



**Australian Government**

**Australian Transport Safety Bureau**



**ATSB TRANSPORT SAFETY REPORT**  
Marine Occurrence Investigation No. 253  
Final

Independent investigation into the engine room fire  
on board the Marshall Islands registered container ship

# **MSC Lugano**

off Esperance, Western Australia  
31 March 2008



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### Abstract

At about 1115 on 31 March 2008, a fire started in the engine room of the container ship *MSC Lugano*. The chief engineer operated the quick closing valves and the remote stops for the engine room fans and oil pumps. The crew closed the dampers for the engine room fans and the funnel vents and rigged fire hoses to boundary cool the engine room casing and funnel.

After about 50 minutes, the fire cut the electrical power supply to the emergency fire pump and water ceased to flow from the fire hoses. The master ordered the crew to close the engine room skylight and then muster. He then instructed the chief engineer to activate the ship's fixed fire extinguishing system.

At 1220, the master reported the fire to the Australian Rescue Coordination Centre (RCC).

By 1600, the crew had determined that the fire was extinguished. The engine room was ventilated and the crew entered to assess the damage. They were able to re-start many of the engine room systems and restore electrical power but they could not re-start the main engine. The ship was now about 90 miles south of Esperance, Western Australia and drifting towards the Archipelago of the Recherche.

The ship's owners entered into an agreement to tow the ship to Fremantle and, on 1 April, the tug *Wambiri* departed from Fremantle, Western Australia. Three other tugs, two based in Esperance and one that was in the vicinity towing a barge, were directed by the Australian Maritime Safety Authority (AMSA) to assist the ship until *Wambiri* arrived.

By 1245 on 5 April, *Wambiri* had rendezvoused with *MSC Lugano* and taken the ship in tow. The tow continued without incident and at 1506 on 13 April, the disabled ship berthed in Fremantle.

The report identifies a number of safety issues and advises of safety actions already taken and those recommended by the ATSB.

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# THE AUSTRALIAN TRANSPORT SAFETY BUREAU

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The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external bodies.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

## **Purpose of safety investigations**

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

## **Developing safety action**

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.





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## TERMINOLOGY USED IN THIS REPORT

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**Occurrence:** accident or incident.

**Safety factor:** an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, risk controls and organisational influences.

**Contributing safety factor:** a safety factor that, if it had not occurred or existed at the relevant time, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious; or (c) another contributing safety factor would probably not have occurred or existed.

**Other safety factor:** a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report.

**Other key finding:** any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.

**Safety issue:** a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Safety issues can broadly be classified in terms of their level of risk as follows:

- **Critical safety issue:** associated with an intolerable level of risk.
- **Significant safety issue:** associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable.
- **Minor safety issue:** associated with a broadly acceptable level of risk.



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## EXECUTIVE SUMMARY

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On 29 March 2008, the Marshall Islands registered container ship *MSC Lugano* sailed from Adelaide, South Australia bound for Fremantle, Western Australia.

At 1115<sup>1</sup> on 31 March, when *MSC Lugano* was about 100 miles<sup>2</sup> southeast of Esperance, Western Australia, the ship's engine room fire alarm sounded.

After hearing the alarm, the second engineer looked out from the engine room workshop and saw smoke and flames aft of the number one (aft) main engine turbocharger. He ran to the engine control room and stopped the main engine. The engine room crew then rigged a fire hose to fight the fire. However, thick black smoke was building up quickly so they decided to evacuate the engine room.

The general alarm was sounded and the chief engineer operated the remote stops for the engine room ventilation fans and fuel oil pumps. He then operated the fuel/lubricating oil quick closing valves. The auxiliary diesel generator soon stopped due to the loss of fuel pressure and the emergency generator automatically started. The chief engineer then started the emergency fire pump.

The crew rigged fire hoses to boundary cool the engine room casing and the funnel. They closed the fire dampers for the engine room ventilation fans and the funnel vents. A fire hose was also set up to spray water into the engine room through the open skylight.

After about 50 minutes, the fire cut the electrical power supply to the emergency fire pump and water ceased to flow from the fire hoses. The master ordered the crew to close the skylight and then muster on the upper deck. When all the crew were accounted for, the master instructed the chief engineer to activate the engine room fixed carbon dioxide (CO<sub>2</sub>) fire extinguishing system.

At 1220, the master reported the fire to the Australian Rescue Coordination Centre (RCC), an operational arm of the Australian Maritime Safety Authority (AMSA). He also reported the incident to the ship's manager, protection and indemnity (P&I) club and charterer.

By 1600, crew members wearing self contained breathing apparatus (BA) units had entered the engine room and determined that the fire was extinguished. The engine room was ventilated and, a short time later, the crew entered the space to assess the damage. They were able to re-start many of the engine room systems and restore electrical power but could not re-start the main engine.

By 1737, the master had informed the RCC, the ship's manager and the charterer that the fire had been extinguished but attempts to re-start the main engine had failed. At this time, the ship was about 60 miles south of the outer edge of the

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1 All times referred to in this report are ship's times. Prior to midnight on 31 March, the ship's time was Coordinated Universal Time (UTC) + 9 hours. At midnight on 31 March, the ship's clocks were retarded one hour to UTC + 8 hours.

2 A nautical mile of 1852 m.

Archipelago of the Recherche. The wind was now from the southwest at force<sup>3</sup> four (11 to 16 knots<sup>4</sup>) with a moderate south-westerly swell.

During the evening of 31 March, *MSC Lugano*'s owners reached an agreement with Svitzer Salvage Australasia to tow the ship to Fremantle. Svitzer then began storing and equipping the Fremantle based tug *Wambiri* for the task.

By the morning of 1 April, the wind had increased to force seven (28 to 33 knots) and the ship's drift had become northerly at a rate of about 1.8 knots. In response to the changing conditions, AMSA decided to intervene by directing tugs to assist the ship.

At 1000, *MSC Lugano*'s master reported to the RCC that the ship was 34 miles south of the Archipelago of the Recherche and that he needed tug assistance.

At 1520, AMSA issued an intervention order and the tug *Shoal Cape* departed Esperance soon afterwards. By 2250, *Shoal Cape* had arrived at *MSC Lugano*'s position and taken the ship in tow. However, at 0200 on 2 April, the tow line parted and fouled one of the tug's propellers.

*MSC Lugano*'s master requested further assistance and another Esperance harbour tug was directed to assist. In the meantime, *Greshanne*, a tug that was in the vicinity towing a barge towards Dampier, Western Australia, was directed by AMSA to assist. *Greshanne* took the ship in tow while *Shoal Cape* stood by *Greshanne*'s barge.

By 1712 on 2 April, the second Esperance tug, *Cape Pasley*, had arrived and connected a tow line to the ship. The ship was now only six miles off the outer edge of the Archipelago of the Recherche and, with the assistance of the two tugs, it began to clear the coast.

By the next morning, 3 April, the weather had started to abate and, at 1045, *Cape Pasley*'s tow line was cast off, while *Greshanne* continued with the tow.

By 1245 on 5 April, *Greshanne*'s tow line had been cast off and *Wambiri* had taken the ship in tow. The tow continued without incident and by 1506 on 13 April, *MSC Lugano* was all fast alongside its berth in Fremantle.

The ATSB investigation identified that there were deficiencies in the engine room procedures and practices implemented on board *MSC Lugano*; the ship's emergency electrical power distribution system did not meet SOLAS<sup>5</sup> requirements; the ship's safety management system gave the master no guidance as to how long to wait before entering the engine room following the release of carbon dioxide; AMSA's intervention was not as timely as desirable and; the Esperance based tugs *Shoal Cape* and *Cape Pasley* were neither designed nor equipped for the deep sea towage of a ship like *MSC Lugano*.

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3 The Beaufort scale of wind force, developed in 1805 by Admiral Sir Francis Beaufort, enables sailors to estimate wind speeds through visual observations of sea states.

4 One knot, or one nautical mile per hour equals 1.852 kilometres per hour.

5 The International Convention for the Safety of Life at Sea, 1974, as amended.

## 1.1 *MSC Lugano*

*MSC Lugano* is a Marshall Islands registered 3032 TEU<sup>6</sup> container ship (Figure 1). At the time of the incident, the ship was owned by Castor Trading, Greece, managed by Transman Shipmanagers, Greece, and classed with the American Bureau of Shipping (ABS).

The ship was built in 1988 by Daewoo Shipbuilding and Heavy Machinery, Korea. It has an overall length of 240.0 m, a beam of 32.2 m, a depth of 19.0 m and a deadweight of 42 978 tonnes at its summer draught of 11.73 m.

Propulsive power is provided by a single seven cylinder Sulzer 7RTA84 single acting, direct reversing, two-stroke diesel engine, delivering 23 170 kW. The main engine drives a single fixed pitch propeller which gives the ship a service speed of about 21 knots.

**Figure 1:** *MSC Lugano* in Fremantle harbour



At the time of the incident, *MSC Lugano* had a crew of 24 Greek, Polish and Filipino nationals. While at sea, the mates maintained a watch-keeping routine of four hours on, eight hours off. In the engine room, the third and fourth engineers maintained a watch-keeping routine of six hours on, six hours off, while the other three engineers and the electrician worked during normal day time hours.

The master had 41 years of seagoing experience. He had been sailing as master since 1992 and held a master's certificate of competency that was first issued in Greece in 1985. He had been employed by Transman Shipmanagers for 10 years and had been *MSC Lugano*'s master since the company took over its management in September 2007.

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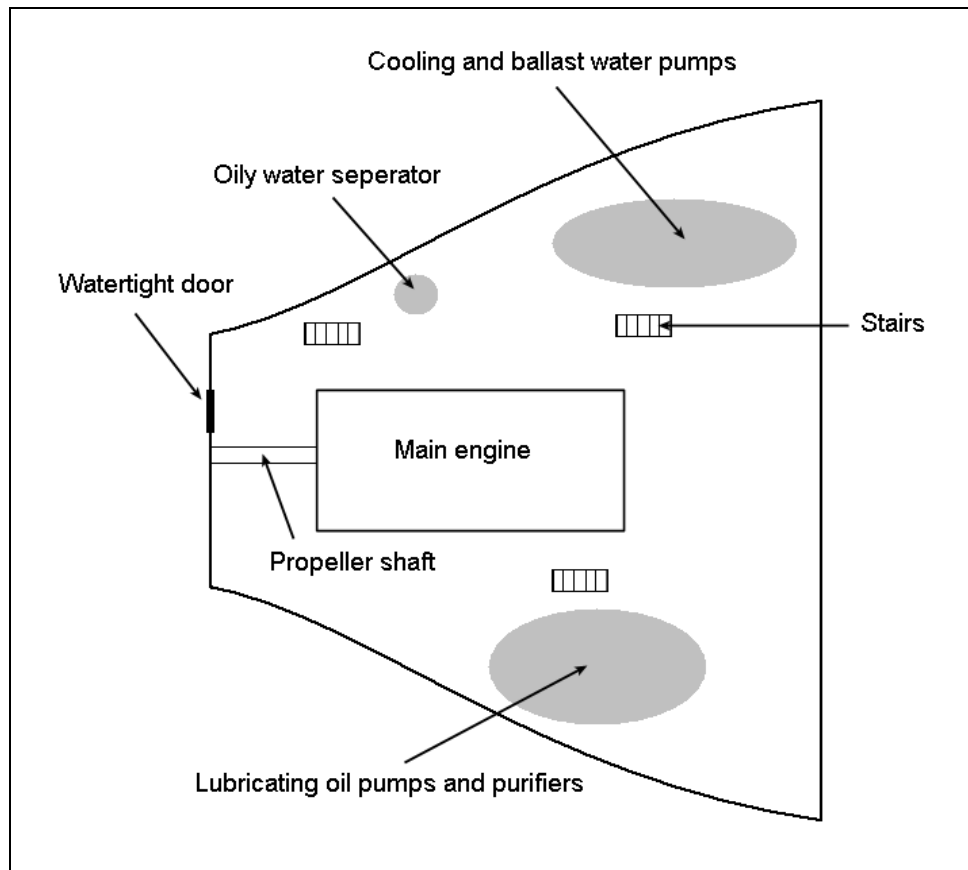
<sup>6</sup> Twenty-foot Equivalent Unit, a standard shipping container. The nominal size of a ship in TEU refers to the number of standard containers that it can carry.

The chief engineer had 32 years of seagoing experience. He held a first class certificate of competency that was first issued in the Philippines in 1999 and had had been sailing as chief engineer for six years. He had been employed by Transman Shipmanagers since 2002 and joined *MSC Lugano* in September 2007.

### 1.1.1 Engine room layout

*MSC Lugano*'s engine room occupies three main deck levels. Equipment on the lowest deck (Figure 2), the floor plates, includes the main cooling and ballast water pumps, located forward and to port of the main engine; the lubricating oil pumps and purifiers, located on the starboard side of the main engine; and the oily water separator, located on the port side of the main engine. At the after end of the deck, the propeller shaft runs through a tunnel that is isolated from the engine room by a watertight door.

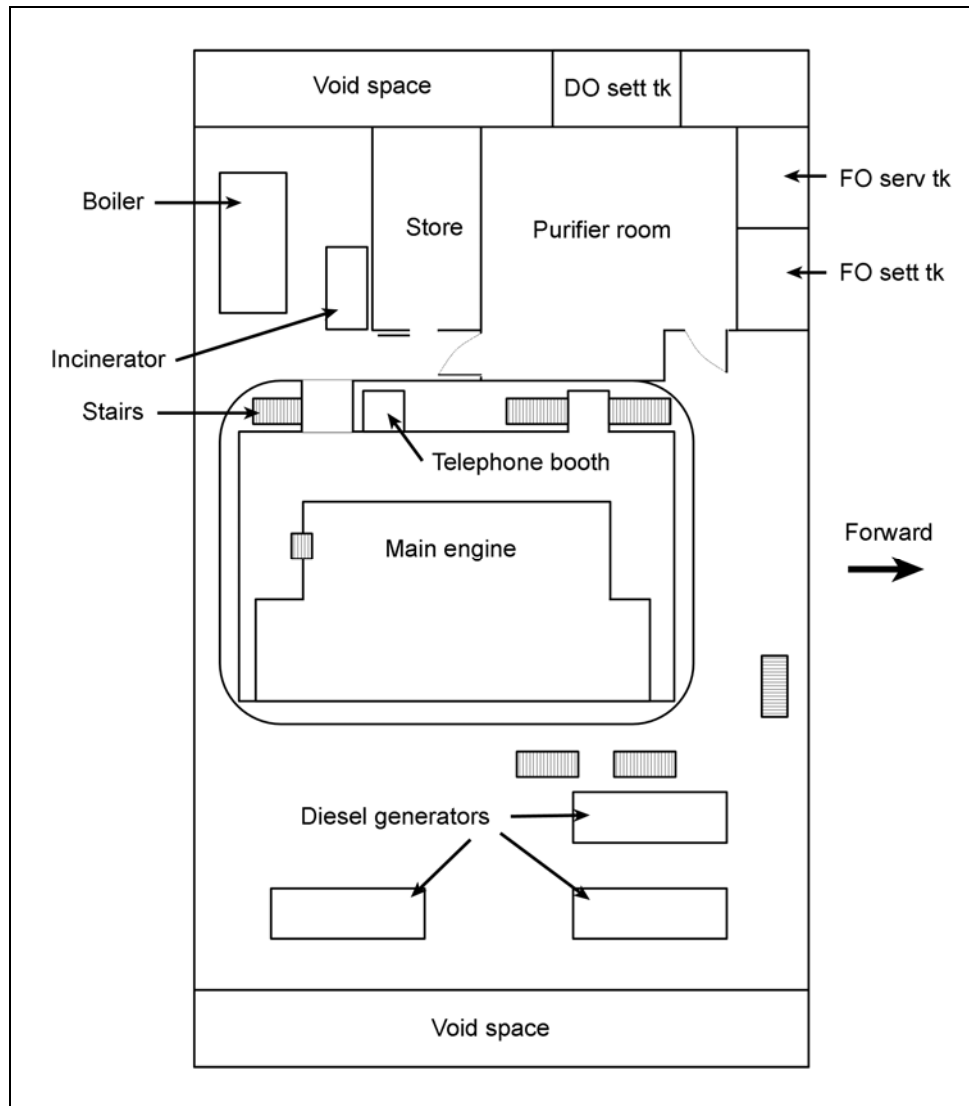
Figure 2: Floor plate level plan



The next deck up is the third platform deck (Figure 3). Located in the forward port corner of this deck is the fuel purification and treatment room (purifier room). A spare gear store is located aft of the purifier room and the waste incinerator and oil fired boiler are located aft of the store. The ship's three auxiliary diesel generators are also located on this deck, to starboard of the main engine.

The ship's air compressors and starting air bottles are located on a small intermediate deck, the upper third deck, on the port side of the main engine. This small deck is directly above the purifier room and the spare gear store.

**Figure 3: Third platform deck plan**



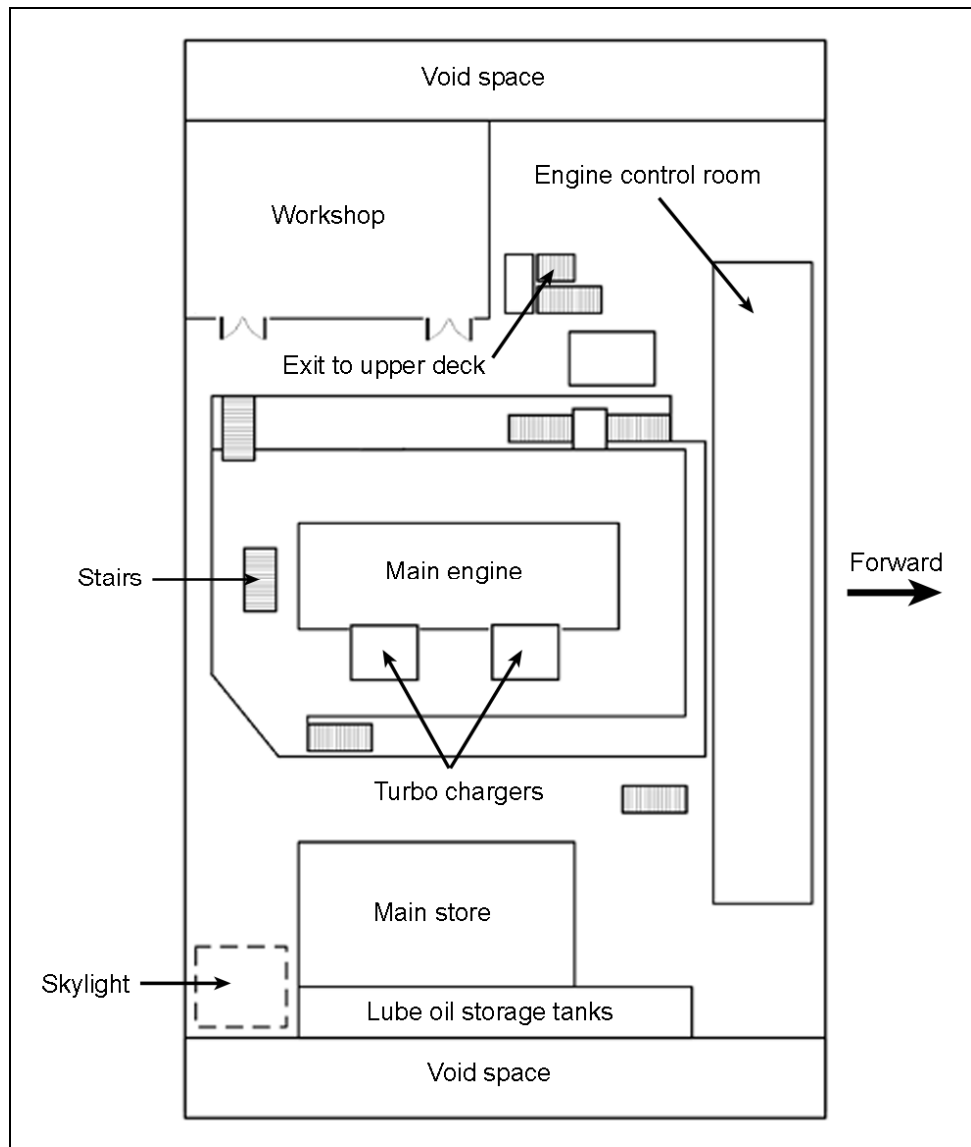
The engine control room is located at the forward end of the next deck, the second platform deck (Figure 4). A workshop is located on the port side of the main engine and the main store is located on the starboard side. Aft of the store is a skylight, which provides stores crane access to the engine room.

The uptakes for the main engine, auxiliary engines and boiler lead upwards through a casing in the aft end of the upper, first, second and third accommodation decks to a single funnel that is mounted aft, on the fourth accommodation deck. The funnel is fitted with four vents (Figure 5) that are provided with fire dampers that can be remotely closed from the fourth accommodation deck.

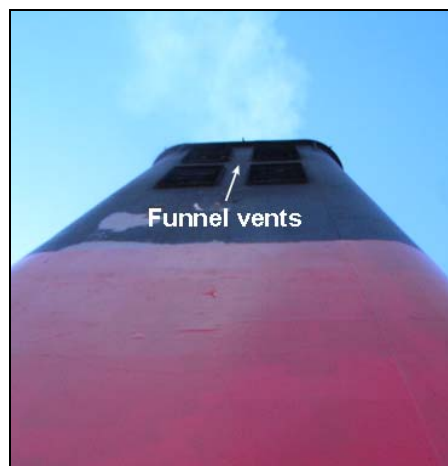
The engine room is supplied with fresh air by four ventilation fans which have their air inlets and fire dampers mounted on the aft end of the fourth accommodation deck (Figure 6).



**Figure 4: Second platform deck plan**



**Figure 5: Funnel (re-painted after fire)**



**Figure 6: Vent fan housing**



### 1.1.2 Fixed fire extinguishing system

*MSC Lugano* is fitted with a fixed carbon dioxide (CO<sub>2</sub>) fire extinguishing system that consists of 168 gas cylinders, with each cylinder containing 45 kg of liquid CO<sub>2</sub>. The cylinders are connected to a common distribution manifold that can supply CO<sub>2</sub> to either the engine room or the cargo holds (Figure 7).

**Figure 7: Fixed CO<sub>2</sub> fire extinguishing system**



In the case of a fire in the engine room, the system can be operated from either the CO<sub>2</sub> room, located on the starboard side of the upper deck, or the fire control station, located inside the accommodation on the upper deck. In both cases, when the master control station door is opened, the CO<sub>2</sub> alarm sounds and the engine room ventilation fans stop automatically. The CO<sub>2</sub> can then be released into the engine room by operating the pilot cylinder, which in turn automatically operates the releases on the designated 158 CO<sub>2</sub> cylinders.

The fire control station also contains the engine room lubricating/fuel oil quick closing valves, a fire alarm panel and remote stops for the engine room oil pumps and ventilation fans. A start/stop control for the emergency fire pump and the fire main isolation valves are also located at the station.

When the fixed fire extinguishing system was inspected and tested in January 2007, all of the gas cylinders contained at least 45 kg of CO<sub>2</sub> and the system operated correctly.

## 1.2 The incident

*MSC Lugano* arrived in Fremantle, Western Australia, its first Australian port of call, on 15 March 2008. The ship then sailed to Sydney, New South Wales and then Melbourne, Victoria, loading and discharging cargo in each port.

On 28 March, the ship arrived in Adelaide, South Australia. On 29 March, after cargo operations were completed, the ship sailed, bound for Fremantle. The sky was partly cloudy, the seas were rough and there was a strong breeze.

During the afternoon of 29 March, and throughout 30 March, the crew carried on with their assigned operational tasks.

At 0800 on 31 March, the engine room staff met in the control room and the second engineer outlined the work plan for the day. The third engineer and the duty oiler were to continue with their watchkeeping duties. The remaining oilers were instructed to clean the bilges and the bottom plates, while the wiper was to remove any oil that was lying in the various save-alls. The extra engineer was asked to continue overhauling the number three diesel generator and the fitter was told to overhaul a cargo hold hatch cover hydraulic ram that was in the workshop. The second engineer also intended to be in the workshop overhauling the spare main engine cylinder lubricator quills.

The engine room staff then went about their assigned tasks, not meeting again until 1000, when they stopped for their morning tea break in the engine control room. At 1030, they returned to work.

At 1115, when *MSC Lugano* was about 100 miles south-southeast of Esperance, Western Australia, the engine room fire alarm sounded.

The second engineer heard the alarm and looked out of the workshop, across the engine room. He could see black smoke and flames in the area aft of the number one (aft) main engine turbocharger. He ran into the control room and stopped the main engine by pulling the engine fuel lever back to the stop position. The third engineer had arrived in the control room at about the same time and the second engineer told him to start the fire pump while he went to rig a fire hose. The second engineer also told the duty oiler, who was in the control room when the alarm sounded, to find the other engine room staff and tell them to come up to the workshop straight away.

The second engineer and the fitter started rigging the fire hose located just forward of the workshop. However, thick black smoke was building up quickly. At about this time, the third engineer ran towards the second engineer telling him that there was too much smoke in the engine room and that he thought it was not safe for him to go down to the bottom plates to start the fire pump. By this time, the rest of the engine room staff had joined the second engineer near the workshop fire hydrant.

With the amount of smoke increasing, the second engineer decided that it was unsafe to remain in the engine room so he instructed everyone to evacuate immediately. They then followed him out of the engine room, through the smoke, and into the accommodation. The engine room/upper deck access door was closed when the fire started so there was no smoke in the accommodation. When they had exited the engine room, the second engineer again closed the door. The men then went out onto the poop deck to get some fresh air.

The chief engineer was completing his end of month report when he heard the fire alarm sound on the alarm panel in his cabin. He glanced at the main engine tachometer and saw that the main engine revolutions were running down. He surmised that there was something wrong so he ran down the stairs and attempted to enter the engine room through the upper deck/engine room access door.

However, when the chief engineer opened the access door, he was engulfed in a cloud of smoke. He closed the door and ran to the fire control station. He activated the remote stops for the engine room ventilation fans and the fuel oil pumps. He then operated the fuel/lubricating oil quick closing valves. About five minutes later, the auxiliary diesel generator stopped, due to the loss of fuel pressure, and the ship blacked out. Soon after, the emergency generator started automatically and the emergency lights came on. The chief engineer then started the emergency fire pump.

The chief engineer had heard the men exiting the engine room so he went out onto the deck to check on them. They were all coughing and taking in large breaths of fresh air as they tried to clear the smoke from their lungs but they appeared to be otherwise unharmed.

Meanwhile, on the bridge, the third mate was on duty and the second mate was preparing charts for the next leg of the ship's voyage when the fire alarm sounded. As both men turned around to look at the fire alarm panel, they saw thick black smoke billowing out of the engine room skylight. The third mate immediately telephoned the master and reported what he had seen.

Shortly afterwards, the master and the chief mate arrived on the bridge. When the master saw the amount of smoke that was coming from the skylight and the funnel, he ordered the second mate to activate the general alarm. The chief mate instructed the third mate to go down to the upper deck and tell the deck crew, who were working forward, to muster immediately.

The crew mustered on the upper deck. Then, under the supervision of the chief mate, they started rigging fire hoses to boundary cool the engine room casing and the funnel. They then closed the fire dampers for the engine room ventilation fans and the funnel vents. A fire hose was also set up to spray water into the engine room through the open skylight. By this time, the heat from the fire was causing the paint to peel off the funnel.

The crew continued to boundary cool the engine room casing and the funnel. After about 50 minutes, the emergency fire pump stopped unexpectedly and water ceased to flow from the fire hoses. The master ordered the crew to close the skylight and then muster outside the CO<sub>2</sub> room. The boatswain and one of the seamen closed the skylight and then checked that all the fire dampers were closed. Then, when all the crew had been accounted for, the master instructed the chief engineer to release CO<sub>2</sub> into the engine room.

Even with the funnel vent fire dampers closed, there was still some smoke escaping from the vents. However, the quantity soon started to reduce. The smoke also began to change colour from black to white. After about 40 minutes, there was no longer any sign of smoke escaping from the funnel. The chief mate was occasionally checking the temperature of the engine room casing bulkheads with his hands and they appeared to be cooling.

At 1220, the master reported the fire to the Australian Rescue Coordination Centre (RCC), an operational arm of the Australian Maritime Safety Authority (AMSA), via an Australian Ship Reporting System (AUSREP) message. Over the next three hours he sent a number of follow up messages, providing further information to the RCC. He also reported the incident to the ship's manager, protection and indemnity (P&I) club and charterer. However, voice communications were difficult and

Inmarsat-C (satellite telex communication) proved to be the only reliable means of communication.

At about 1300, the crew prepared to enter the engine room through the upper deck/engine room access door. The electrician and the boatswain donned fire suits and self contained breathing apparatus (BA) units. When the two men entered the engine room, they found that it was very hot and filled with smoke. They looked around the second platform deck and could see the glow of a couple of small fires at the after end of the main engine. They exited the engine room and reported what they had seen.

A short while later, the boatswain and one of the oilers donned BA units and entered the engine room carrying portable CO<sub>2</sub> fire extinguishers. They discharged the extinguishers onto the small fires at the after end of the engine room but were unable to extinguish them. The boatswain took a closer look and saw that the glow of fire was coming from some pieces of smouldering timber. The two men returned to the upper deck and reported what they had found.

About two hours later, the crew again prepared to enter the engine room. The fourth engineer and one of the seamen donned BA units. Each man was given a foam fire extinguisher and instructed to extinguish any fires he found. They entered the engine room and, on this occasion, the smoke had cleared a little. They could see the glow of the timber that was still smouldering at the aft end of the main engine so they discharged their extinguishers onto it. At about 1600, they returned to the upper deck and reported that there was no longer any sign of fire.

The master instructed the crew to open the engine room fire dampers in order to ventilate the space. A short time later, the engineers and the electrician entered the engine room to assess the damage and to attempt to re-start the machinery. All of the bulkheads from the third platform deck up were covered in soot. The aft port side of the main engine had been damaged by fire and heat (Figure 8). There was a large amount of damage and deformation to the deck, and deck head, outside the third platform deck store (Figure 9). The oily water separator had also been damaged by fire (Figure 10) but the auxiliary diesel generators appeared to be undamaged.

The electrician inspected the main switchboard and opened all the circuit breakers. He then inspected the number one generator. The engineers opened the diesel oil quick closing valves and inspected the diesel generator fuel oil, lubricating oil and cooling water systems. Everything appeared to be satisfactory so they started the number one diesel generator and then closed the main circuit breaker, thereby supplying power to the main switchboard. Many of the electrical circuits had been damaged by the fire but the electrician was able to get some engine room lighting to work. The engineers rigged cargo lights in other areas of the engine room and the electrician ran temporary cabling to them. Soon after, lighting and power was restored in the accommodation.

During the afternoon, AMSA continued to monitor the situation. By about 1600, they had identified that the Esperance harbour tugs and the tug *Greshanne*, which was in the vicinity towing a barge towards Dampier, Western Australia, were the most suitable 'vessels of opportunity' available if an emergency towage operation became necessary.

**Figure 8: Aft port side of main engine middles**



**Figure 9: Area outside the spare gear store**



**Figure 10: Oily water separator**



At 1737, the master sent the following message to the RCC:

SHIP NOT UNDER COMMAND IN PSTN 3522S/12220E. ALL CREW EFFORTS TO RESTORE SHIPS PROPULSION, IN VAIN. OWNERS/MANAGERS INFORMED ACCORDINGLY FOR FURTHER ACTION.

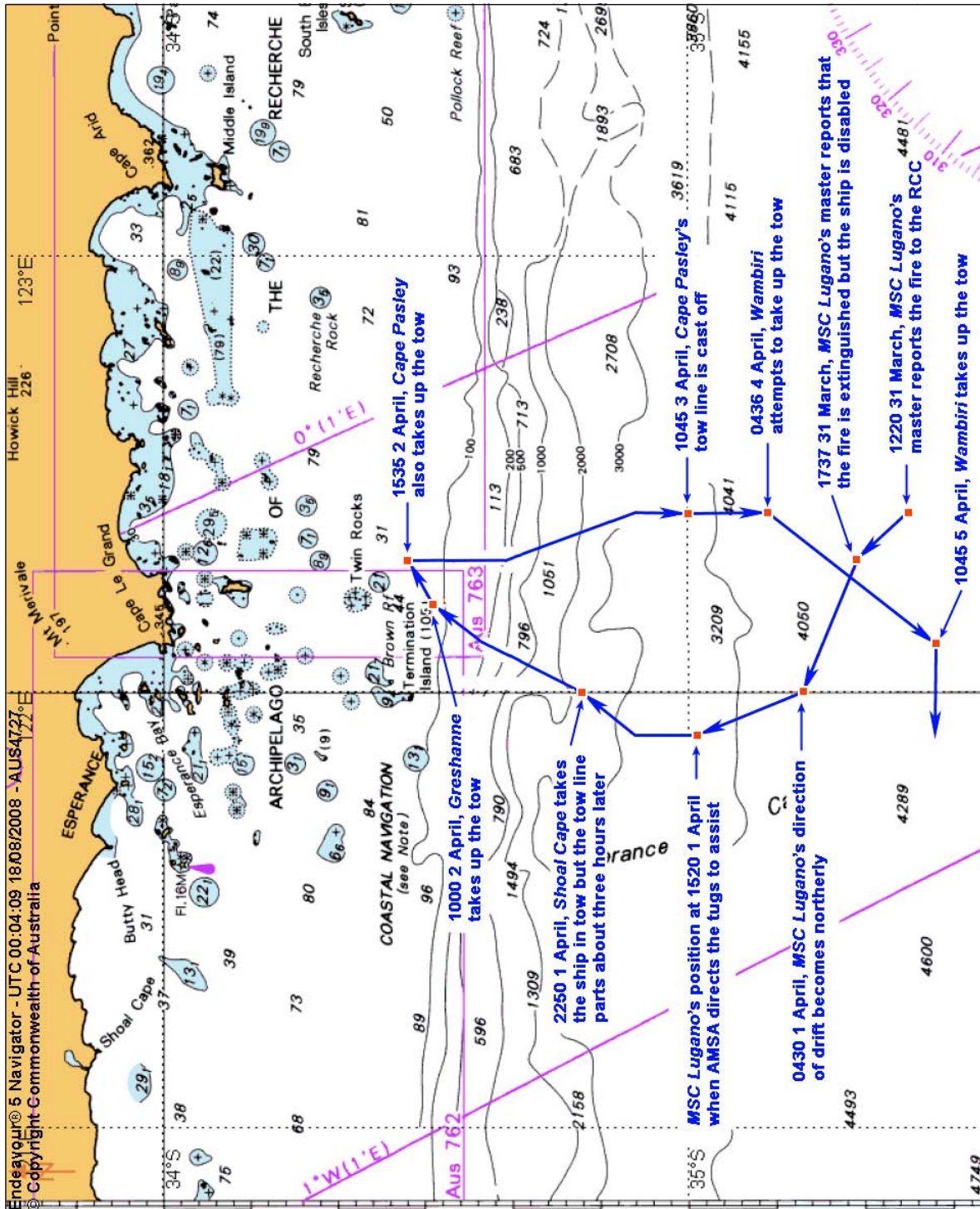
The ship was now about 60 miles south of the outer edge of the Archipelago of the Recherche (Twin Rocks), and drifting in a north-westerly direction (Figure 11). The wind was from the southwest at force four (11 to 16 knots) with a moderate south-westerly swell. The weather forecast indicated that over the next 24 hours the wind would increase to force six to seven (22 to 33 knots) and that the sea would build to two metres on a two metre swell.

*MSC Lugano*'s owners held discussions with both Mackenzie's Tug Service, the Esperance harbour tug operator, and Svitzer Salvage Australasia, a company with a Fremantle based tug suitable for offshore towage/salvage work. During the evening of 31 March, they reached an agreement with Svitzer to tow the ship to Fremantle.

By 0430 on 1 April, *MSC Lugano* was about 50 miles from the outer edge of the Archipelago of the Recherche. The wind was now from the south-southeast at force seven (28 to 33 knots) and the ship's direction of drift had become northerly.

As a result of the change in the ship's drift, AMSA's officers, using their powers of intervention, decided to direct an Esperance based harbour tug to assist the ship. Efforts were then made to come to a contractual arrangement with Mackenzie's Tug Service.

Figure 11: Section of navigational chart Aus 4727 showing the ship's track from the time the fire was reported to the RCC until *Wambiri* successfully took the ship in tow





At 1000, *MSC Lugano*'s master sent the following message to the RCC:

VESSEL NOT UNDER COMMAND IN POSITION 3005S / 12158E, SE WIND 7, DRIFTING NW DIRECTION AT 1.8 KNOTS TOWARDS ARCHIPELAGO OF RECHERCHE, ESPERANCE. PRESENT DISTANCE TO REEFS 34 NM.

FEARING POSSIBLE GROUNDING, REQUEST TUG TO ASSIST AND KEEP THE SHIP AWAY FROM REEFS, UNTIL TOWING ASSISTANCE FROM FREMANTLE ARRIVE.

Meanwhile, on board *MSC Lugano*, the electrician ran temporary wiring to the auxiliary boiler fuel pumps and checked the other boiler systems. He was able to get the boiler to fire but the water level automation had been damaged by the fire. As a result, the engineers had to control the water level manually.

The main engine cooling water, lubrication oil and fuel oil pumps were all operable and, with the boiler now firing, the engineers were able to start these pumps and bring the systems back up to their normal operating pressures and temperatures.

The engineers were also working on the engine control systems in an effort to start the main engine. They replaced the number one cylinder (after most) air start valve, replaced a leaking high pressure fuel pipe on number one cylinder and overhauled the starting air distributor valve. They also checked the operation of the automatic starting air valve and rigged an air supply to the exhaust valve air spring system. By the end of the day, they had attempted to start the main engine but it would not start.

The chief engineer reported to the master that he had not yet been able to start the main engine. During the conversation, the master told the chief engineer that tugs were on the way. He then instructed the chief engineer not to continue attempts to re-start the engine but to focus his efforts on ensuring that another fire did not start in the engine room. Hence, the crew began to concentrate on removing debris from the engine room and tidying up as much as possible.

By 1520, contractual towage arrangements were in place between AMSA and Mackenzie's Tug Service and an intervention direction was issued. Soon after, the tug *Shoal Cape* departed Esperance. At about the same time, AMSA also directed the tug *Greshanne* to assist.

At 1910, the Svitzer tug *Wambiri* sailed from Fremantle, with about 60 hours steaming time to rendezvous with *MSC Lugano*.

By 2000, *Shoal Cape* had arrived at the ship's position. At 2250, *MSC Lugano*'s master reported to the RCC that the ship was under tow. As a result, at about 2400, AMSA cancelled *Greshanne*'s direction order.

At 0200 on 2 April, the tow line parted and fouled one of *Shoal Cape*'s propellers. *MSC Lugano*'s master requested further assistance from the RCC and AMSA directed *Greshanne* and another Esperance harbour tug, *Cape Pasley*, to assist the ship. The wind was now southwest at force seven to eight (28 to 40 knots) with a heavy swell.

By 1000, *Greshanne*'s tow line had been made fast to the ship. However, the ship was only about seven miles south of Twin Rocks and an uncharted area within the Archipelago of the Recherche and it was drifting northwards (Figure 11). The wind was now from the south-southwest at force seven (28 to 33 knots) and the swell had increased to about three metres.

At 1535, *Cape Pasley* arrived at the ship's position and attempts were made to connect a tow line to the ship. However, the line parted. A spare tow line was then passed from *Greshanne* to *Cape Pasley*. By 1712, this tow line had been made fast to the ship. Now, with the two tugs towing the ship, it began to clear the coast.

The weather started to abate and, at 1045 on 3 April, *Cape Pasley's* tow line was cast off and the tug returned to Esperance while *Greshanne* continued with the tow. The wind was now from the south-southeast at force four (11 to 16 knots) with a swell of two to three metres.

At 0436 on 4 April, *Wambiri* arrived and *Greshanne's* tow line was cast off. However, while one of *MSC Lugano's* mooring lines was being passed to *Wambiri*, it fouled the tug's propeller. The ship was now well clear of any danger so it was left to drift while *Wambiri* sailed to Esperance to have the mooring line removed from its propeller.

At 1110 on 5 April, *Wambiri* returned to the ship's position and by 1245, the tug had taken the ship in tow.

The tow continued without incident and at 1130 on 13 April, a Fremantle harbour pilot boarded *MSC Lugano* for the transit from sea to the Patrick container terminal. By 1506, the ship was all fast alongside its berth.



## 2.1 Evidence

Between 13 and 17 April 2008, investigators from the Australian Transport Safety Bureau (ATSB) attended *MSC Lugano* in Fremantle. The master and directly involved crew members were interviewed and they provided accounts of the incident. Photographs of the ship and copies of relevant documents were obtained, including log books, charts, reports, manuals, procedures and statutory certificates.

In the days following the fire, the ship's crew had cleaned various areas of the engine room and removed much of the debris that resulted from the fire. The ATSB had issued a protection order to the ship's master in accordance with Division 4, Section 43 of the *Transport Safety Investigation Act 2003* that should have prevented the removal of evidence from the fire scene. The protection order did not prevent the crew from cleaning the engine room or removing the debris if the master believed carrying out these tasks was essential to ensure the safety of the ship and its crew. However, the clean-up went further than just removing combustible material from the engine room. Bulkheads were wiped down and the decks were swept clean, removing valuable evidence from the probable point of origin of the fire.

During the course of the investigation, further information was obtained from the Australian Maritime Safety Authority (AMSA), Tas Ocean Shipping, Mackenzie's Tug Service and Svitzer Salvage Australasia.

### 2.1.1 Record keeping

*MSC Lugano*'s master was not able to supply the ATSB investigators with a record of the events following the fire alarm at 1115 on 31 March 2008. As a result, the times used in this report have been approximated following analysis of interviews with the various crew members.

Generally, during similar emergencies, one of the crew members on the bridge is assigned the task of recording the actions taken during the emergency response. However, in this case the timing of key events was not recorded.

As a result, the master did not know at what time the fixed CO<sub>2</sub> fire extinguishing system was operated. Therefore, when he was considering when to allow the crew to re-enter the engine room, he could not have been certain how long it had been since the CO<sub>2</sub> had been released.

On three occasions, crew members wearing breathing apparatus entered the engine room to inspect the space. However, there was no record of when they either entered or exited the engine room. Without such records, the crew would have been unable to appropriately monitor how long each crew member had been inside the engine room and the state of their air supply.

A clearly recorded time line of the actions taken by the crew on 31 March would have made the task of reconstructing the events of that day much easier and possibly more accurate. More importantly, it would have been an essential detail in ensuring that the operations carried out by the crew during the emergency response were as safe as possible.

## **2.2 The fire**

The removal of evidence from the engine room made it very difficult to determine the fire's point of origin. However, witness accounts, the areas of concentrated damage, the burn patterns on the main engine, bulkheads and decks, and the debris that remained, gave an indication of what may have happened.

The ATSB investigators examined the evidence and considered a number of possible scenarios. Each scenario was studied in detail and only discarded if it was determined that the available evidence did not support it.

In submission, Transman Shipmanagers stated that, in their opinion and that of their fire investigator, the fire started when fuel oil, leaking from a high pressure fuel line on the main engine's number one unit, sprayed onto the hot surface of the nearby main engine exhaust. They believe that the evidence provided by the crew regarding the location of the fire, a fuel leak that was discovered on the main engine number one unit high pressure fuel line following the fire and the large amount of damage abaft of the main engine, support their conclusion.

The ATSB had considered the possibility that the fire had started in the area aft of the main engine and on receiving Transman Shipmanagers submission this scenario was reconsidered. However, in the opinion of the ATSB, the available evidence does not support the concept of a fire starting in the area aft of the main engine turbocharger and then moving downwards on the engine and then to port across the third platform deck.

One of the oilers had inspected the main engine cylinder heads only minutes before the fire alarm sounded and he had not seen any signs of fuel leakage. Had the high pressure fuel line been leaking in the few minutes between the time when the oiler checked the cylinder heads and the time that the fire alarm sounded, only a small quantity of fuel oil would have been available to fuel the fire and when the engine was stopped the leakage of fuel would have ceased. There was also no evidence found by the ATSB that would suggest that fuel oil pooled on the engine or ran down it. Furthermore, the fire would have had to propagate downwards and to port, against the flow of the ventilation which was directed upwards.

In the end, the ATSB was left with only one plausible theory, detailed below, that was supported by all of the available evidence.

### **2.2.1 Primary fire**

The evidence indicated that the primary fire probably started in the area outside the entrance to the third platform deck store, on the port side of the main engine (Figures 12 and 13). There had been a very intense fire in this area of the engine room. The steel deck and the deck head above were deformed by the heat from the fire, as was the bulkhead between the store and the purifier room. While a secondary fire had not started in the purifier room, the transfer of heat through the

store/purifier room bulkhead had caused extensive damage to the electrical cabinets fixed to the bulkhead inside the purifier room (Figure 14).

**Figure 12:** View of the area outside the store looking from forward



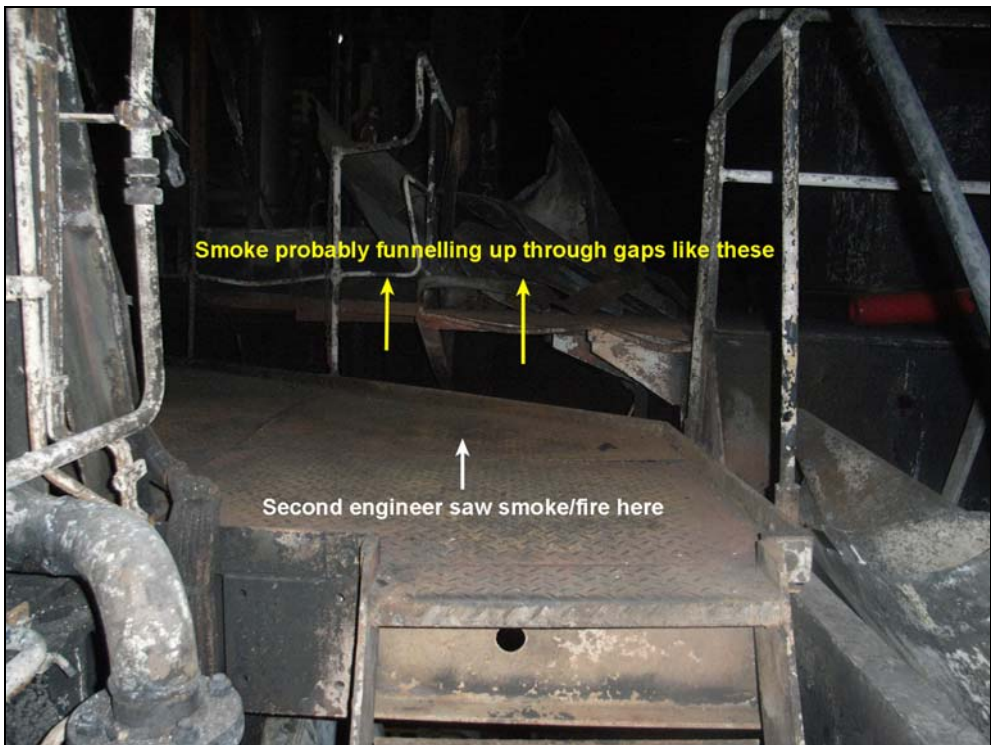
**Figure 13:** Inboard view of the front of the store



Figure 14: Inside the purifier room electrical cabinet



Figure 15: The area aft of the main engine turbocharger where the second engineer saw the smoke and flame



While the second engineer stated that when he looked out of the workshop he saw 'smoke and flame' in the area aft of the number one (aft) main engine turbocharger, it is likely that he actually saw the thick black smoke that was being produced by a fire that had started one deck below. The smoke was probably funnelling up

through the gaps in and around the second platform deck plating (Figure 15). While it is possible that he saw flames from the fire below, it is more likely that he saw the thick black smoke and drew the natural conclusion that there must have been some flame.

**Figure 16: Shelving at the front of the store**



**Figure 17: Shelving at the rear of the store**

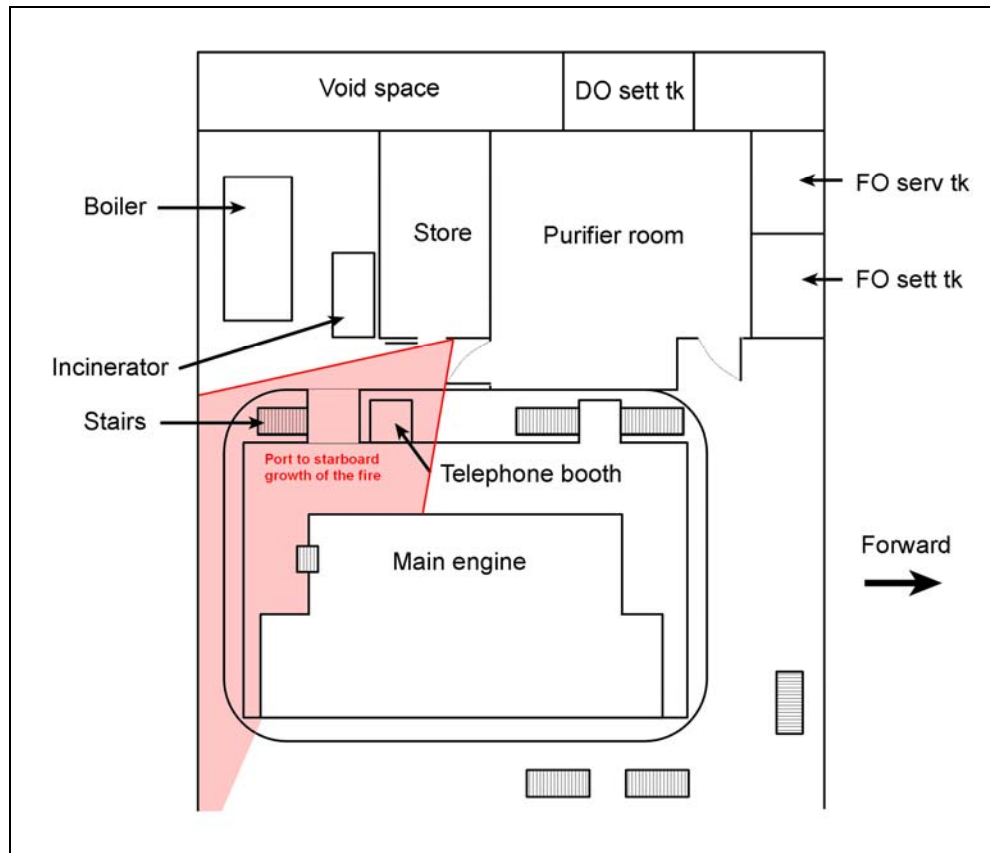




From the store's entrance, the fire moved in two directions, both into the store and away from it. Nearly everything stowed near the entrance of the store had been destroyed (Figure 16). However, the fire had caused little damage to the equipment stowed at the rear of the store, particularly to those items stowed on the higher shelves (Figure 17).

It is likely that the fire's spread was initially being directed by the engine room ventilation. Thus, as the fire developed, it was directed inboard, towards the main engine and upwards towards the exhaust casing and funnel abaft the main engine (Figure 18). Even with the engine room ventilation fans stopped, and the fire dampers shut, there would have been a natural funnelling effect of air flow from the seat of the fire, to starboard and aft, up towards the open engine room skylight.

**Figure 18: Diagram indicating the fire's port to starboard development**



There were several areas on the engine that indicated the port to starboard, forward to aft, spread of the fire, at both the main engine middle level and the cylinder head level. The most obvious examples of this were the three aft cylinder heads and exhaust valves (cylinders one, two and three). The port side of the exhaust valves had been subjected to fire and heat while the starboard sides of the valves had suffered little damage, indicating that they had been shielded from the fire. In fact, the paint on the starboard sides of the valves had not been affected by the fire at all (Figure 19). While the aft end of number one cylinder head and exhaust valve had also been damaged by heat, this damage was consistent with a flow of heat from under the decking immediately aft of the main engine.

The fire and heat damage to the main engine was concentrated at the port aft end of the engine at, and above, the engine middles. The fire had not developed downwards on the engine towards the floor plates below. The aft end of the engine at the floor plate level was still coated in a film of lubricating oil that had not been affected by the fire.

**Figure 19: Main engine number three cylinder head and exhaust valve**



**Figure 20: Engine side control stand**



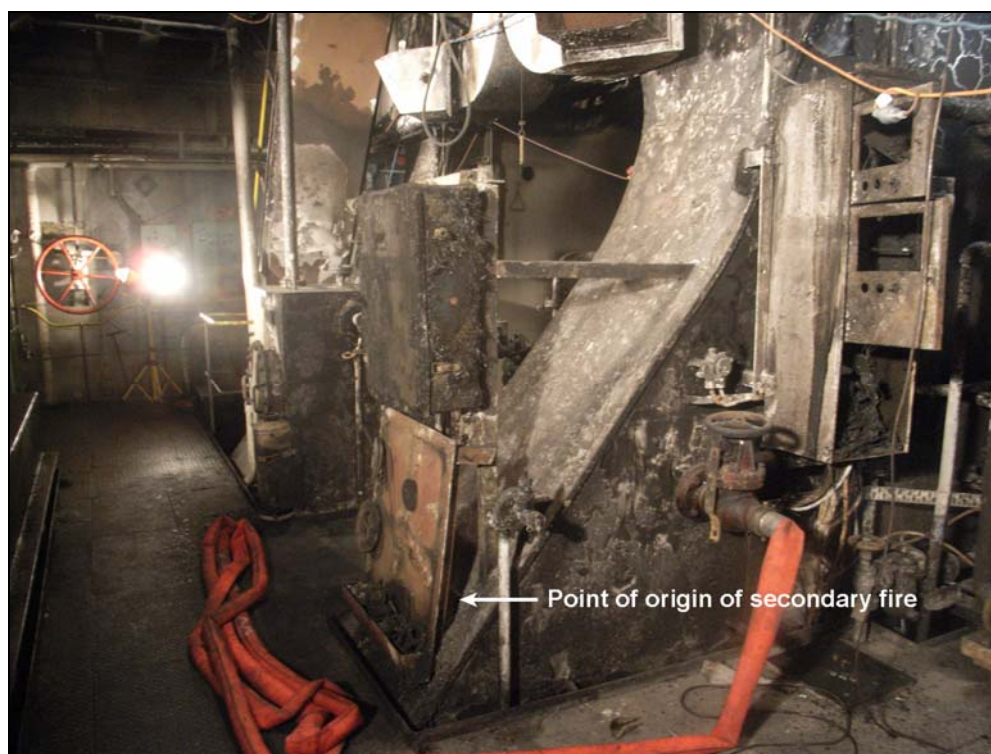
The engine side controls and much of the main engine remote control system were located at the port aft end of the engine at the middle level. As a result, they were severely damaged by the fire (Figure 20).

Many of the deck plates around the main engine had buckled as a result of the fire and the heat generated. There was also a great deal of smoke and heat damage to the second platform deck bulkheads. Equipment stowed outside the workshop and aft of the main engine also showed signs of heat and smoke damage. The bulkheads and structure above the second platform deck were also similarly damaged.

### 2.2.2 Secondary fire

The investigation found that another fire had started at the floor plate level in the vicinity of the oily water separator (Figure 21), on the port side of the main engine, immediately below the third platform deck store. The evidence links this fire to the primary fire on the deck above.

**Figure 21: Point of origin of the secondary fire**



As the primary fire developed, it engulfed a telephone booth located near the engine control stand, destroying it (Figure 22). When this occurred, the perspex door fitted to the telephone booth (Figure 23) caught fire. The burning liquid perspex dripped downwards and landed behind a shadow board located directly below (Figure 21). Pieces of timber stowed behind the shadow board were then ignited by the burning perspex and a fire started in this area, eventually engulfing the oily water separator.

**Figure 22: Burnt out telephone booth**



**Figure 23: Undamaged booth**



### **2.2.3 Source of fuel and ignition**

Prior to the ship arriving in Fremantle, the crew had removed the debris from the area outside the store, the area where the fire probably started. As a result, the ATSB investigators were not able to determine exactly how the fire started. However, given the ship's history, the general condition of the engine room and the routine practices of the crew, the investigators were able to get an indication of what may have happened.

#### ***Source of fuel***

*MSC Lugano* had been subjected to many routine Port State Control (PSC) inspections and, on at least three occasions since 2000, these inspections had identified 'engine room cleanliness' as a safety deficiency. Since taking over the ship in September 2007, the new owners, managers and crew had made a determined effort to clean up the engine room. As part of the cleanup, they had also repainted most of the bulkheads and many items of machinery.

In an attempt to keep the engine room clean, and to pass any impending PSC inspections without deficiency, it was normal practice for the ship's crew to build dams of cotton waste around items of machinery, like the fuel transfer pump, to stop oil from spreading over the tank tops. It was also normal practice for them to use rags to wipe the oil off the main engine and the other machinery prior to the ship arriving in port. The rags and cotton waste were sometimes soaked in diesel oil or kerosene to assist with the cleaning process. The crew also routinely cleaned up any oil that was lying in the various save-alls and bilges before the ship reached port. In essence, the crew were attempting to make the engine room appear clean while the ship was in port.

In their attempts to keep the engine room clean, the crew were consuming large quantities of rags and cotton waste. The cotton waste (Figure 24 and 25) was particularly effective when wiping up the oil because of its large surface area and the natural absorbency of cotton.

**Figure 24: Cotton waste**



**Figure 25: Oily cotton waste and rags**



When the crew had finished their cleaning tasks, they stowed the oily rags and cotton waste in drums outside the third platform deck store, the location identified as the likely point of origin of the fire. Then, every few days, the oily rags and cotton waste would be burnt in the waste incinerator, located just aft of the store.

The evidence indicates that there were oily rags and cotton waste stored near the incinerator when the fire started on board MSC Lugano on 31 March and it is likely that these rags provided the initial fuel source for the fire.

### ***Source of ignition***

When all of the rags and cotton waste were burnt, the incinerator would be left to cool down for a short period. Then, the still hot ash would be removed from the incinerator and placed in an open top cut down 200 litre steel drum, which was kept outside the store for this purpose, and allowed to cool. When the ash had cooled sufficiently, the crew would separate any metal from the ashes and then dispose of the metal and the ashes separately.

Storing highly flammable used oily rags/cotton waste in the engine room is an extremely dangerous practice. Furthermore, storing them near an exposed heat source, like ash, increases the risk of them catching fire.

The storing of oily rags and cotton waste, and hot ash, in the engine room were not the only bad habits that the ship's crew had adopted. Many of the crew smoked cigarettes and while the company's policies and on board signage prohibited smoking in the engine room, the ATSB investigators observed some of the crew disregarding this direction. Smoking in the engine room is an example of a 'normalised deviance'<sup>7</sup>. The crew had deviated from a known standard and they had not experienced any negative outcomes as a result of this practice. Consequently, over time, they had probably come to believe that it was acceptable to smoke in the engine room.

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<sup>7</sup> Normalised deviance occurs when groups, or individuals, take risks by deviating from a known standard and, because there is no negative outcome, they receive the false feedback that they can get away with it. Over time they grow to believe that deviation from the standard is acceptable.

It is possible that the used cotton waste and/or rags were inadvertently placed on top of the still hot ash from incinerator and that they were ignited by the heat from the ashes. It is also possible that a lit cigarette butt, inadvertently dropped onto the oily cotton waste and rags, ignited them.

## 2.3 Shipboard emergency response

The crew's response to the fire was prompt and there were some effective steps taken to control the fire. These included the operation of the quick closing valves, stopping the fuel and lubricating oil pumps, stopping the engine room ventilation fans and closing the fire dampers.

After the engine room was evacuated, the crew boundary cooled the funnel and the engine room casing. They also sprayed water into the engine room through the open skylight. However, these actions did not control the fire. In fact, the open skylight acted as a chimney and allowed the fire to continue to grow in size and intensity.

The crew continued with their attempts to control the fire and it was not until about 50 minutes after the fire alarm sounded that the master decided to use the ship's fixed CO<sub>2</sub> fire extinguishing system. It is likely that if the fire was allowed to go unchecked for much longer it would have spread to the purifier room. A fire in the fuel laden purifier room would have caused far more damage in the engine room and may have ultimately resulted in the loss of the ship.

When the master and the ship's crew were interviewed by the ATSB investigators, they were all of the opinion that they needed to try everything in their power to extinguish the fire before they considered using the fixed CO<sub>2</sub> fire extinguishing system. The general consensus was that the fixed fire extinguishing system was their 'last resort'.

With respect to delaying the use of a ship's fixed CO<sub>2</sub> fire extinguishing system, the author of Rushbrook's Fire Aboard<sup>8</sup> states:

As the rate at which a fire grows is exponential even a short delay can result in significant fire growth and consequent damage.

Generally, there are two types of engine room fire. The first is a small fire that can be effectively extinguished by the crew members with the use of portable fire extinguishers or fire hoses. The second is a fire that quickly grows in intensity. When this occurs, the crew are soon aware that they cannot safely fight the fire with hoses and extinguishers and hence must evacuate the space. They should then operate the ship's fixed fire extinguishing system as soon as possible. This ensures that the fire is extinguished before it becomes too large for the fixed system to effectively extinguish.

There should have been no doubt in the master's mind about the size of the fire that the crew were dealing with. While the crew had attempted to fight the fire with a fire hose, they soon determined that it was unsafe to remain in the engine room. Furthermore, the master could see the large amounts of thick black smoke that were billowing from the skylight. When faced with such a fast growing intense fire, the

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<sup>8</sup> Rushbrook's Fire Aboard, Third edition 1998, Brown, Son & Ferguson Ltd Glasgow.

master's first course of action should have been to use the ship's fixed CO<sub>2</sub> fire extinguishing system.

Had the master appropriately considered the size and type of fire that the crew were dealing with, he would have realised that the release of CO<sub>2</sub> into the engine room was his only realistic course of action. This action could have taken place within a few minutes of the fire alarm sounding. Had this been the case, the fire may have been extinguished some 50 minutes earlier than it was. This would have resulted in far less damage to the engine room and, in particular, the main engine and its associated control systems. As a result, the crew may have been able to re-start the main engine and hence avert the need to tow the ship into port.

### 2.3.1 Engine room re-entry

At about 1300 on 31 March 2008, only about 105 minutes after the CO<sub>2</sub> was discharged, the master decided to send the crew into the engine room to see if the fire had been extinguished. The fire had not been extinguished and they subsequently inspected the space on two more occasions before declaring it extinguished at 1600.

While, in this instance, the master's actions proved to be correct, there is always a considerable risk of re-ignition if a space is entered too quickly after the release of an extinguishing agent such as CO<sub>2</sub>. Carbon dioxide is heavier than air and it extinguishes a fire by displacing the air and, therefore, starving the fire of oxygen. Carbon dioxide does not readily conduct heat away from hot surfaces. Hence, it only has a limited effect in cooling spaces heated by a fire. As a result, a fire can re-ignite when air is admitted into a space, which is still hot, following the use of CO<sub>2</sub>.

The engine room fire on board the livestock carrier *Bader III* on 21 April 2000 clearly demonstrates the danger involved with re-entering a space too early. In this instance, the crew entered the engine room three hours after releasing CO<sub>2</sub> into the space and the fire subsequently re-ignited. Fortunately, the crew were able to ventilate the engine room and extinguish the fire with the use of fire hoses. However, it was not until four hours later that the fire was brought under control<sup>9</sup>.

*MSC Lugano*'s safety management system gave the master no guidance as to how long to wait before re-entering the ship's engine room after the release of CO<sub>2</sub> into the space. In the absence of such guidance, the master had to consider the evidence at hand when making the decision as to when it might be safe to re-enter the engine room. He should have considered the size, location and intensity of the fire along with the thermal inertia<sup>10</sup> of the materials heated by the fire.

Eye witness accounts of the fire, the amount of smoke it produced, the peeling of the funnel paint and the heat being radiated from the engine room casing were all indicators of the size and intensity of the fire. The master should have been aware that a large scale fire had been burning for almost an hour when the CO<sub>2</sub> system was operated. As a result of this long burning, large scale fire, there had certainly been a large build up of heat in the engine room.

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9 The Commonwealth of the Bahamas, Report of the investigation into the fire in the engine room of the Livestock Carrier "BADER III" on 21 April 2000.

10 The term used to describe the response of a material to the heat energy impacting on it. A material with high thermal inertia will retain heat for longer than a material with a low thermal inertia.

Therefore, in order to allow the engine room to cool down and thereby reduce the risk of re-ignition, it would have been prudent for the master to wait for a longer period of time, certainly more than 105 minutes, before allowing the crew to re-enter the space.

## 2.4 Emergency fire pump power supply

At about 1210 on 31 March, *MSC Lugano*'s emergency fire pump stopped and, as a result, water ceased flowing from the fire hoses.

At the time of the incident, the ship's emergency fire pump was an electric motor driven, self priming, centrifugal pump. It was located in the shaft tunnel, which was separated from the engine room by two doors, one of which was a remotely operated watertight door. Power for the pump's electric motor was supplied from the ship's emergency generator and switchboard, both of which were located on the port side of the accommodation at upper deck level.

However, the electrical cabling between the emergency switchboard and the emergency fire pump was not located entirely outside the engine room. A closer examination of the cabling showed that a section of it lay in cable trays inside the engine room. One part of this cable tray ran directly above the oily water separator. As a result, the cabling was damaged by the fire and the supply of electrical power to the emergency fire pump was cut off.

While the emergency fire pump and the emergency generator were both located in a part of the ship that met the relevant SOLAS requirements, the electrical cabling between them did not meet this standard. With reference to emergency electrical cabling, SOLAS<sup>11</sup> states:

The location of the emergency source of electrical power, associated transforming equipment, if any, the transitional source of electrical power, the emergency switchboard and the emergency lighting switchboard in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard shall be such as to ensure to the satisfaction of the Administration that a fire or other casualty in the space containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard, or in any machinery space of category A will not interfere with the supply, control and distribution of emergency electrical power.

The emergency electrical power distribution system on board *MSC Lugano* did not meet this SOLAS requirement. The events of 31 March 2008 clearly illustrate that a fire in the ship's engine room, the machinery space housing the main source of electrical power and the main switchboard, interfered with the distribution of emergency electrical power.

## 2.5 Deck perforations

The steel decks and bulkheads in the engine room were effective in slowing the transfer of fire through the space. An example of this was the purifier room, where

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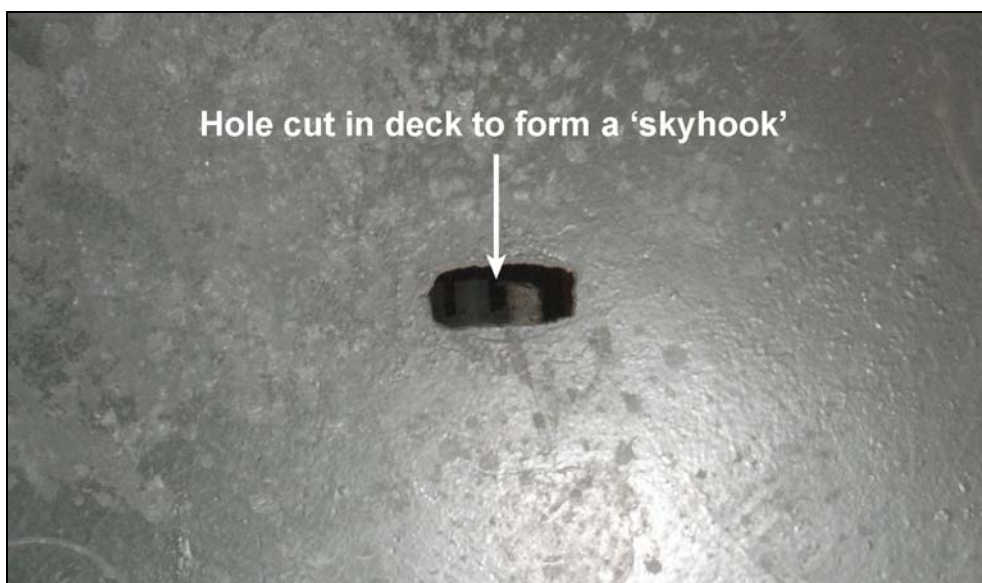
<sup>11</sup> SOLAS, Chapter II-1 Construction – Structure, subdivision and stability, machinery and electrical installations, Regulation 43.



the heat that was being conducted through the steel bulkhead from the intense fire outside was insufficient to ignite a secondary fire inside the purifier room.

However, when the ATSB investigators inspected the engine room after the fire they discovered that a large number of holes had been cut in the steel decks around the engine room (Figure 26). It was also noted that while the conduction of heat through the decks in these areas was insufficient to cause widespread damage, the transfer of heat via convection through the holes in the deck was sufficient to cause localised damage.

**Figure 26: Hole cut in deck**



An example of this was the electrical distribution board mounted to starboard at the forward end of the engine room, on the second platform deck, diagonally across the engine room from the fire's point of origin. The area surrounding the distribution board was almost unaffected by the fire. However, the distribution board, with a hole cut in the deck directly in front of it, showed signs of heat and smoke damage (Figure 27).

The holes in the decks had been used to create 'sky hooks' to allow various pieces of machinery to be removed or stripped down. When in use as a 'sky hook', a sling would be passed through the hole from below, around a length of pipe lying on the deck and then back through the hole. A chain block could then be hooked onto the two ends of the sling.

When the holes were cut in the engine room decks to create the 'sky hooks', the consideration was probably only for the immediate need to lift a piece of machinery. Time was not taken to weld an appropriate lifting eye in place and it is likely that the risks associated with cutting the holes in the deck were not appropriately considered.

**Figure 27:** Electrical distribution board with damaged switches directly in line with the hole that had been cut in the deck



## 2.6 Shore-side emergency response

On 2 April 2008, *MSC Lugano* came within five miles of either grounding on Twin Rocks or entering a high risk, unsurveyed area within the Archipelago of the Recherche. While the ship's owners had implemented a plan for the Fremantle based tug *Wambiri* to take the ship in tow, it was AMSA's intervention and the combined efforts of the crews on board the tugs *Greshanne*, *Shoal Cape* and *Cape Pasley* that prevented the ship from grounding.

This was not the first occasion in which a ship has encountered difficulties in this area of the Australian coast. One notable example that clearly identified the consequences of a ship grounding in the area was that of the bulk carrier *Sanko Harvest* on 14 February 1991<sup>12</sup>.

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<sup>12</sup> Transport and Communications, Marine Operations, Investigation Report No. 27. This report can be downloaded from the ATSB website, [www.atsb.gov.au](http://www.atsb.gov.au)

*Sanko Harvest* grounded when it was about 19 miles south-southeast of Esperance, in shoal water that was not shown on the ship's charts. It was severely damaged by the impact with the reef and, as a result, heavy fuel oil was released from its double bottom fuel tanks. The ship was exposed to the prevailing weather and swell, which resulted in the breaching of further tanks and cargo holds. The crew were evacuated and, on the night of 17 February, the ship broke into three sections and sank.

The grounding of *Sanko Harvest* and the events that followed over the ensuing days clearly demonstrate the risks that a grounded ship pose to this relatively isolated section of the Australian coastline.

### 2.6.1 **Actions taken by *MSC Lugano*'s master and owners**

At 1220 on 31 March, *MSC Lugano*'s master reported the fire on board the ship to the Australian authorities and the ship's managers, protection and indemnity (P&I) club and charterer. The notification to the Australian authorities was sent as part of an Australian Ship Reporting System (AUSREP) message to the Australian Rescue Coordination Centre (RCC).

Within the RCC, AUSREP messages are monitored by a duty operator and, if a message contains a report that requires action, the operator will ensure that the relevant officer within the RCC is notified. However, there may be a delay in processing these reports if there is queue of messages that require the AUSREP operator's attention.

At no time did the master declare to the RCC that the ship was in distress. However, due to the gravity of the ship's predicament, he should have forwarded an urgency or distress message directly to the RCC. This would have ensured that the appropriate officer within the RCC was alerted to the message as soon as it was received.

The primary responsibility for the safety of *MSC Lugano* and its crew, and the protection of the marine environment, rested with its master and owners. After being informed that the ship was permanently disabled, the ship's owners held discussions with Mackenzie's Tug Service and Svitzer Salvage Australasia with the aim of arranging for the ship to be towed to Fremantle. During the night of 31 March, the ship's owners agreed to terms with Svitzer and on 1 April, a towage contract was signed. However, it would take in the vicinity of 70 hours preparation and steaming time for the Fremantle based Svitzer tug *Wambiri* to rendezvous with *MSC Lugano*.

Given that the weather was forecast to deteriorate over the following days, with the wind backing to the south and increasing in strength to force six to seven (22 to 33 knots) and the seas increasing to 2.5 m on a swell of 1.5 m, there was always a risk that *Wambiri* would not arrive in time to prevent the ship from grounding. In these circumstances *MSC Lugano*'s owners should have made interim arrangements with local towage providers to ensure that the ship was safe until *Wambiri* arrived. Alternatively, they could have signed a Lloyds Standard Form of Salvage (LOF 2000), rather than a towage contract. This would have enabled the salvor to use their best endeavours to salve the ship and to prevent or minimise damage to the environment. For example, had Svitzer been contracted as a salvor; they could have contracted other tug services to stabilise the situation until *Wambiri* had arrived and taken the ship in tow.

Since it was likely that the actions of the ship's owner were not going to be effective in preventing the ship from grounding, it was left to the Australian authorities to intervene and take control of the situation.

## 2.6.2 The intervention

In 2005, the Australian, State and Northern Territory governments agreed to the National Maritime Emergency Response Arrangements (NEMERA). The objective of the NEMERA is to protect the marine environment from ship-sourced pollution by enhancing preventative arrangements through the provision of an appropriate level of maritime emergency towage capability around the Australian coastline and by enhancing the emergency response management framework.

Under the NEMERA, AMSA assumes the role of the single national decision maker with the responsibility for intervention in shipping incidents involving threats of significant pollution. The NEMERA requires AMSA to consider all legal, practical, environmental, socio-economic and operational issues in deciding whether and how to respond to a maritime casualty. In relation to AMSA's powers to take measures to prevent pollution of the sea by oil within the Australian Economic Exclusion Zone (EEZ), Territorial sea and internal waters, section 10(2) of the *Protection of the Sea (Powers of Intervention) Act 1981* (the Act), as amended in 2006, states:

Where oil or noxious substance is escaping, or has escaped, from a ship in which this section applies, or the Authority is satisfied that oil or noxious substance is likely to escape from such a ship, the Authority may, subject to subsection (4), take such measures as it considers necessary:

- a) to prevent, or reduce the extent of, the pollution, or likely pollution, by oil or noxious substance, of any Australian water, any part of the Australian coast or any Australian reef;
- b) to prevent, or reduce the extent, or likely extent, of damage, to any of the related interests of Australia by reason of the pollution, or likely pollution, of the sea by oil or noxious substance;
- c) to protect any Australian waters, any part of the Australian coast or any Australian reef from pollution or likely pollution by oil or noxious substance;
- d) to protect any other related interests of Australia from damage by reason of pollution, or likely pollution, of the sea by oil or noxious substance; or
- e) in a case where oil or noxious substance has escaped – to remove or reduce the effects, or likely effects, of pollution or likely pollution, by the oil or noxious substance, on any Australian waters, any part of the Australian coast, any Australian reef or any of the related interests of Australia.

Section 10(4) of the Act, which provides guidance on how AMSA can use its powers of intervention, states:

The Minister and the Authority shall, in the exercise of powers under this section, act in accordance with the following principles:

- a) measures taken under this section shall be in proportion to the damage, whether actual or threatened, in relation to which the measures are taken;
- b) in determining whether measures are in proportion to the damage in relation to which the measures are taken, regard shall be had to:

- (i) the extent and probability of imminent damage if the measures are not taken;
  - (ii) the likelihood of those measures being effective; and
  - (iii) the extent of the damage which may be caused by the measures;
- c) measures taken under this section shall not exceed those reasonably necessary to achieve the end sought to be achieved by the measures and shall cease as soon as that end has been achieved;
  - d) measures taken under this section shall not unnecessarily interfere with the rights and interests of other countries, and of any persons, likely to be affected by the measures;
  - e) in taking measures under this section, any risk to human life shall, as far as possible, be avoided.

Once alerted of the fire on board *MSC Lugano*, at 1220 on 31 March 2008, the RCC notified the appropriate officers within AMSA. The RCC was then requested to start hourly Inmarsat-C polling of *MSC Lugano* so that the ship's position, direction and rate of drift could be monitored. The RCC was also asked to obtain more information from the master.

Between 1220 and 1737, when *MSC Lugano*'s master notified the RCC that the ship was permanently disabled, the ship drifted in a north-westerly direction at a rate of about 0.8 knots. At this time, the weather conditions were relatively good with southwest winds at force four (11 to 16 knots) and a moderate swell and the ship was about 60 miles south of Twin Rocks and an unsurveyed area within the Archipelago of the Recherche (Figure 11). If the ship continued to drift in a north-westerly direction, the nearest known danger was the coastline about 113 miles away.

However, the weather forecast predicted that the wind would back to the south and increase in strength to force six to seven (22 to 33 knots) with the seas increasing to 2.5 m on a swell of 1.5 m. While the effect of the change in weather on the drift of the ship was difficult to accurately predict, it was reasonably foreseeable that the rate of drift would increase significantly as the weather deteriorated and that it would drift in a more northerly direction.

From 1737 until about 0430 on 1 April, *MSC Lugano* drifted in a north-westerly direction at a rate of about 1.6 knots. At 0430, the ship was about 50 miles south of Twin Rocks. From 0430 onwards, the ship's set became more northerly and, as the weather continued to deteriorate, its rate of drift increased.

Later on the morning of 1 April, after *MSC Lugano*'s set had become northerly, AMSA considered that issuing a direction to the Port of Esperance for the release of a harbour tug was a proportionate measure in response to the probability of imminent damage at that time. This consideration recognised the interests of other persons who may be affected by the measure (i.e. the ship owner and the port) in accordance with the principles laid out in section 10(4) of the Act.

At 1000 on 1 April, *MSC Lugano*'s master reported to the RCC that the ship was 34 miles south of the Archipelago of the Recherche and drifting in a northerly direction at a rate of about 1.8 knots. The master was now clearly concerned that the tug *Wambiri* would not arrive in time to prevent the ship from grounding so he requested tug assistance from the RCC.

At 1100, AMSA carried out a 'net water movement analysis' that predicted the ship's possible direction and rate of drift over the next 18 hours. While this analysis did not conclude that the ship would ground, it included the following statement.

This should be used as a guide only as the ship appears to be drifting in a more northerly direction.

At 1520, about five hours after *MSC Lugano*'s master advised the RCC that he needed tug assistance; contractual arrangements were agreed between AMSA and Mackenzie's Tug Service. Shortly afterwards, the tug *Shoal Cape* departed from Esperance.

At 2000, when *Shoal Cape* rendezvoused with *MSC Lugano*, the ship was only about 26 miles south of Twin Rocks. By this stage, it was late at night, the weather conditions were poor and the ship was approaching an area of danger. Therefore, there was now no option but to connect the tow on arrival.

Over the next 19 ½ hours, despite AMSA's intervention and the assistance provided by *Shoal Cape* and later *Greshanne*, *MSC Lugano* continued to drift northwards. It was not until 1535 on 2 April, when *Cape Pasley*'s tow line was also made fast to *MSC Lugano* that the ship began to clear of the coast. It was now less than five miles off Twin Rocks.

The ATSB considers that it would have been reasonable for AMSA to have intervened on 31 March, given that the nearest point of danger was Twin Rocks and an unsurveyed area within the Archipelago of the Recherche, about 60 miles to the north, and that there was some uncertainty surrounding the ship's direction and rate of drift over the next 24 hours.

However, AMSA considers that while the criterion set out in sections 10(1) and 10(2) of the Act had been met, thus allowing the Authority to exercise its powers of intervention, the measures that the Authority considered necessary to take in order to prevent any likely pollution were subject to the principles laid out in section 10(4) of the Act. According to AMSA, the circumstances on 31 March did not justify the issue of a direction order to the Port of Esperance for the release of a harbour tug. The Authority considered that such a measure would not have been proportional to the threatened damage posed by the then drifting ship and that an intervention at that time would have interfered with the rights of *MSC Lugano*'s owners to negotiate towage arrangements and for the Port of Esperance to conduct safe commercial shipping operations. Therefore, AMSA continued to monitor the ship's drift, carried out drift prediction modelling, determined what assets were available to provide towage assistance and assessed the likely impact of removing tugs from the Port of Esperance.

While AMSA did not consider that the disabled ship posed an imminent threat to the environment on 31 March, an appropriate consideration of the effect that the forecast deteriorating weather conditions would have on the ship's predicament should have determined that its rate of drift would increase and that its set would become northerly. It was foreseeable that connecting a tow to the ship in poor weather conditions would be difficult and that the effectiveness of the harbour tugs would decrease as the weather worsened. Had these factors been given sufficient weight when AMSA was deliberating as to when the Authority would direct the tugs to assist the ship, it is possible that AMSA could have come to the conclusion that an intervention on 31 March was a proportional response to the imminent risk posed by the drifting ship. While an intervention at this time may have interfered with the rights of the ship owner, and the port, it is likely that it would have also

increased the likelihood of success in ‘meeting the end sought’, i.e. the prevention of pollution from the ship if it was to ground.

While AMSA’s intervention was ultimately successful, *MSC Lugano* came within five miles of entering a high risk unsurveyed area within the Archipelago of the Recherche. Had AMSA intervened soon after 1737 on 31 March, when the master notified the RCC that *MSC Lugano* was permanently disabled, the ship could have been taken in tow while it was still over 50 miles away from the nearest danger and before the wind and sea conditions had deteriorated significantly. This probably would have reduced the risks to the tugs, their crews and the marine environment.

In submission, AMSA stated:

that its actions to intervene and direct two tugs (*Shoal Cape* and *Greshanne*) to the scene were evidently timely, both in meeting the critical time and distance requirements of the operational situation and in regard to the imminence of damage requirements of the Act.

### 2.6.3 Difficulties encountered by the harbour tugs

Both *Shoal Cape* (an ASD tug<sup>13</sup> with a rated bollard pull<sup>14</sup> of 69 tonnes) and *Cape Pasley* (an ASD tug with a rated bollard pull of 65 tonnes) parted tow lines in their attempts to take *MSC Lugano* in tow. While the tugs were relatively modern and well equipped, they were neither designed nor equipped for the deep sea towage of a ship like *MSC Lugano*, particularly in the rough sea conditions that were encountered on 1 and 2 April.

Neither tug was designated by AMSA as an ‘emergency towage vessel’ and AMSA did not require them to be appropriately equipped for emergency deep sea towage operations. Furthermore, there was no requirement for the crews to have deep sea towage experience or training. When AMSA directed the tugs to assist *MSC Lugano* they were considered to be ‘vessels of opportunity’.

When the tugs sailed from Esperance to assist *MSC Lugano*, they were each equipped with about 400 m of 68 mm diameter 12 strand braided ‘Dyneema’ lightweight synthetic tow line. According to the manufacturer, these light weight lines are stronger than wire rope. They also provide superior flex, fatigue and wear resistance with little elastic elongation (stretch).

These strong lightweight lines are very suitable for harbour towage operations. However, they are not as suitable in deep sea towage applications because of the dynamic movements of vessels in a seaway. In a deep sea towage situation, the tug and the tow are moving independently in the seaway and, as a result, the tow line connecting them is subjected to fluctuating ‘snatch loadings’ as the load comes off the line and then on again. As the sea state increases, these snatch loadings will also increase. Tow lines need to have ample in-built stretch, or weight and length, to accommodate this type of fluctuating load. If not, as was the case of the tow lines on board *Shoal Cape* and *Cape Pasley*, the lines will be unable to withstand the snatch loadings and they will eventually part.

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<sup>13</sup> Azimuth stern drive tug.

<sup>14</sup> The pulling power of a tug expressed in tonnes.

In submission, *Greshanne*'s owner stated:

I believe it is paramount that the Australian Maritime Safety Authority ensures that the money allocated for stand by coastal salvage is firstly and primarily for the purchase and storage of new certified ship heavy tow ropes and associated wires and shackles. If this gear is made available and is stored around the Australian Ports the Rescue Centre can then mobilise tugs, trawlers and small ships to affect a rescue.

Lowering one of *MSC Lugano*'s anchor cables and connecting the tug's tow line to the cable may have reduced the snatch loadings on the lines by creating a deeper catenary. However, the ship's master considered that it was unsafe to break out the anchors in the prevailing weather conditions.

While *Shoal Cape* and *Cape Pasley* were based in Esperance and the most appropriate vessels available to assist with the emergency towage of *MSC Lugano*, they were neither designed nor equipped for the task.





### 3.1 Context

At 1115 on 31 March 2008, a fire broke out in the engine room of the container ship *MSC Lugano*. The crew responded to the fire and, after about 50 minutes, the master decided to operate the fixed CO<sub>2</sub> fire extinguishing system.

By 1600, the crew had determined that the fire was extinguished. The engine room was then ventilated and the crew entered the space to assess the damage. They were able to re-start many of the engine room systems and restore electrical power but they could not re-start the main engine.

The master informed the Australian Rescue Coordination Centre (RCC) that the fire had been extinguished and that the disabled ship was south of Esperance, Western Australia and drifting towards the coast.

The ship's owners entered into an agreement to tow the ship to Fremantle and, at 1910 on 1 April, the tug *Wambiri* departed from Fremantle. Three other tugs, two based in Esperance and one that was in the vicinity towing a barge, were directed by AMSA to assist the ship until *Wambiri* arrived.

By 1245 on 5 April, *Wambiri* had arrived and taken *MSC Lugano* in tow.

### 3.2 Contributing safety factors

- There were deficiencies in the engine room procedures and practices implemented on board *MSC Lugano*. As a result, used oily cotton waste/rags and hot ash from the incinerator furnace were routinely stored in the engine room. [*Safety issue*]
- Some of the ship's crew smoked cigarettes in the engine room and it is likely that this had become the norm although it was in direct contravention of the ship's procedures.
- The crew's attempt to control the fire with the use of fire hoses was ineffective and the delay in closing the skylight allowed the fire to continue to grow in size and intensity.
- The ship's emergency electrical power distribution system did not meet the relevant SOLAS requirements. As a result, the fire interrupted the supply of electrical power to the emergency fire pump. [*Safety issue*]
- The master waited for about 50 minutes before discharging CO<sub>2</sub> into the engine room. As a result, there was far more damage in the engine room than there would have been if he had used it earlier.
- When holes were cut in the engine room decks to create 'sky hooks', the consideration was probably only for the immediate need to lift a piece of machinery. It is likely that the risks associated with cutting the holes in the deck were not appropriately considered.

### 3.3 Other safety factors

- The ship's crew did not keep a record of what actions they took during their emergency response to the fire. As a result, they did not have sufficient information to enable them to make well informed decisions during their response to the emergency.
- It would have been prudent for *MSC Lugano*'s master to wait for a longer period of time, certainly more than 105 minutes, before re-entering the engine room.
- *MSC Lugano*'s safety management system gave the master no guidance as to how long to wait before entering the engine room following the release of carbon dioxide into the space. [Safety issue]
- The action taken by *MSC Lugano*'s master and its owners in their response to the disabled ship's predicament, arranging for the ship to be towed to Fremantle, was not sufficient to ensure the safety of the ship and its crew or the protection of the marine environment.
- On the afternoon of 31 March, the available information indicated that *MSC Lugano* may ground before the arrival of the salvage tug from Fremantle in four days time. However, the Australian Maritime Safety Authority waited a further 23 hours before issuing an intervention direction because of the Authority's concern to comply with the principles of the *Protection of the Sea (Powers of Intervention) Act 1981*. [Safety issue]
- The Esperance based tugs *Shoal Cape* and *Cape Pasley* were neither designed nor equipped for the deep sea towage of a ship like *MSC Lugano*, particularly in the rough sea conditions that were encountered on 1 and 2 April. [Safety issue]

### 3.4 Other key findings

- The master's initial notification was sent as part of an Australian Ship Reporting System (AUSREP) message. However, given the severity of the situation, an urgency message should have been sent directly to the Australian Rescue Coordination Centre (RCC).

### 4.1 **Safety action taken by the Australian Maritime Safety Authority**

The ATSB has been advised that the following safety action has been taken by the Australian Maritime Safety Authority (AMSA) following this incident.

A post-incident debrief hosted by the Esperance Port Authority and including the Western Australian Department of Primary Industry (DPI), the Esperance Port Authority and Mackenzie's Tug Services, concluded that the towage equipment on *Shoal Cape* were not the most appropriate for a direct-line tow in the prevailing weather conditions. As a result AMSA will review the "vessels of opportunity" component of its emergency towage vessel program, in regards to both towage equipment and communications.

The post-incident debrief also examined the conduct of the overall response to identify opportunities for improvement by all agencies involved in the incident. Arising from this analysis, AMSA agreed to:

- Review its assessment procedures in light of the incident, in particular the time period over which weather forecasting and modelling are conducted.
- Review its procedures to monitor the negotiations involving shipowners and ship masters with potential salvors/towage providers to encourage the parties to make appropriate contractual arrangements for the safe resolution of any given incident.

AMSA is undertaking action to implement these improvements to its emergency response strategy.

AMSA also notes that Marine Notice 6 of 2007, *National Maritime Emergency Response Arrangements (NMEMA) implementation*, issued in February 2007 provided advice to the maritime industry about AMSA's revised powers of intervention under the NMEMA. In consideration of the issues raised by the ATSB, AMSA intends re-issuing the Marine Notice emphasising the responsibility of ship owners and masters to resolve shipping incidents on a commercial basis with salvage or towage providers. It will confirm that AMSA's powers of intervention are exercised where shipowners and masters do not take timely action consistent with Australia's national interest. It will remind ship owners and masters of their obligation to report incidents and accidents to AMSA at the earliest opportunity when the ship is experiencing difficulties to ensure action can be considered and taken to prevent a potential casualty. It will draw attention to the various stakeholder interests that AMSA is required to balance in the exercise of its intervention powers in accordance with the statutory principles in the *Protection of the Sea (Powers of Intervention) Act 1981* and in line with the NMEMA Inter-Governmental Agreement.

## 4.2 Safety action taken by the American Bureau of Shipping

The ATSB has been advised that the following safety action has been taken by the American Bureau of Shipping (ABS) following this incident.

The cables to the emergency fire pump on board *MSC Lugano* have been renewed with fire resistant cables and they are now routed outside the engine room. The Bureau is also reviewing its files to determine any sister vessels which may require modifications if found with similar arrangements.

## 4.3 Safety action taken by Mackenzie's Tug Service

The ATSB has been advised that the following safety action has been taken by Mackenzie's Tug Service following this incident.

The company has purchased two 220 m lengths of 115 mm polypropylene line that are readily available for use by its tugs if they are again called upon to assist with an emergency towage operation.

## 4.4 ATSB safety advisory notices

### MS20090001

*MSC Lugano*'s safety management system gave the master no guidance as to how long to wait before entering the engine room following the release of carbon dioxide into the space.

The Australian Transport Safety Bureau advises that owners, managers and masters should consider the safety implications of this safety issue and to take action where considered appropriate.

### MS20090002

There were deficiencies in the engine room procedures and practices implemented on board *MSC Lugano*. Used oily cotton waste and rags were routinely stored in the engine room, as was hot ash from the incinerator furnace. Furthermore, some of the crew smoked cigarettes in the engine room.

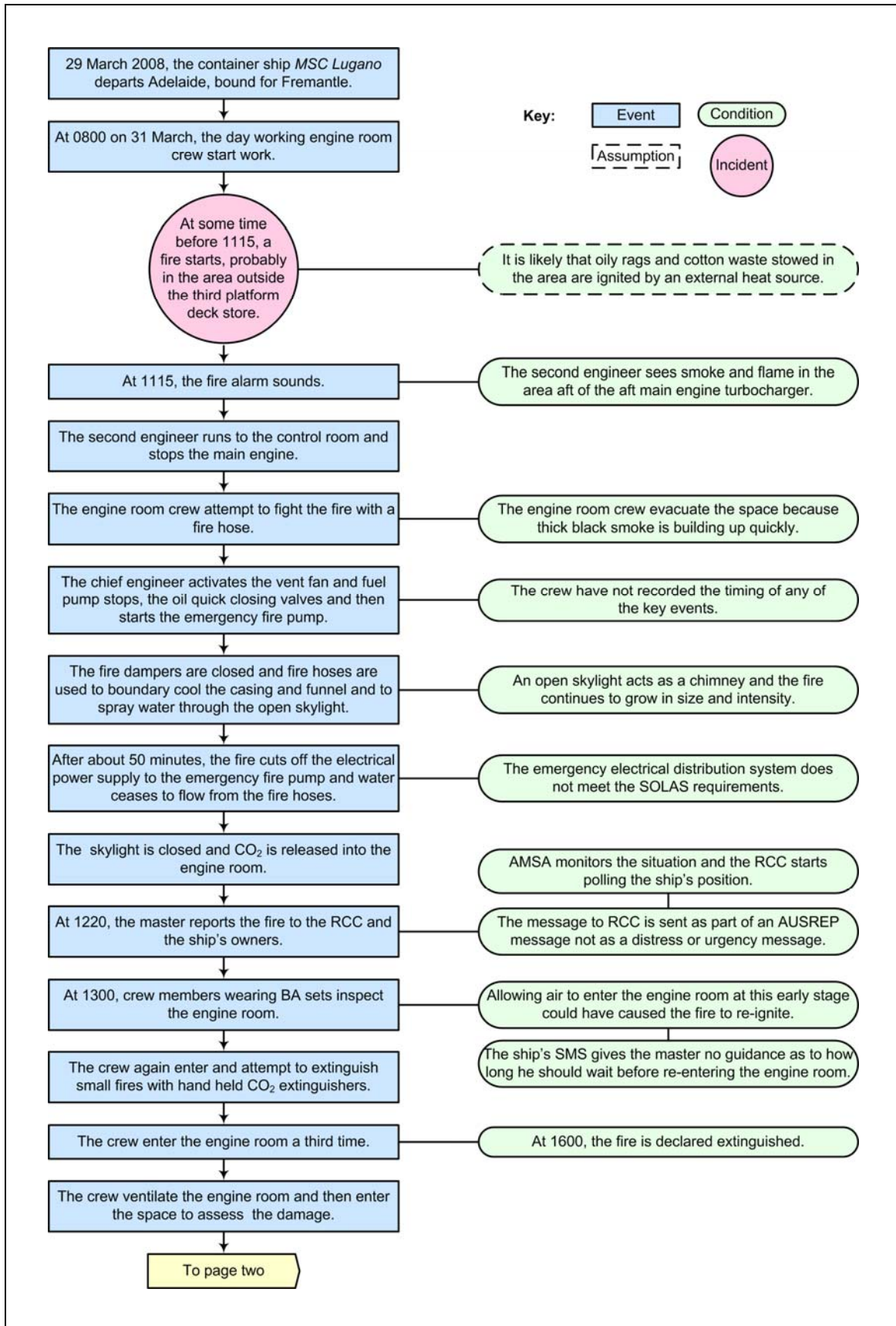
The Australian Transport Safety Bureau advises that owners, managers and masters should consider the safety implications of this safety issue and to take action where considered appropriate.

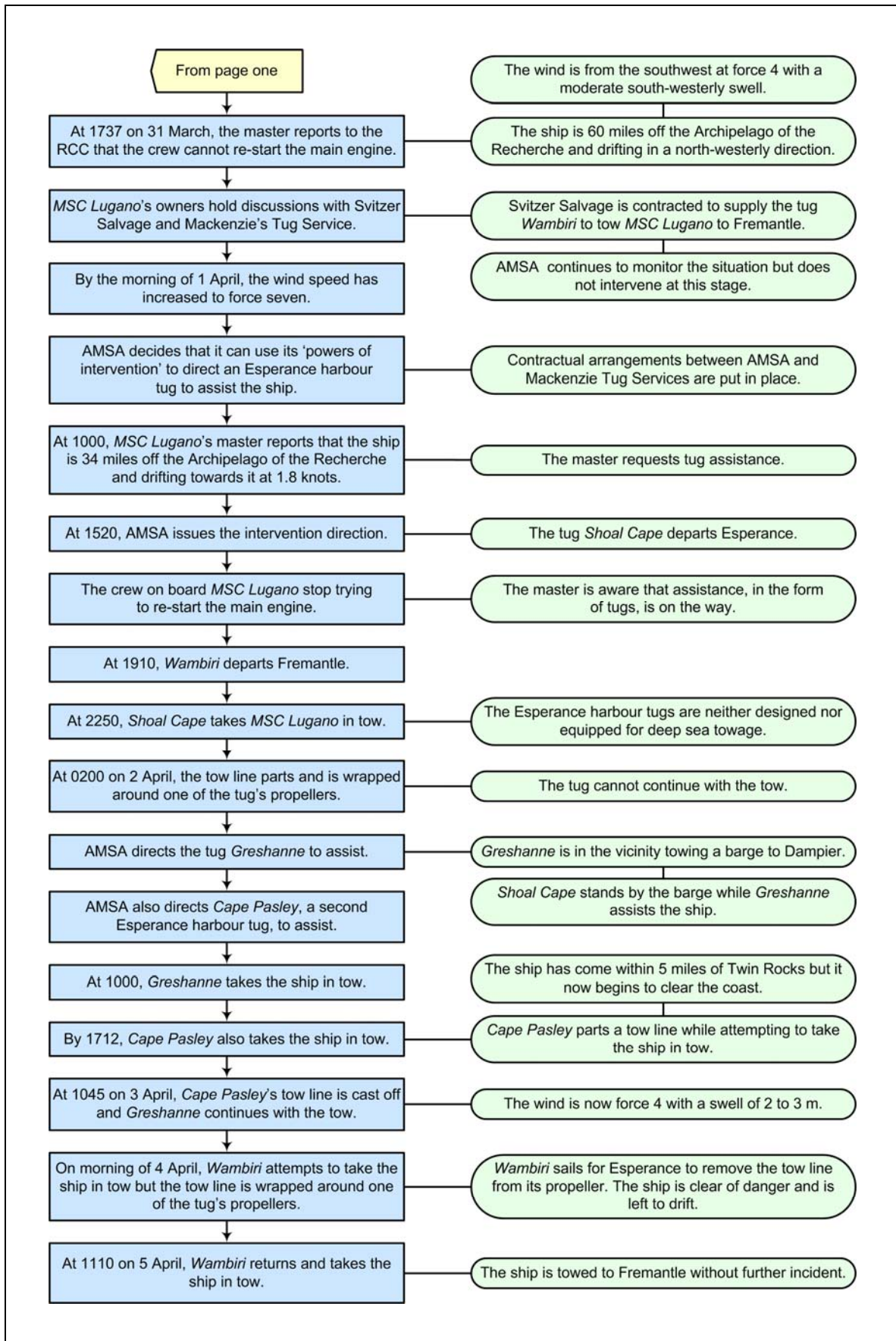
### MS20090003

The Esperance based tugs *Shoal Cape* and *Cape Pasley* were neither designed nor equipped for the deep sea towage of a ship like *MSC Lugano*, particularly in the rough sea conditions that were encountered on 1 and 2 April.

The Australian Transport Safety Bureau advises that towage vessel operators should consider the safety implications of this safety issue and to take action where considered appropriate.

# APPENDIX A : EVENTS AND CONDITIONS





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## APPENDIX B : SHIP INFORMATION

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### ***MSC Lugano***

IMO Number	8714217
Call sign	V7NM2
Flag	Marshall Islands
Port of Registry	Majuro
Classification society	American Bureau of Shipping (ABS)
Ship Type	Container ship
Builder	Daewoo Shipbuilding and Heavy Machinery
Year built	1988
Owners	Castor Trading Company, Greece
Ship managers	Transman Shipmanagers, Greece
Capacity (TEU)	3032
Gross tonnage	35 958
Deadweight (summer)	42 978 tonnes
Summer draught	11.73 m
Length overall	240.0 m
Length between perpendiculars	224.0 m
Moulded breadth	32.2 m
Moulded depth	19.0 m
Engine	Sulzer 7RTA84
Total power	23 173 kW
Crew	24





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## APPENDIX C : SOURCES AND SUBMISSIONS

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### Sources of information

The master and crew of *MSC Lugano*

The Australian Maritime Safety Authority

Mackenzie's Tug Service

Tas Ocean Shipping

Svitzer Salvage Australasia

### References

Rushbrook's Fire Aboard, Third Edition 1998

SOLAS, Consolidated Edition 2001

Transport and Communications, Marine Operations, Investigation Report No. 27

The Commonwealth of the Bahamas, Report of the investigation into the fire in the engine room of the Livestock Carrier "BADER III" on 21 April 2000

The Inter-governmental Agreement on the National Maritime Emergency Response Arrangement, 2006

### Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the Executive Director may provide a draft report, on a confidential basis, to any person whom the Executive Director considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the Executive Director about the draft report.

The final draft of this report was sent to the Australian Maritime Safety Authority (AMSA), Marshall Islands International Registries, the American Bureau of Shipping (ABS), Mackenzie Tug Services, Tas Ocean Shipping, Svitzer Salvage Australasia, Transman Shipmanagers and *MSC Lugano*'s master, chief engineer and second engineer.

Submissions were received from AMSA, ABS, Mackenzie Tug Services, Tas Ocean Shipping and Transman Shipmanagers. The submissions have been included and/or the text of the report was amended where appropriate.



Independent investigation into the engine room fire on board the Marshall Islands registered container ship *MSC Lugano* off Esperance, Western Australia,, 31 March 2008.