Australian Government
Australian Transport Safety Bureau

Engine room fire on board the bulk carrier *Marigold*

Port Hedland, Western Australia, 13 July 2014

ATSB Transport Safety Report
Marine Occurrence Investigation
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Addendum

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The occurrence

The information contained in this preliminary report is released in accordance with section 25 of the Transport Safety Investigation Act 2003 and is derived from the ongoing investigation of the occurrence. Readers are cautioned that new evidence will become available as the investigation progresses that will enhance the ATSB's understanding of the accident as outlined in this preliminary report. As such, no analysis or findings are included in this report.

At 0145[1] on 13 July 2014, the 309 m long bulk carrier *Marigold* (Figure 1) berthed at Finucane Island B berth, in Port Hedland. The loading of iron ore started at 0600 and it was expected to be completed the next day.

Figure 1: *Marigold* at Port Hedland

Source: Port Hedland Pilots

As cargo loading progressed, the ship's water ballast tanks were gradually emptied. Electrical power for the ballast pumps and various services was supplied by the ship's number one and number two diesel generators.[2]

At 1300, *Marigold*'s engineers and engine room ratings met in the engine control room (ECR). The chief engineer assigned them work, which included routine checks in preparation for the ship's departure from port. To progress the work, they split into three separate work teams (Figure 2).

At 1420, a third generator, number three, was started to meet power requirements.

Fire alarms

At about 1447, the fire alarms began sounding throughout the ship indicating a fire in the engine room. The chief engineer, who was in the ECR, went to investigate and saw smoke coming from deck 3. He attempted to use a portable fire extinguisher but could not get sufficiently close to the fire because of the smoke. He returned to the ECR and phoned the duty seaman on the bridge, confirming that there was a fire in the engine room.

The master and second mate went to the ship's bridge, where the duty seaman informed them of the reported fire. The second mate made an announcement on the ship's public address system, directing all crew to their muster stations and to prepare to fight a fire in the engine room. By that time (about 1448), cargo operations had been stopped.

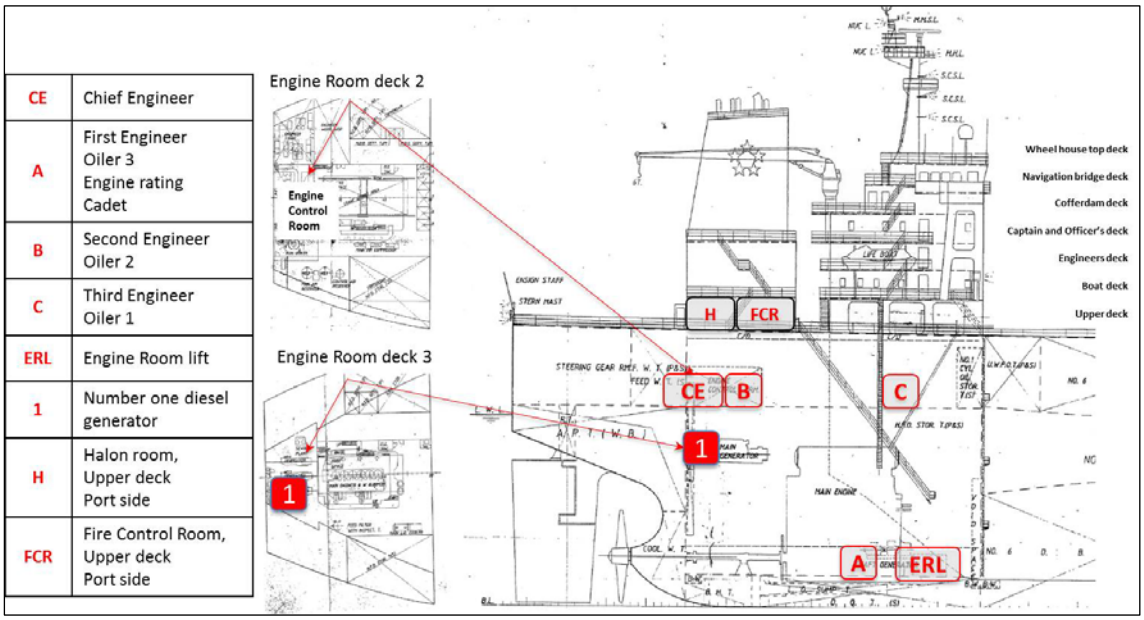
When the first engineer realised that there was a fire, he told his team members to leave the engine room using the engine room lift. He could smell smoke and decided to locate the seat of

[1] All times referred to in this report are local time, Coordinated Universal Time (UTC) + 8 hours.

[2] Diesel engine driven generators that provide the ship's electrical power.

the fire. Meanwhile, the third engineer and oiler 1 began making their way to the ECR. However, they became separated after the oiler became disoriented in the smoke.

Figure 2: Diagram showing crew locations in the engine room when the fire started



Source: ATSB

At 1450, the master reported the fire to the Port Hedland shipping control tower (SCT) and asked for immediate assistance. In turn, the SCT notified and requested the volunteer fire and emergency services (VFSR), BHP Billiton emergency services, Port Hedland pilots, harbour tugs and the local police to respond to the emergency.

Meanwhile in the engine room, the first engineer reached deck 3 but could see little in the dense smoke. He located the ECR windows and banged on them to attract attention until he was pulled in through the ECR door by those inside.

At 1453, the chief, first, second and third engineers and oiler 2 left the engine room through the steering gear room (Figure 2). Oiler 1 took a different exit route and came out through the forward funnel door. He was the last crew member to be accounted for at the muster stations.

At 1500, *Marigold*'s master ordered all engine room fire dampers and quick-closing valves[3] (QCV) to be closed. A fire hose for boundary cooling[4] the engine room was also prepared.

At 1501, the ship blacked out as number one, two and three diesel generators shut down. Shortly afterwards, the emergency generator started and supplied power to the emergency switchboard.

It was not until 1517 that the chief engineer reported that all dampers and QCVs had been closed. The master confirmed all crew had been accounted for and ordered the engine room Halon gas fixed fire suppression system (Halon system) to be deployed.

Emergency services arrival

At about 1520, the emergency services arrived at Finucane Island north gate, while two harbour pilots boarded *Marigold* from a pilot boat. The pilots were briefed on the bridge about the situation, where one of them remained to assist with ship-shore communications. To provide on scene

[3] Remotely operated pneumatic quick closing valves to shut off the fuel supply to machinery in case of emergency.

[4] Cooling of the structure around the fire origin to lower the temperature and reduce heat transfer to adjacent compartments.

updates and to advise the crew, the other pilot went to the crew's muster station on the upper deck (Figure 2).

The chief engineer advised him the Halon system had been deployed. The pilot decided to visually check the system and opened the door of the Halon room (where the gas bottles were stored). He saw that there was a significant amount of Halon gas inside the room.

Two crew members at the muster station appeared to be suffering from smoke inhalation, and with dense smoke emissions from the engine room hatches, funnel fire dampers and accommodation block doors nearby, the pilot asked the crew to relocate away from the smoke. Medical assistance for the smoke affected crew was then requested by his colleague on the bridge.

At 1525, two harbour tugs began boundary cooling *Marigold* 's starboard quarter. The emergency generator was shut down to prevent the boundary cooling water from entering its air intakes.

Meanwhile, the ship's crew attempted to boundary cool the area above the fire. However, they were unsuccessful because by then, there was no power to supply the emergency fire pump.

At about this time, the BHP Billiton emergency services supervisor (ESS) arrived at the berth and, once briefed, assumed the role of the shore response on-scene incident controller. After the pilot on the upper deck and the ESS exchanged information, the ship's crew was asked to assist in lifting shore fire equipment on board the ship. A paramedic was also arranged to board the ship via a work boat to attend to the smoke affected first engineer and oiler 1.

At about 1550, preparations for the evacuation of both smoke affected crew members began and they were subsequently evacuated from the ship by helicopter and then taken to the local hospital for treatment.

At 1610, four BHP Billiton emergency services officers (ESO) boarded *Marigold* with breathing apparatus (BA). Another harbour pilot also boarded to assist with communications. They set up a forward staging area near the accommodation block on the upper deck and planned an engine room entry.

Shortly afterwards, the ESS was informed that a Department of Fire and Emergency Services (DFES) team from a neighbouring town was expected on scene at 1730. The ESS then stood down the VFSR team.

At 1648, two ESOs using BA and carrying a pressurised fire hose entered the steering gear room from the main deck. After passing through two fire doors, they succeeded in entering the adjoining ECR. However, the fire hose was not long enough for the ESOs to go any further.

At about the same time, the DFES district officer (DO) phoned the ESS and instructed him to ensure that no one entered the engine room, close all doors and hatches and start recording temperatures.

Shortly after, the ESOs were withdrawn from the engine room and the ship's master decided to disembark non-essential crew.

At about 1730, the DO and his team arrived at the berth and were briefed by the ESS. About 10 minutes later, the ESOs reported smoke was once again coming from the engine room.

Shortly afterwards, the pilots raised concerns that the ship's mooring lines needed to be tended with the rising tide. Without electrical power, they needed to be manually handled so the master recalled the crew sent ashore.

By 1820, the ESOs reported that temperatures had stabilised and the tugs suspended boundary cooling. However, smoke emissions from the engine room soon increased and the tugs resumed boundary cooling.

At 2015, the DO took over as incident controller of the shore response from the ESS. At 2045, the DO boarded *Marigold* and began assessing the situation.

At 2116, the ESOs reported increasing temperatures and heavy smoke from the engine room. The DO called the SCT and asked that 20 m^3 of CO_2 be arranged to suppress the fire. In response, the SCT also informed the Port Hedland harbour master who then recalled BHP Billiton emergency services to the scene. Engine room boundary cooling was maintained.

At 2233, *Marigold* 's master and chief engineer, accompanied by the pilots, inspected the Halon room. They found that of the two banks of Halon bottles, one bank had been partially released and the other bank had not been released at all. They also found that only one of the two Halon gas distribution valves to the engine room had opened. The chief engineer attempted to manually release the remaining Halon bottles but was unsuccessful.

Meanwhile, with no regional DFES capability for fighting ship board fires, specialised 'vessel entry' fire fighters were mobilised to fly up from Perth (about 1,650 km from Port Hedland) on the following day.

Shortly after midnight, the DO and a pilot using BA entered the steering gear room. They closed both fire doors leading into the ECR to better seal the engine room.

Boundary cooling continued throughout the night and engine room temperatures remained steady.

Fire burnt out

At 1330 on 14 July, specialist fire fighters boarded *Marigold* and confirmed that the fire had burnt out, so the CO_2 arranged earlier was not used. Later that evening at 1912, an inspection of the engine room found significant damage to the generators, electrical system, wiring and switchboards throughout the ECR.

Additionally, an inspection of the ship's accommodation block found considerable smoke damage throughout, with soot making the accommodation uninhabitable.

Once it was considered safe, the emergency generator was started and supplied power to essential services and ventilation of the engine room and accommodation was commenced.

At 2000 on 15 July, engine room and accommodation atmosphere tests by DFES indicated that respiratory equipment was required for entry to those spaces.

At 1045 on 16 July, the DO handed over charge to the Port Hedland harbour master.

On 17 July, two shore generators were moved onto the ship to power forward and aft mooring winches, temporary lighting and steering gear.

At 1330 on 19 July, *Marigold* departed Finucane Island B berth with pilots on board and eight tugs in attendance. The ship was moved to an anchorage outside the port awaiting towage for repairs at a suitable port.

On 23 July, *Marigold* was taken in tow by a salvage tug from the anchorage, bound for Singapore.

Context

The fire

On 13 July, a fire started in the engine room of *Marigold* while the ship was berthed at Port Hedland. The evidence indicates that a fuel oil pipe coupling on number one diesel generator had failed. Pressurised fuel oil and mist from the coupling ignited and resulted in a fire around the generator turbocharger.

Attempted firefighting measures included deploying the ship's Halon gas fixed fire suppression system for the engine room. However, a full release of Halon gas did not occur and the engine room was not properly closed. Consequently, the fire continued for about 12 hours until it burnt itself out.

Marigold

At the time of the incident, *Marigold* was registered in Panama, classed with Korean Register of Shipping (KR) and managed by Korea Line Corporation, South Korea.

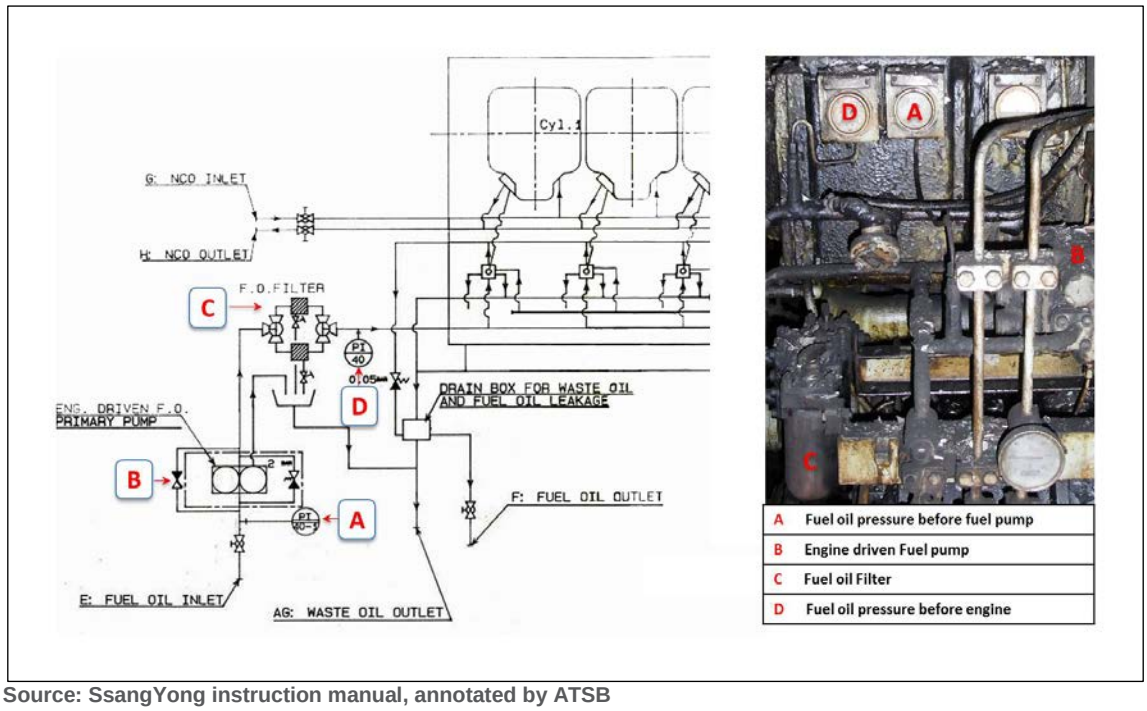
The ship had a crew of 23 Korean and Burmese nationals all of whom were appropriately qualified for the positions they held on board the ship.

The master had 30 years of seagoing experience, including 12 years as master on large bulk carriers. He had joined *Marigold* about 2 months before the incident.

Diesel generators

Marigold was equipped with three Ssangyong MAN B&W medium speed, turbocharged, six cylinder diesel engine driven generators, each providing 650 kW of electrical power. The generators were located on engine room deck 3, directly below the ECR.

Figure 3: Diesel generator fuel oil supply system



Source: SsangYong instruction manual, annotated by ATSB

The generator fuel system (Figure 3) included a feed pump to supply fuel oil from a service tank. A camshaft-driven low pressure fuel pump supplied fuel to the main injection pumps via a duplex filter. The condition of the fuel filters was monitored by two pressure gauges (as shown in Figure 3) to indicate the fuel pressure before and after the filter.

Halon system

Marigold's engine room was protected by a Halon 1301 fixed fire suppression system (Figure 4). Halon 1301 (Halon), the common name for bromotrifluoromethane, is a colourless, odourless gas about five times denser than air. Halon chemically reacts in a fire to inhibit the combustion process and has excellent fire extinguishing properties. Halon is known as a clean agent because it leaves no residue. The gas also has low toxicity.

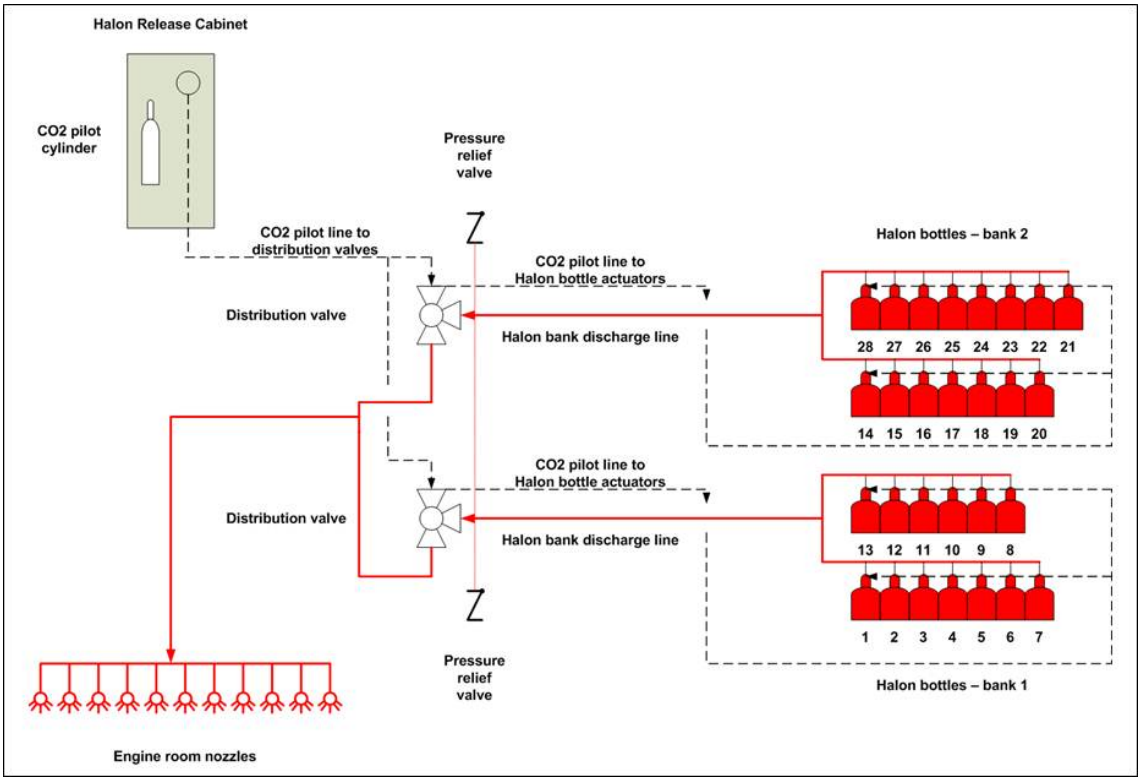
The Halon was stored under pressure in two banks of cylinders in the Halon room, located on the port side of the upper deck (Figure 2). The system was designed to simultaneously discharge gas into a common manifold system leading to the engine room Halon discharge nozzles.

Release of Halon from the cylinders and operation of the distribution valves utilised a carbon dioxide (CO_2) pilot system. The pilot CO_2 cylinders were located in two identical control boxes in the Halon room and the fire control station.

When the door of a control box is opened, a switch activates audible and visual alarms in the engine room and stops its ventilation fans. Pilot CO_2 is then manually discharged to pneumatic actuators of the engine room distribution valves and then to the pressure actuators on the Halon cylinders. Halon is then discharged from twenty-eight, 130 litre cylinders into the engine room via the distribution valves.

The Halon system operating instructions were posted in the Halon room and fire control station. The instructions stated that no one was to enter the protected area in which a fire has been extinguished until it is certain that there is no danger of re-ignition.

Figure 4: *Marigold*'s Halon fire suppression system



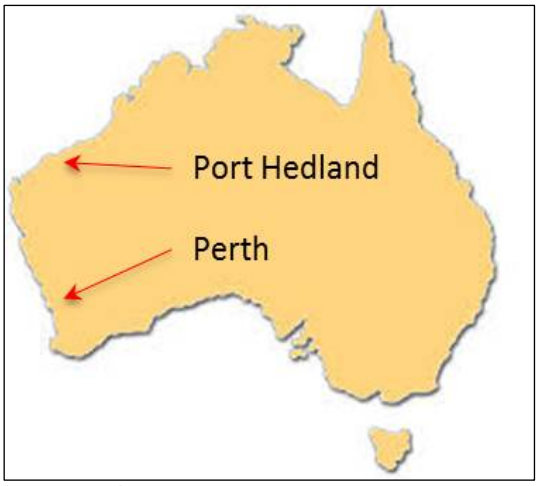
Source: ATSB

Port Hedland

Port Hedland (Figure 5) is Australia's largest bulk cargo port. It is located on the north-west coast of Western Australia and services the mineral rich Pilbara region. The port's major export commodity is iron ore. In the financial year ending 30 June 2014, more than 372 million tonnes of iron ore was exported on over 2,500 ships.

Port Hedland has 16 berths, including 12 privately owned iron ore berths. The port has a single shipping channel. Pilbara Ports Authority is responsible for the safety and efficiency of shipping in the port and waters, for which it has overall responsibility for planning and development.

Figure 5: Port Hedland



Source: ATSB

Responsibility for Fire Fighting

Pilbara Ports Authority (PPA) has an emergency response plan for events of major significance that may occur in Port Hedland.

If a ship's master raises the alarm and requests assistance from the Port Hedland Shipping Control Tower (SCT), the plan is used as guidance for the initial response to an emergency incident within port limits.

The callout procedures required the nominated emergency services to be alerted and the helicopter and medical services to be put on standby.

While a ship's master maintains responsibility for firefighting on board, when shore assistance is required, overall control of firefighting is carried out under the harbour master's authority.

Responsibility for deciding on the course of action to be taken once the extent and nature of the emergency is fully known rests with the incident controller from the lead combat agency.

Subsequently, future actions will be determined by the responsible officers when they arrive on the scene.

Ongoing investigation

The investigation is ongoing and areas of focus will include:

- confirming the cause of the fire
- reason/s for the partial failure of the Halon system
- maintenance of the ship's firefighting equipment and appliances
- ship's emergency response, including preparedness
- shore emergency response, including coordination and capability

General details

Occurrence details

Date and time:	13 July 2014 – 1450, UTC + 8 hours	
Occurrence category:	Serious Incident	
Primary occurrence type:	Fire	
Location:	Port Hedland, Western Australia	
	Latitude: 20° 18' S	Longitude: 118° 34' E

Ship details

Name	*Marigold*
IMO number	8815255
Call sign	3FEE7
Flag	Panama
Classification society	Korean Register of Shipping (KR)
Ship type	Bulk carrier
Builder	Hyundai Heavy Industries, Ulsan, Korea
Year built	1990
Owner(s)	Tiger United S.A.
Operator	Korea Line Corporation
Manager	KLCSM Co. Ltd
Gross tonnage	110,779
Deadweight (summer)	207,250
Summer draught	18.019 m
Length overall	309.0 m
Moulded breadth	50.00 m
Moulded depth	25.70 m
Main engine(s)	B&W 6L80MCE
Total power	12,181 kW MCR: 12,181 kW (16,561 hp) at 72 rpm
Speed	14.80 knots
Damage	Significant damage to the generators, electrical system, wiring and switchboards throughout the engine room and engine control room.

Sources and submissions

Sources of information

On 15 July 2014, investigators from the Australian Transport Safety Bureau (ATSB) attended *Marigold* while the ship was berthed in Port Hedland. The master and directly involved crew members were interviewed and each provided their account of the incident. Photographs of the ship and copies of relevant documents were obtained, including log books, statutory certificates, reports, manuals and procedures. In addition, Port Hedland's harbour master and shipping superintendent, Port Hedland Pilots, BHB Billiton marine manager and emergency services supervisors provided accounts of the incident, copies of reports, procedures and related documents.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

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 identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, 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 initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.