station? (yes/no)

Of the 123 respondents, 87 answered 'No', 30 answered 'Yes', 5 did not answer this question while 1 respondent did not know.

Q. 24 Did you understand the announcements made over the ship's public address system? (yes/no)

Of the 123 respondents, 106 answered 'Yes', 11 answered 'No', while 6 did not answer.

Q. 25 Was there a member of the crew with you at the muster station at all times? (yes/no). Comments

Of the 123 respondents, 110 answered 'Yes', 5 answered 'No', 6 did not answer and 2 did not know.

Comments included:

The crew were excellent, helpful, professional (39).

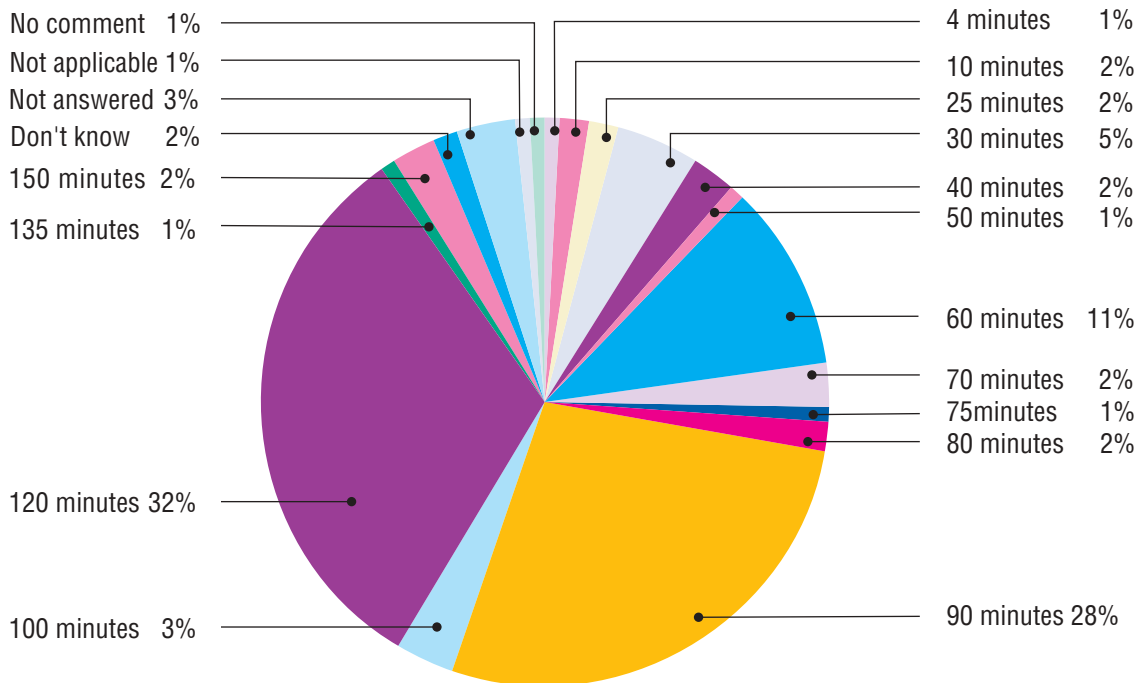
There was insufficient information given by the crew (2).

The crew were reassuring (3).

The crew were wearing life-jackets (1).
 The crew were there most of the time (1).
 Several crew were at the station (1).
 The crew were inexperienced (2).

Q. 26 How long were you at the muster station?

Length of time at muster station



Comments:

'At the muster station for 40 minutes – we were moved to the Tiger Bar for a further 65 minutes' (respondent 36).

'At the muster station for 60 minutes approximately – then we went to a public room for another 90 minutes' (respondent 49).

Q. 27 When the emergency was over did you return to your cabin? (yes/no)

If no, please specify where you went

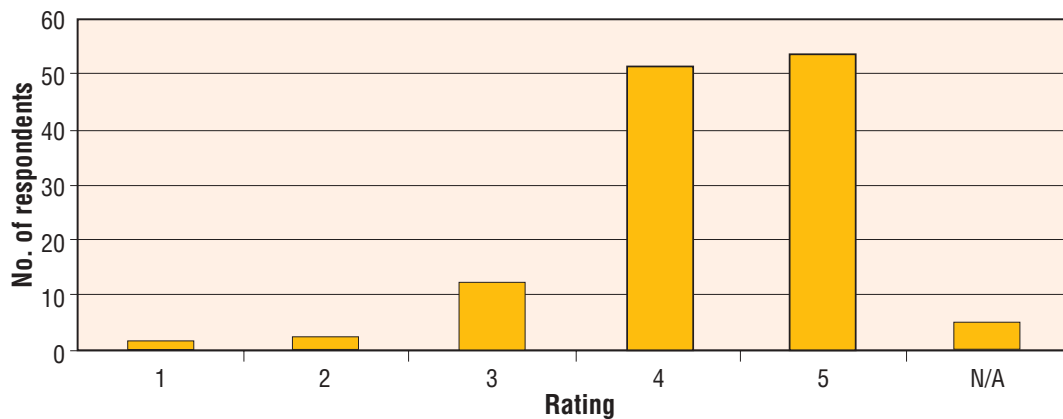
Of the 123 respondents, 113 answered 'Yes', 5 answered 'No' and 5 did not answer this question.

Those respondents who did not return to their cabin specified that they went to:

- Bar (1)
- Dance floor area (1)
- Moved to the public room (2)
- 'No' but did not specify where they went (9)

Q. 28 How do you rate the overall performance of the crew during the evacuation? 5,4,3,2,1

Overall performance of crew (1-5)



Other Comments:

Of the 123 respondents 92 provided comments.

Felt anxious	3
No oxygen masks available	1
Valium obtained too late by passengers	1
Thermal blankets were required	1
Alarms not heard in Hostel	6
Muster station should be better organised (eg water/seating)	3
Crew were professional	19
Insufficient care given to elderly/children	1
Exposure to cold conditions	8
Not hearing alarm	2
Compensation sought	4
Warm clothing was locked in car	1
Unsuitable comments from Captain	1
Difficult passengers	1
Intoxicated passengers	3
Passenger unaware of incident	1
Insufficient details of emergency	19
Still enjoyed the trip	1
Concerns that life jackets not handed out	4
Smokey muster station	2
Crew efficient and helpful	20
Unaware passengers left in cabin	4
Frightening experience	1
Passengers equipped to help were not asked	1
Debrief to passengers should have been offered	1
Passengers were slow in climbing stairs	1
Safety instructions not clear	1
Concerns over the elderly	1
Reservations about using 'Spirit' again	2
PA, FA and Crews warnings heard all at once	1

Muster station should have been re-located (away from smoke)	1
Muffled PA announcements	7
Incident exaggerated by media	2
Safety announcement dept. Melbourne hard to hear	7
Staff poorly trained	2
Crew should have better ID	1
Will not travel on 'Spirit' again	1
Confused as to what was happening	1
Insufficient life boats	1
Crew Professional –No panic	19
Muster station confusion	1
Would not stay in hostel again	1
Discount on trip sought	1
Not frightened	2
Distressed woman in wheelchair	1
Will travel on 'Spirit' again	4
No comments	24

**Independent investigation into the fire and muster of the passengers aboard
the Australian flag passenger ferry Spirit of Tasmania**

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