



Australian Government

Australian Transport Safety Bureau

Breakaway of *Spirit of Tasmania II*

Station Pier, Port Melbourne, Victoria 13 January 2016

ATSB Transport Safety Report

Marine Occurrence Investigation

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Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

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Addendum

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Safety summary

What happened

On the afternoon of 13 January 2016, the roll-on/roll-off passenger ship *Spirit of Tasmania II* was loading cargo, vehicles and passengers at Station Pier, Melbourne. At 1752, strong wind gusts blew the ship off the wharf and all but two of the ship's mooring lines (on the bow) parted. After breaking away, the stern swung around until the ship was 90 degrees to the wharf, parallel to nearby Port Melbourne Beach and in danger of grounding. While waiting for tugs to assist, the ship's propulsion and thrusters were used to maintain its position and prevent grounding. By 1905, the ship was back alongside the wharf, assisted by two tugs.

The ship suffered minor damage to its lower bow ramp and bow doors. Shore infrastructure suffered extensive damage to the elevated roadway and ramp arrangement on the wharf and minor damage to wharf structures. No one was injured.

What the ATSB found

During the afternoon of 13 January, a band of severe thunderstorms passed across the location of *Spirit of Tasmania II*, with little warning. As the ship's bridge was unattended throughout the port stay, none of its crew saw indicators of the approaching storm until just before the breakaway.

The ship's crew responded swiftly. The bridge was manned and machinery was operational by the time the ship had turned 90 degrees to the wharf. The ship's movement was then controlled using its thrusters and main propulsion until, with tug assistance, it was returned to the wharf.

What's been done as a result

The ship's managers, TT-Line Company, advised the ATSB that it has implemented immediate changes to shipboard weather monitoring and notification arrangements along with changes to heavy weather and mooring procedures. These changes include: weather triggers for increased shipboard readiness; immediate notification of weather warnings; access to the Bureau of Meteorology (BoM) website from the bridge; changes to the wind speed alarm settings and; requiring all mooring lines to be held on the winch brakes.

TT-Line also engaged external marine consultants to complete extensive investigations and analyses into the mooring requirements and design for Station Pier. The consultants have completed mathematical modelling and incident replication simulations. Subsequent analyses will be used to identify and define operational parameters and recommend any alterations to berthing arrangements and infrastructure. The ATSB has issued one recommendation to TT-Line to complete safety action to adequately address the safety issue with respect to moorings.

The Victorian Ports Corporation (Melbourne) advised the ATSB that Melbourne vessel traffic service will broadcast BoM weather warnings on VHF channel 12. All masters of ships in port waters, including at berth or anchorage, are to ensure a listening watch is maintained at all times.

The BoM advised the ATSB that in addition to verifying the subscription service with the Victorian Ports Corporation (Melbourne) it continues to upgrade its marine weather services. This includes a one-stop webpage on its website for improved education, information and accessibility to marine and ocean services.

Safety message

All ships, especially those with high windage, are prone to breaking away from moorings during short-term events such as thunderstorms and squalls. The risks this presents to ships with large numbers of people on board mean that weather monitoring, mooring systems and procedures need to be regularly checked and verified for changing weather conditions.

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The occurrence

At 0600 on 13 January 2016, the roll-on/roll-off passenger ship *Spirit of Tasmania II* (Figure 1) berthed at Station Pier in the Port of Melbourne. The ship had just completed its usual, scheduled Bass Strait transit from Devonport, Tasmania to Melbourne, Victoria.

Figure 1: *Spirit of Tasmania II*'s upper and lower bow ramps deployed at Station Pier



Source: Australian Pictorials

A 'strong wind warning'¹ for Port Phillip was in effect and had been re-issued at 0527 and 1041 that morning. The warnings noted the risk of afternoon and evening thunderstorms with squalls to 45 knots.² The master was aware of these warnings, and also knew a 'cold front'³ was expected to pass across the port at about 2100 that evening. Departure was scheduled for 1930 and, as a precaution, the master had instructed that two of the ship's four main engines be ready for manoeuvring at immediate notice from 1600.

After the ship had berthed, unloading of cargo, vehicles and passengers started and continued into the afternoon. As usual, *Spirit of Tasmania II* was to load cargo and vehicles via its bow, using a lower and an upper vehicle ramp (Figure 1). At about 1600, unloading was completed and the loading of cargo and vehicles started.

The master slept from 1330 onwards to rest for *Spirit of Tasmania II*'s evening sailing. At 1630, he awoke and attended to some administrative tasks. He also checked the Bureau of Meteorology (BoM) website and noted little change to the weather forecast. At about 1700, when he went to the navigation bridge (bridge), the weather situation appeared normal and as expected. At the time, the wind was about 20 knots from the west and it was cloudy and hot (44°C).

At about 1730, passengers began boarding – those with cars drove on board via the lower vehicle ramp while others boarded via the aft passenger access. The ship's managers and master had

¹ The Bureau of Meteorology (BoM) defines strong winds as those with a 10-minute average speed between 26 and 33 knots. <www.bom.gov.au>

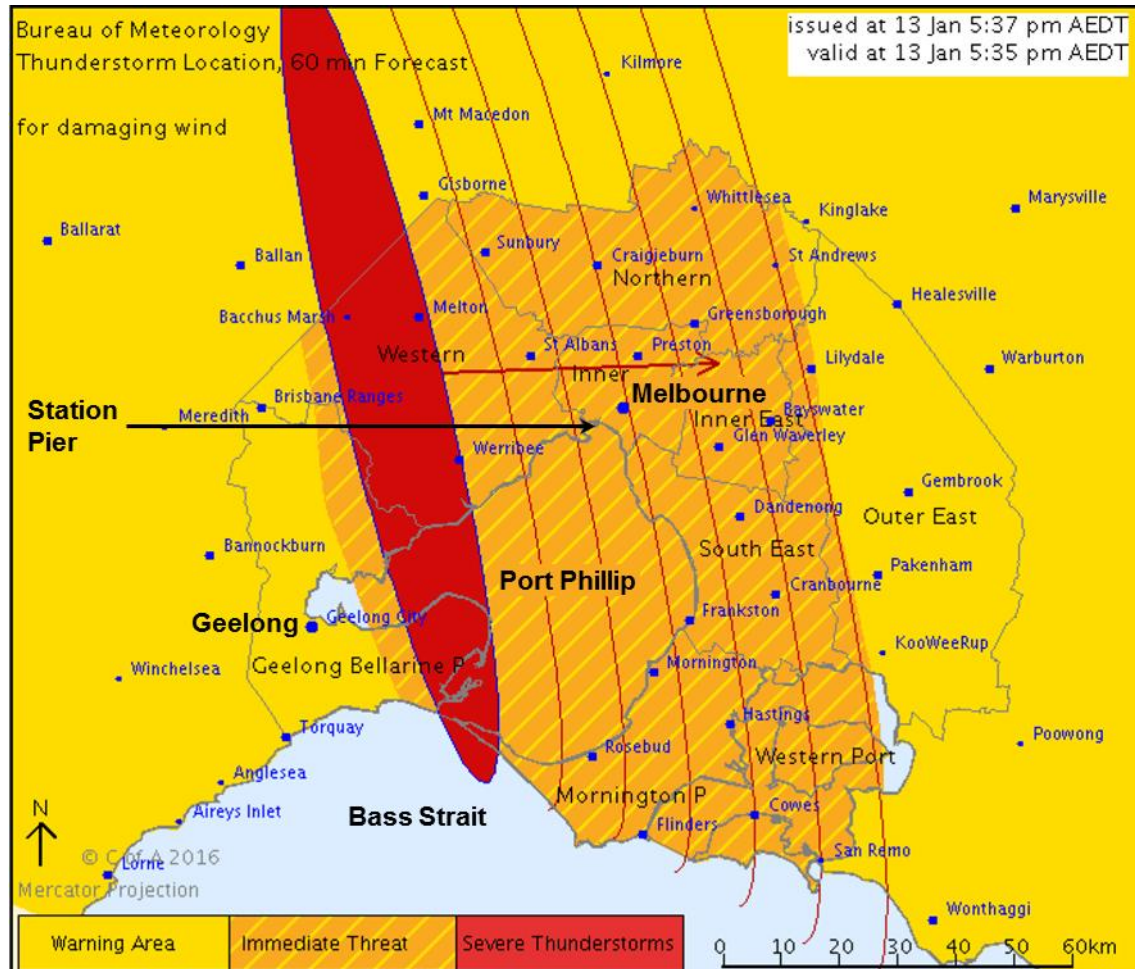
² One knot, or one nautical mile per hour, equals 1.852 kilometres per hour.

³ The boundary between an approaching cool air mass and a warm air mass. The air behind the front is colder, drier and denser than the air preceding it. This cold air pushes under the warm moist air lifting it higher in the atmosphere and can produce cloud, causing rain bands, showers or thunderstorms to form, generally within 100 kilometres of the front.

agreed to board the waiting passengers about 30 minutes earlier than usual because it had been a hot day.

It was not until shortly after 1745 that the master returned to his cabin and again checked the BoM website (no internet access was available on the bridge). He saw that a 'severe thunderstorm warning'⁴ had been issued at 1737. The website indicated a series of thunderstorms approaching Station Pier from about 13 miles⁵ to the west (Figure 2).

Figure 2: Map issued with the severe thunderstorm warning at 1737 on 13 January



Source: Bureau of Meteorology, annotations by ATSB

At about the same time, the second mate (the duty officer) was on the main vehicle deck attending to loading of cars into the main and lower decks. Vehicle traffic had been stopped on the landside of the ship's bow ramp as traffic had banked up in the vehicle deck.

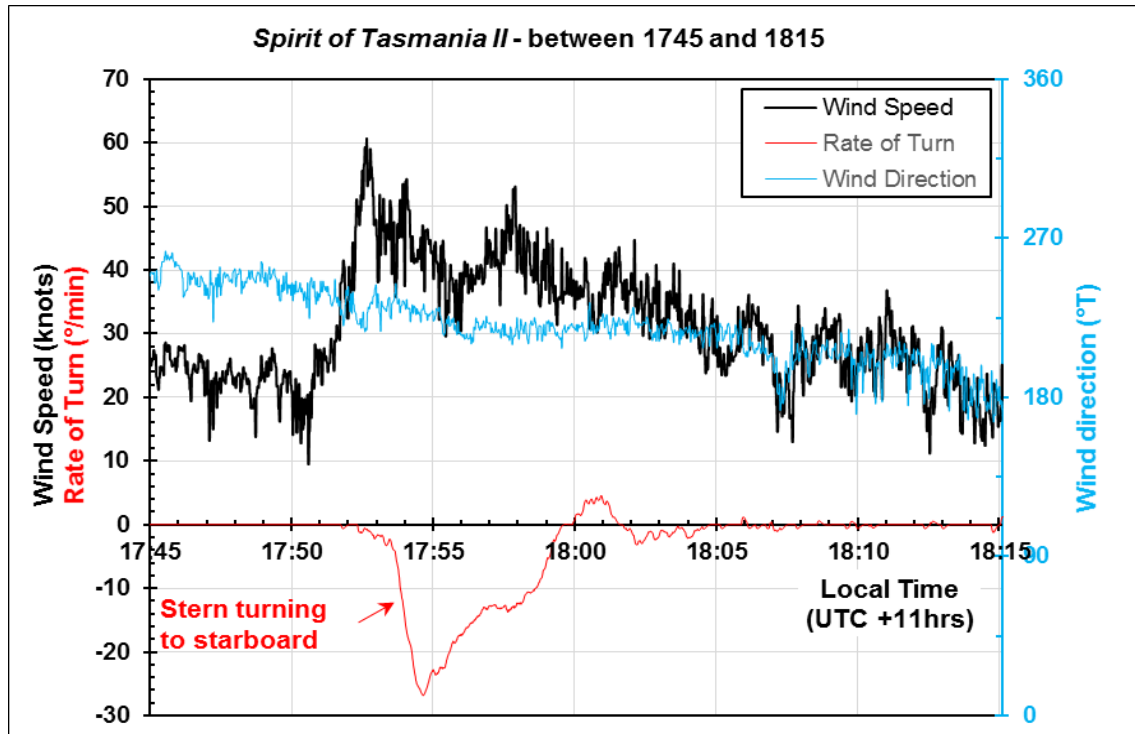
The second mate noticed a breeze coming in through the open pilot access door in the ship's side. He called the chief mate via radio and informed him that the wind had picked up, suggesting that the change in weather may have arrived. He closed the passenger door/ramp and pilot access door.

Shortly after, as the master left his cabin to go to the bridge, he saw the wind speed indicator outside his cabin indicated gusts of up to 59 knots. He hurried to the bridge. At 1753, the wind peaked at 60.5 knots (112 km/h) from the southwest (Figure 3). By then, about 120 passengers had boarded and the ship's stern had started to move off the wharf.

⁴ The BoM defines a severe thunderstorm as one that produces, amongst other criteria, damaging wind gusts, generally exceeding 48.6 knots (90 km/h).

⁵ A nautical mile of 1,852 m.

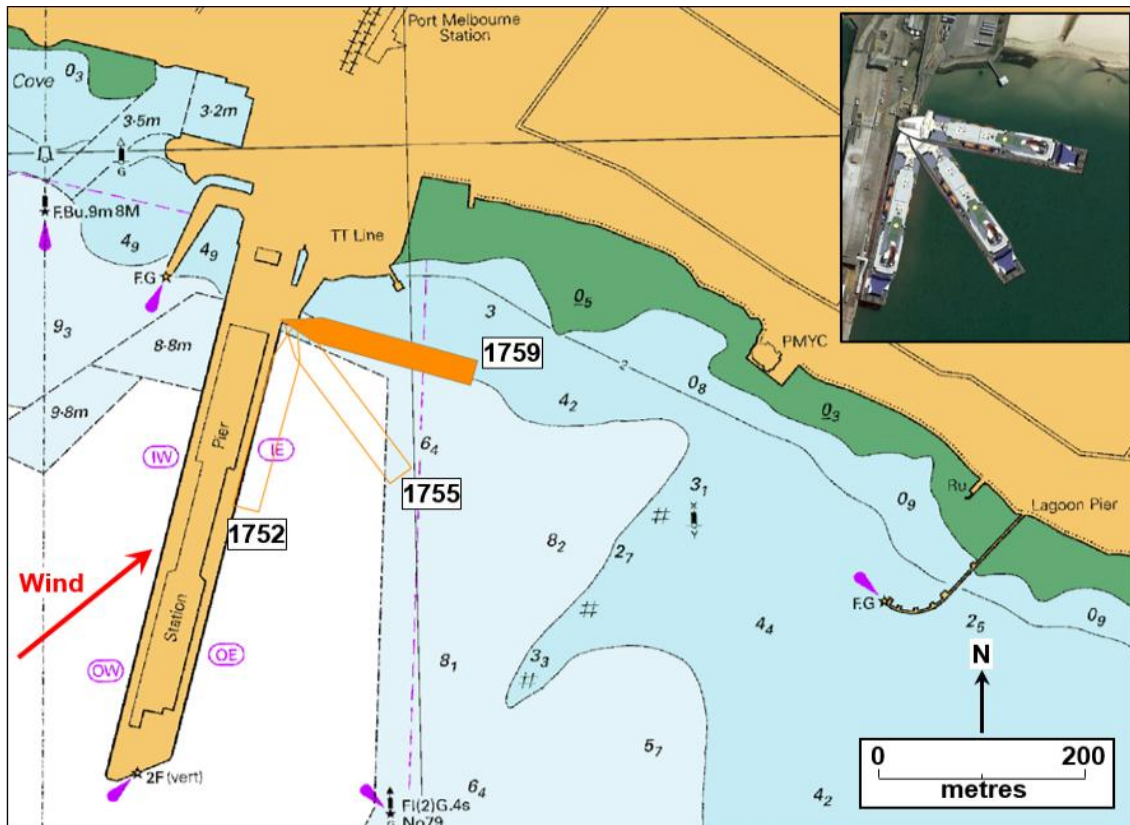
Figure 3: Wind speed and direction, and the ship's rate of turn



Source: *Spirit of Tasmania II*'s voyage data recorder

With the strong winds pushing the stern away from the wharf, the ship's aft mooring lines failed in rapid succession. The ship pivoted about its bow and swung away towards the shore (Figure 4).

Figure 4: Section of navigational chart Aus 154 showing the ship's breakaway



Source: Australian Hydrographic Service with annotations by ATSB (Inset: Google Earth)

On the bridge, *Spirit of Tasmania II*'s master saw the stern move off the wharf. He telephoned the engine control room but received no response. He then broadcast a message over the ship's

public address system asking an engineer to call the bridge and all crewmembers to go to their mooring stations. The senior engineer in the engine room heard the broadcast, returned to the engine control room, and called the bridge. The master asked for the bow and stern thrusters, followed by two main engines, to be started as quickly as possible.

By 1755, the ship was at an angle of approximately 45 degrees to the wharf and turning away from it (negative rate of turn in Figure 3) at 27°/min.

At 1756, an additional diesel generator was running and the thrusters were ready for use. The engineers then started necessary pumps and by 1758½, two main engines were also ready.

As the ship's stern came off the wharf, all the aft mooring lines parted. At the bow, the breast line came under tension, but, along with one head line, did not part. The ship pivoted about the bow and its lower bow ramp slid across and dropped off the wharf leaving it hanging over the bulbous bow. As the ship continued to turn, the end of the lower bow ramp swung under the wharf, damaging two wooden piles below the wharf apron.

The upper vehicle ramp detached from the ship's bow mount and jammed between the bow bulwarks.⁶ As the ship continued to turn, the ramp twisted away from the bow and hung down from its elevated roadway base.

Spirit of Tasmania II's purser and hotel staff were assisting passengers on board when the ship broke away. The purser became aware of the situation when she heard, and then saw, the aft mooring lines parting and the stern moving off the wharf. She followed the developments and response by listening to the ship's internal radio traffic. She and her staff assisted passengers, distributed food, drinks and provided reassurance and information as it became available.

By 1759, *Spirit of Tasmania II* was lying at right angles to Station Pier, parallel to the nearby Port Melbourne Beach. By then, the stern thruster was being used to control the movement of the ship's stern.

The Port of Melbourne's vessel traffic service (VTS) had been aware of the strong wind warning and had two tugs standing by throughout the day. One tug was at Webb Dock (about 1 mile to the west of Station Pier) as a precaution to assist a high-sided ship berthed there. The duty VTS officer directed the tug's master to proceed to the nearby Station Pier to assist *Spirit of Tasmania II*.

By 1800, the ship's stern was being held off the beach using the main propulsion (twin screw, variable pitch) and the thrusters (bow and stern).

At 1809, the tug arrived off *Spirit of Tasmania II* and made fast to the ship's stern. At 1826, the second standby tug also arrived and began assisting.

By 1900, the wind speed had dropped to about 10 knots and was blowing from the south. At 1905, the ship was again port side alongside Station Pier. It was held alongside using repaired mooring lines and spares, with the tugs assisting. The ship's engines and thrusters were kept ready for use as required.

Later in the evening, passenger access was restored, and many were accommodated on board for the night. Access to unload vehicles and freight became available the following day.

When *Spirit of Tasmania II* had turned off the wharf, its starboard bow door had come to rest against the wharf structure. Weight had then come onto it and pushed it against the lower bow ramp, resulting in damage to a number of its door operating components. The hydraulic system used to operate the doors was not damaged. As the lower bow ramp moved off and under the wharf, its end fingers were damaged as they made contact with the wharf piles. The upper vehicle ramp suffered extensive damage (Figure 5) requiring it to be removed from the wharf and taken away for repairs.

⁶ Fore-and-aft vertical plating directly above the upper edge of the ship side surrounding the exposed deck(s).

Figure 5: *Spirit of Tasmania II*'s damaged upper bow ramp (skybridge)



Source: TT-Line Company

Inspections and repairs as required by the Australian Maritime Safety Authority, the ship's flag State authority, and its classification society were then undertaken. On 17 January, 4 days after the incident, *Spirit of Tasmania II* returned to service.

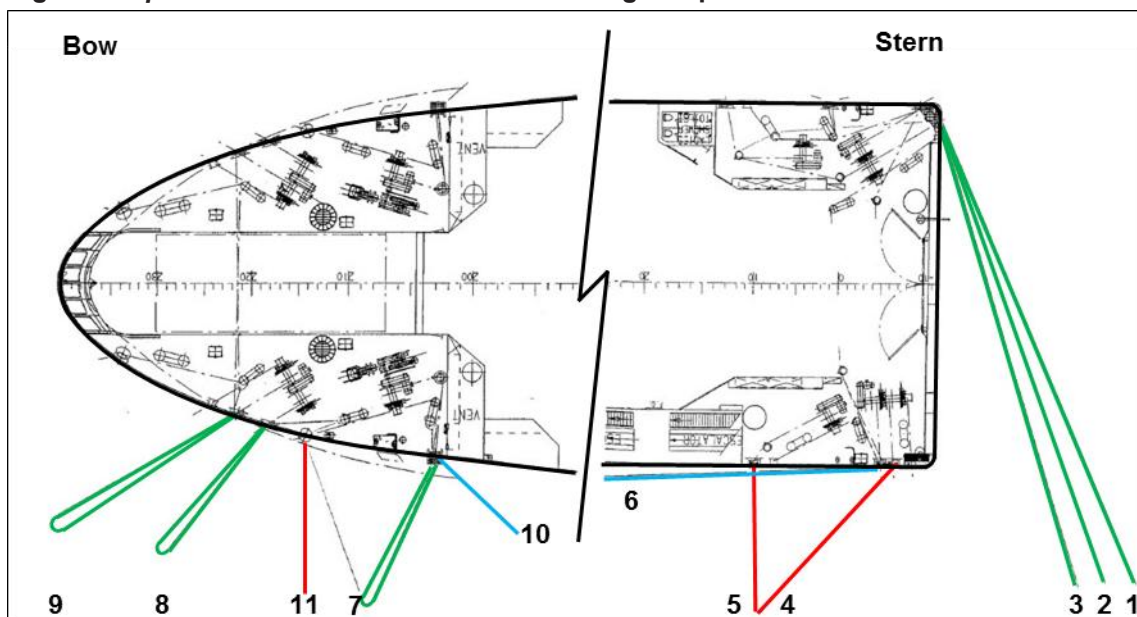
Context

Spirit of Tasmania II

At the time of the incident, *Spirit of Tasmania II* was registered in Australia, and owned and managed by TT-Line Company, Australia (TT-Line). The ship was classed with the American Bureau of Shipping (ABS).

Spirit of Tasmania II's standard mooring line pattern⁷ had been developed for the Station Pier berth (Figure 6). This consisted of three head lines on bights⁸ (numbered 7, 8 and 9 in Figure 6), a spring line (10) and a breast line (11) forward, and three stern lines (1, 2 and 3), two breast lines (4 and 5) and a spring (6) line aft. All mooring lines were 64 mm diameter, mixed synthetic fibre rope,⁹ each with a breaking load of 82 t.

Figure 6: *Spirit of Tasmania II*'s standard mooring line pattern for Station Pier



Source: TT-Line Company with annotations by ATSB

In Melbourne, the ship loads cargo and vehicles via its bow, using a lower and an upper vehicle ramp. The lower ramp is part of the ship's equipment and, when deployed, extends out from the main vehicle deck, through the bow doors and onto the wharf. The upper ramp, also known as the skybridge, extends from a raised roadway above the wharf onto the ship's bow. The skybridge attaches to the ship's bow via a ball hitch arrangement that accommodates movement of the ship. This provides vehicular access into the upper vehicle decks through the foredeck cargo door.

The ship had a crew of 70 Australians. The master held an Australian master's certificate of competency and a pilotage exemption for the Port of Melbourne (which includes Port Phillip). He first went to sea as a cadet in 1981, and obtained his master's certificate of competency in 1994. He had sailed on board *Spirit of Tasmania II* and its sister ship, *Spirit of Tasmania I*, since 2002 and first sailed as master of *Spirit of Tasmania II* in 2004. He had joined the ship about 3 weeks before the incident.

⁷ Mooring line pattern is the geometric arrangement of mooring lines between the ship and the berth.

⁸ A loop formed by doubling back a rope upon itself, effectively doubling the single rope's restraint capability.

⁹ Twenty-four strand, 40 per cent polyester, 60 per cent polypropylene/polyethylene rope (KapaFlex 24).

Moorings

A ship's moorings are intended to keep it safely alongside the berth in the prevailing and expected weather conditions, up to certain limits. Mooring equipment is not designed to be used in extreme conditions. A number of industry organisations publish a range of useful guidance material to assist with effective mooring.

Equipment design

A ship's mooring equipment, including related machinery and fittings, and its positioning, is determined at the ship design stage. The size, strength and other specifications of various equipment (including mooring ropes, brakes and winches) are based on the 'equipment number' or EN. The EN is based on a ship's size (displacement, beam and height above the waterline)¹⁰ so that a new ship is outfitted with the appropriate equipment. If circumstances during the ship's service life change, for example its trading pattern, the mooring equipment, machinery and fittings and how these are arranged on deck may need to be modified.

Other than the EN, there are few other design criteria, rules, regulations or class requirements for mooring equipment. Mooring equipment arrangements are not part of class requirements, other than the sizing of the equipment and the strength of the supporting structure. Class does require a minimum number and size of mooring lines, based upon the ship's EN, to be used. Mooring equipment must be properly maintained to preserve its design specifications.

Influencing factors

Many of the dynamic factors influencing a ship's mooring arrangement are weather-related. These include wind, sea and swell along with local factors such as currents, tides and tidal streams. Port and harbour specific factors include berths, channels, other infrastructure and traffic. Many factors interact with and/or influence other factors, for example strong winds can affect currents or streams.

Wind

Wind is one of the most significant factors influencing a berthed ship. The wind force acting on the ship depends on the wind speed and the surface area of its hull exposed to wind (windage). When the wind blows across the berth and towards the water, it will tend to push the ship away from the berth and its moorings will need to withstand the forces imposed.

A simple formula¹¹ that gives an approximation of wind loading is:

$$F = 1.5 \times 10^{-5} \times A \times V^2$$

where F is the wind force in tonnes
A is the exposed area in m²
V is wind speed in knots.

Since the wind force varies as the square of the wind speed, small increases in speed translate to large increases in force. In strong winds, gusting amplifies these forces significantly. Strong winds frequently contribute to breakaways.

Sea, swell, currents and tides

The sea and swell acting on a ship's underwater hull, when sufficiently strong, can cause it to move and impose forces on its moorings. Currents or tidal streams also act on the underwater hull and create lateral forces. The ship's moorings need to withstand all of these forces.

¹⁰ $EN = \frac{\Delta^2}{3} + 2 \times h \times B + \frac{A}{10}$, where Δ = summer displacement (t), h = effective height (m) of uppermost house above the summer load waterline (LWL), B = moulded breadth (m) and A = area (m²) in profile of hull and superstructures above LWL.

¹¹ Modified from Clark, IC 2009, *Mooring and Anchoring Ships, Volume 1: Principles and Practice*, The Nautical Institute, London to account for wind speed in knots and provide wind force in tonnes.

The height of tide is another important factor as the ship's hull rises or falls relative to the berth and its mooring lines tighten or slacken. The lines need to be appropriately tended to keep the ship safely alongside.

Port, berth and local factors

The design and location of a port is intended to provide a sheltered area for ships. Some ports have a naturally sheltered harbour, whereas others might need a man-made breakwater at their entrance. Similarly, wharves and jetties are designed to provide appropriate berths for ships. The number and position of bollards and hooks at a berth is an important factor.

Factors such as the proximity of a berth to a shipping channel are important considerations. Passing ships in the channel can interact with a berthed ship and cause it to surge and part its moorings. Ship speeds in channels are limited to eliminate such interaction.

Industry guidance

The Oil Companies International Marine Forum (OCIMF) provides comprehensive industry guidance on mooring in publications such as its *Mooring Equipment Guidelines* and *Effective Mooring*. The Nautical Institute provides guidance in two volumes of its *Mooring and Anchoring of Ships* publication. Together, these publications are the most significant body of research and information on the subject. They are regularly referred to within and outside the oil sector and are accepted as best practice for effective mooring.

The following points summarise some key considerations for effective mooring line patterns described in the publications referred to above:

- optimum load sharing between mooring lines is achieved when lines are loaded to the same percentage of each line's breaking strength (rather than each line carrying an equal share of the load)
- lines should be of the same material and diameter (lines of differing materials and diameters have different elasticities and will not share additional load evenly)
- lines should be of similar lengths because, as the ship moves off the wharf, the lines will be stretched the same amount which will result in uneven loading in lines of different lengths
- the steeper the angles a line forms with the pier surface and with the parallel side of the ship, the less effective it is in holding the ship against the pier
- mooring winches should be left on the brake once the ship is secured alongside because the brake holding capacity is significantly more than that available in self-tensioning mode¹²
- if self-tensioning mode is used, it is best used for lines at 90 degrees to the ship's axis (breast lines)
- sharp bends in a line under load decrease its strength and may cause premature damage or failure
- while running a line as a bight increases its effective holding capacity, if the line parts then two components of the mooring line pattern are lost in a single event
- regular inspection and tending of the mooring lines is required to maintain the mooring effectiveness and counter changes in forces including those due to environmental conditions, tide and draught changes.

The mooring line pattern of a ship will vary significantly with its size and type, port and berth infrastructure, weather and dynamic factors, and effective mooring depends on a range of complementary measures. The pattern should allow for the maximum static load on the moorings with an adequate safety factor to account for expected dynamic factors.

¹² Self-tensioning (or auto-tensioning) mode refers to a winch setting in which mooring lines are held to a set tension with the winch brake off and the winch motor automatically activated by sensors to drive out or haul in when the line tension differs from the set value. The holding capacity of the winch is then a proportion of its rated pull, not the brake capacity.

However, certain dynamic situations cannot be easily accounted for by design features or by precautionary measures. For example, when the forces acting on the moorings change suddenly and last longer than it takes the mooring line pattern to respond, a failure becomes more likely. A typical situation is the parting of a mooring line due to a sudden gust in a period of strong winds or surging due to interaction with a large ship passing close at high speed.

The mooring equipment arrangements and mooring line pattern are just two components of effective mooring. Other important considerations include regular tending of mooring lines and effective monitoring of the weather to ensure necessary precautionary measures can be taken in a timely manner. The management of both the ship and the port have a role in effective mooring.

TT-Line Company

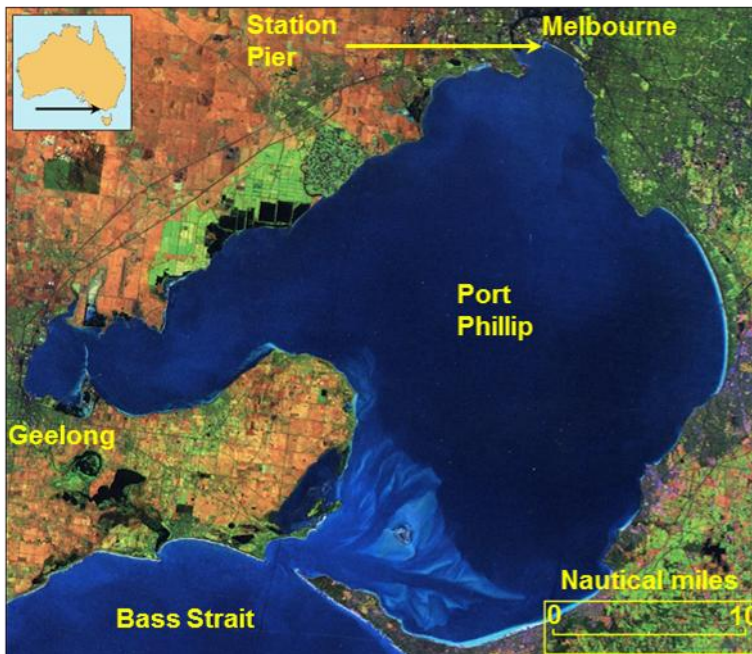
The TT-Line Company (TT-Line) has been operating passenger and vehicle ferry services across Bass Strait since 1985. The sister ships *Spirit of Tasmania I* and *Spirit of Tasmania II* began service in 2002. Both ships maintain year round, daily, one-way sailings with daily return sailings during the peak summer period. Each ship can carry 1,400 passengers and 500 vehicles. In the 2014-15 financial year, the company's ships carried 384,501 passengers.

Port of Melbourne

The Port of Melbourne is Australia's largest container and automotive port. Victorian Ports Corporation (Melbourne) manages the port,¹³ which is located at the northern end of Port Phillip (Figure 7). The port has 36 commercial berths for all types of cargo. In the 2014-15 financial year, the port recorded 3,023 ship visits and handled 87 million tonnes including over 2.58 million containers and 350,000 new motor vehicles.

The Port of Melbourne vessel traffic service (VTS) operates 24-hours a day, 7-days a week, to coordinate the port's maritime operations.

Figure 7: Melbourne and Port Phillip



Source: Port Phillip Sea Pilots, annotations by ATSB

¹³ At the time of the incident the port was managed by the Port of Melbourne Corporation.

Station Pier is a historic pier in Port Phillip. Opened in 1854, the pier is Melbourne's primary passenger terminal, servicing interstate ferries and cruise ships. To the east of the pier is Port Melbourne Beach, a popular public beach for residents and visitors.

Weather

The Bureau of Meteorology (BoM) provides weather forecasts, warnings and observations for marine users in coastal and local water areas and high seas off Australia (see Appendix A). Forecasts for wind speed and direction, and sea and swell height are routinely issued every 12 hours. When a wind warning is in force, these forecasts are updated every 6 hours. Wind warnings are issued whenever averaged 10-minute wind speeds are expected to exceed the thresholds for the following categories: strong wind (26 to 33 knots), gale (34 to 47 knots), storm force (48 to 63 knots) and hurricane force (more than 64 knots). Initial warnings aim to provide 24-hour lead times and are updated every 6 hours.

Weather warnings are broadcast on high frequency radio each hour. The warnings are also broadcast via the maritime SafetyNet satellite communication network when issued and updated at 0400 and 1600. These messages are automatically received and printed on board ships to which SOLAS¹⁴ applies. All current warnings are posted on the BoM website.

In the absence of severe weather, such as thunderstorms or squalls,¹⁵ it is normal for wind speed to vary by up to 40 per cent over a 10 minute period. The preamble in all marine forecasts cautions that wind gusts can be 40 per cent higher than the mean wind speed predicted. Stronger gusts are also likely near showers and frontal systems. During thunderstorms or squalls, significantly stronger gusts (higher than the 40 per cent caution) can occur.

In addition to official warnings and marine forecasts, BoM provides a range of weather monitoring tools on its website (see Appendix B). These include tools for accessing weather forecasts as well as weather observations (current and past weather), such as MetEye, weather watch radar and wind forecasting tools. The information displayed by all the tools is to some extent historical as it is based on average data recorded over a period of time and not instantaneous readings. The BoM cautions against using the tools for real-time monitoring and decision-making. These tools cannot be used to accurately monitor short-term weather events such as thunderstorms, squalls and gusts in real time. The intensity of these short duration weather events is also difficult to display historically.

Port Phillip

The weather in Port Phillip is regularly affected by fronts associated with east moving depressions (low pressure weather systems) often centred well south of the coast. On 35 to 40 occasions each year, these depressions create winds of gale force or greater strength offshore. Such weather is more than twice as likely during winter as in summer. While the wind in Port Phillip is less intense than offshore, it can still be significant. Thunderstorms and squalls can also produce strong local winds in Port Phillip and are more frequent in summer (December to February).

In addition to local waters forecasts and wind warnings for Port Phillip, severe thunderstorm warnings for the Melbourne region are particularly relevant to users and the Port of Melbourne. These warnings provide short-term advance warning of severe thunderstorms and are updated every 3 hours. Typically, such warnings are issued on 10 days per year. Squall warnings not associated with thunderstorms are issued on a further 5 or 6 days a year. Sudden wind gusts over 48 knots are experienced often in Port Phillip and a number of weather related incidents have occurred over the years.

¹⁴ International Maritime Organisation (IMO), 1974, *The International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS)*, IMO, London.

¹⁵ A squall is an abrupt and large increase in wind speed that usually only lasts for minutes then diminishes rather suddenly. The Bureau of Meteorology cautions that 'the gusts in a squall may exceed 40 or 50 knots...'

Previous incidents

Amongst previous weather related incidents, the two breakaways described below have some similarities to *Spirit of Tasmania II*'s 2016 breakaway.

2002 - *Spirit of Tasmania II*

On 13 October 2002, in westerly winds of about 53 knots (98 km/h), *Spirit of Tasmania II* broke away from Station Pier and turned parallel to the nearby Port Melbourne Beach. At the time, the ship's two stern lines were made fast to a single wharf bollard. This bollard shifted under the strain causing uneven loading of the mooring lines, which then parted in rapid succession.

Safety action taken by TT-Line after this incident included:

- fitting a wind alarm in the alleyway adjacent to the master's and deck officers' cabin
- the ship's starboard stern fairlead array was altered to allow extra mooring lines to be run
- a new heavy bollard was fitted on the wharf for running of ships' stern lines.

The mooring line pattern in use on 13 January 2016 was the same pattern that was implemented after the 2002 incident.

Further, this 2002 incident led to a number of procedural changes related to precautions to consider if adverse weather was experienced while berthed. These include:

- monitoring the wind indicator and alarm outside the master's cabin
- manning the bridge and monitoring weather reports and warnings
- placing the main engines and thrusters on short notice
- closely monitoring mooring lines and equipment
- stopping cargo and passenger operations
- retracting ramps and closing hull doors
- preparing for emergency letting go
- engaging tugs.

2009 - *Leyte Spirit*

On 21 August 2009, a severe squall with winds of up to 68 knots (126 km/h) passed over the Port of Melbourne causing the crude oil tanker *Leyte Spirit* to breakaway from its berth.

A safety investigation into the incident¹⁶ found that the squall line developed very rapidly and, while it was detected by BoM and a warning was issued, neither the terminal nor the tanker received the warning. No appropriate systems were in place to obtain and share local weather information and the investigation recommended that port users develop procedures for obtaining local weather information.

Subsequently, the terminal updated its procedures to ensure that vessels are aware of local weather warnings. The Port of Melbourne Corporation *Harbour Master's Directions*¹⁷ were updated to assist ship masters with obtaining local weather information.

¹⁶ Office of the Chief Investigator 2009, *Breakaway from Berth, MT Leyte Spirit, Gellibrand Pier Melbourne, 21 August 2009*, Transport Safety Victoria, Melbourne. Available at < <http://economicdevelopment.vic.gov.au/chief-investigator/marine-incidents> >

¹⁷ Port manager at the time of this incident. In 2017 this document is published by Victorian Ports Corporation (Melbourne) and is available at <www.vicports.vic.gov.au>.

Safety analysis

Breakaway

Between 1751 and 1753 on 13 January 2016, the south-westerly wind at Station Pier, Melbourne, increased from about 25 knots to 60 knots. As the wind speed was peaking, *Spirit of Tasmania II*'s aft mooring lines parted in quick succession and its stern broke away from the Station Pier wharf. As the stern swung away from the wharf, the originally slack forward breast line (11) came under tension and, along with one head line on the bight (9), did not part (Figure 6).

By 1759, the ship lay at right angles to the wharf and parallel to Port Melbourne Beach (Figure 8). While waiting for tugs to assist, the ship's propulsion was used to maintain its position and prevent grounding. By 1905, the ship was back alongside Station Pier with the two tugs assisting. No one was injured and damage was limited to the ship's bow ramp and doors.

The sudden and significant increase in wind speed contributed directly to *Spirit of Tasmania II*'s breakaway. The more than doubling of wind speed increased the wind loading on the ship's side exponentially (nearly six times). As the buildings on the pier provided least protection from the wind to the shipside area aft, the aft mooring lines took the load first.

As the wind speed was peaking, the ship's stern moved more than 4 m off the wharf stretching the aft moorings lines. Soon after 1753, the shortest of the stern lines parted. As the ship moved further off the wharf, the load increased on the other stern lines and they quickly parted. The two breast lines were unable to pay out quickly enough and parted. As the ship pivoted about its bow, the forward mooring lines overloaded and parted leaving just two lines intact (Table 1).

Figure 8: *Spirit of Tasmania II* adjacent to Port Melbourne Beach



Source: George Donikian

Table 1: Sequence and times of lines parting

Mooring line (numbered as per inset)	Parting time	
Stern line 3	17:53:11	
Stern line 2	17:53:27	
Stern line 1	17:53:55	
Breast line 5	17:54:08	
Breast line 4	17:54:47	
Aft spring 6	~1755 (Not in CCTV coverage)	
Head line 8	17:55:33	
Head line 7	17:56:58	
Head line 9 and forward breast line 11	Did not part	

Weather on 13 January

The weather conditions experienced in Port Phillip on 13 January were consistent with the typical Australian summer weather patterns. The weather systems, including those associated with short-term events such as thunderstorms, regularly develop in the area and were not unusual or extraordinary.

Forecasts

The Port Phillip local waters forecast issued at 1641 on 12 January indicated the possibility of afternoon thunderstorms with squalls up to 45 knots on the following day. The local waters forecast issued at 0527 on 13 January reiterated that earlier forecast, and stated:

Weather Situation

A high pressure centre lies over the Tasman Sea while a strong cold front approaches from the west during Wednesday. The cold front is expected at Port Phillip and Western Port around 2100hrs.

Forecast for Wednesday 13 January until midnight

Strong Wind Warning for Wednesday for Port Phillip

Winds: Variable around 10 knots tending northerly 15 to 20 knots during the morning. Winds shifting west to northwesterly 15 to 25 knots during the afternoon ahead of a southwesterly change of 20 to 30 knots during the evening. Squalls to 45 knots possible near the change and with thunderstorms. Seas: Around 1 metre. Weather: Sunny morning. 40% chance of showers during this afternoon and evening. The chance of a thunderstorm during this afternoon and evening.

The next local waters forecast at 1041 confirmed the 'strong cold front' was expected at about 2100 that evening and repeated the strong wind (26 to 33 knots) warning. Significantly, both the 0527 and 1041 local waters forecasts included the possibility of squalls up to 45 knots associated with afternoon and evening thunderstorms.

Severe thunderstorms were detected in western Victoria that afternoon. As the storms moved east, severe thunderstorm warnings for damaging winds for the state were issued from 1436 onwards. Each warning included a map highlighting the warning area. The 1508 warning stated that a detailed severe thunderstorm warning for the Melbourne area would be issued should thunderstorms develop there. At 1603, a warning indicated that Melbourne may be affected, including the possibility of damaging winds (defined by BoM as exceeding 49 knots or 90 km/h).

The local waters forecast at 1640 retained information about the cold front and squalls associated with thunderstorms. At 1714, a severe thunderstorm warning was issued for the Melbourne area, which indicated that two thunderstorm cells with damaging winds located southwest of Melbourne were moving southeast (Figure 9). The next warning was due to be issued an hour later, at 1815.

Figure 9: Maps issued with the 1714 and 1737 severe thunderstorm warnings



Source: Bureau of Meteorology, with annotations by ATSB

However, at 1737, a further severe thunderstorm warning was issued after thunderstorms were detected west of Melbourne. This band of thunderstorms with winds up to 54 knots (100 km/h) was moving east toward Melbourne and forecast to affect the city by 1805. The thunderstorm passed across Station Pier at 1753, bringing with it a sudden increase in wind speed. By 1830, the storm had passed and, a couple of hours later, the thunderstorm warnings were cancelled.

Therefore, the weather experienced at Station Pier when *Spirit of Tasmania II* broke away on 13 January had been generally forecast, well in advance, in local waters forecasts. However, the thunderstorm that actually passed over Station Pier at 1753 was not specifically predicted until 1737 (that is, 15 minutes before the breakaway) shortly after the band of storms was detected.¹⁸

Ship's preparedness

Spirit of Tasmania II's master had monitored successive Port Phillip local weather forecasts for the period covering the ship's stay at Station Pier. He was aware of the strong wind warning and the 'strong cold front' expected in Port Phillip at 2100 on 13 January. As a precaution, he required the engine room and machinery to be at 'short notice'¹⁹ from 1600, well before the cold front's arrival.

Once the ship berthed, its bridge was not manned and weather forecasts and warnings available via VHF radio and other equipment were not continuously monitored. The master's cabin had internet access from where he could access the BoM website. However, he was sleeping between 1330 and 1630 and remained unaware of the thunderstorm warnings issued since 1436. After he awoke, he checked the local waters forecast and found it unchanged.

At about 1700, while on the bridge, he saw that the wind and weather were also as he expected. There was no internet access on the bridge so he could not check the BoM website and remained unaware of the severe thunderstorm warning issued at 1714. After returning to his cabin at 1745, he checked the BoM website at about 1750 and saw the severe thunderstorm warning issued at 1737. By then, it was too late for the propulsion to be readied as the thunderstorm struck a couple of minutes later at 1753.

The master had use of the ship's thrusters and main engines about 5 minutes after it broke away. He was able to use the ship's propulsion to partially recover from the situation. Had he been able to use its propulsion earlier when the thunderstorm struck, it is likely that he would have used it to try to prevent the breakaway.²⁰

While the local waters forecasts predicted thunderstorms in the afternoon and evening, the evidence suggests that the master expected the weather to deteriorate when the cold front arrived in the evening. He had no means to automatically receive thunderstorm or squall warnings other than to continually check BoM's website.

TT-Line expected masters to take appropriate adverse weather precautions based on their significant experience on board company ships regularly calling at the same ports. However, there were no specific trigger points for taking any particular precaution and reliance was on an individual master's discretion and decision-making. On this occasion, the master did not become aware of the thunderstorms which developed that afternoon and precautions such as manning the bridge, monitoring the moorings or engaging tugs were therefore not taken.

The wind monitor and alarm outside the master's cabin was of little use in providing advance warning for the thunderstorm. The alarm was set to activate (audible alarm) when a wind speed of 18 m/s (33 knots) or more persisted for at least 10 minutes. In other words, it was set to provide a warning of a steady gale force wind. The winds experienced in the thunderstorm did not activate

¹⁸ Short lead times for severe thunderstorm warnings are not unusual due to the complexity in forecasting where specific storms will develop.

¹⁹ Shipboard procedures made reference to being prepared to start engines and/or thrusters at relatively short notice - generally considered to be 5 minutes.

²⁰ In 2013, the main engines and thrusters were used to keep *Spirit of Tasmania II* alongside Station Pier in a strong westerly gale during which another ship, a high sided car carrier, in the port broke away from its berth.

the alarm. When the master was going to the bridge, he saw that the wind speed indicator had registered 59 knots.

The precautions taken on board *Spirit of Tasmania II* on 13 January provided little defence against the sudden, storm force winds experienced during the thunderstorm. Shipboard procedures for adverse weather when alongside did not take into account all the necessary factors required to provide effective defences against significant, short-term weather events such as thunderstorms.

Port's response

The Port of Melbourne's vessel traffic service (VTS) provides essential and timely information to masters to assist in safe and efficient traffic movement in the port. The weather is an important part of such information and VTS provides current and forecast weather reports on request via VHF channel 12. The port also requires all ships to monitor weather conditions and obtain BoM forecasts, including weather reports issued by Coast Radio Melbourne on VHF channels 16/67.

The masters of berthed ships are also required to attend to moorings to ensure their ship is appropriately and effectively secured and notify VTS if mooring lines part. High-sided ships such as car carriers are required to have a tug standing by in certain conditions depending on the berth (for example, a car carrier at Webb Dock must have a tug standing by when there is a steady wind of 30 knots or more from the south-west to west). However, there were no other requirements for berthed ships when strong winds were expected.

At the time of the incident, VTS received BoM marine weather forecasts and warnings, and severe thunderstorm warnings via email subscription. However, on 13 January, the severe thunderstorm warnings were not received due to an incorrect BoM system configuration. The harbour master was trialling a third party weather monitoring and alert system and received the warnings. He telephoned VTS at 1622 and found it had not received the state-wide severe thunderstorm warning issued by BoM at 1603. He read out the warning and then forwarded a copy to VTS.

At 1721, a Port Phillip pilot advised VTS that there were winds of about 70 knots in Geelong.²¹ At 1726, VTS contacted the harbour tug company and asked for tugs to be readied, one of which was to attend a car carrier berthed at Webb Dock. During the following 30 minutes, VTS called a number of port users (terminals, ship agents and some ships) and warned that winds over 50 knots were approaching from the west. However, neither TT-Line nor *Spirit of Tasmania II* was amongst the parties that VTS notified.

The VTS procedures provided for limited assistance to be given to the masters of berthed ships in the event of a weather event. The responsibility remained with the ships' masters to monitor and respond to the weather. As a consequence, on 13 January, VTS's response to the sudden weather event was only partially effective in dealing with the situation in Port Phillip.

***Spirit of Tasmania II's* moorings**

Spirit of Tasmania II's mooring line pattern on 13 January was effectively the same as the standard pattern for that berth (Figure 6). The only difference was that a forward headspring²² had not been run that day, and the forward breast line was slack at the time of the breakaway. Therefore, the ship was effectively being held alongside by three mooring lines on the bight forward and six lines aft (Figure 10).

The ship's planned maintenance system required mooring lines to be inspected every month. The maintenance records indicated that all aft lines were in good or new condition when inspected on 2 January, a few days before the breakaway. The records indicated that regular maintenance had been carried out on the mooring winches. The design winch brake holding capacity was 69 t. No defects were recorded at the previous 3 monthly mooring equipment inspection, completed in

²¹ Thirty miles south-west of Station Pier.

²² A mooring line leading in a nearly fore and aft direction, the purpose of which is to prevent the ship from moving forward along the berth.

October 2015 and, while the brakes had never been render (slip and pay out) tested, there was no requirement for such testing.

Figure 10: *Spirit of Tasmania II*'s mooring lines as run on 13 January (lines highlighted)

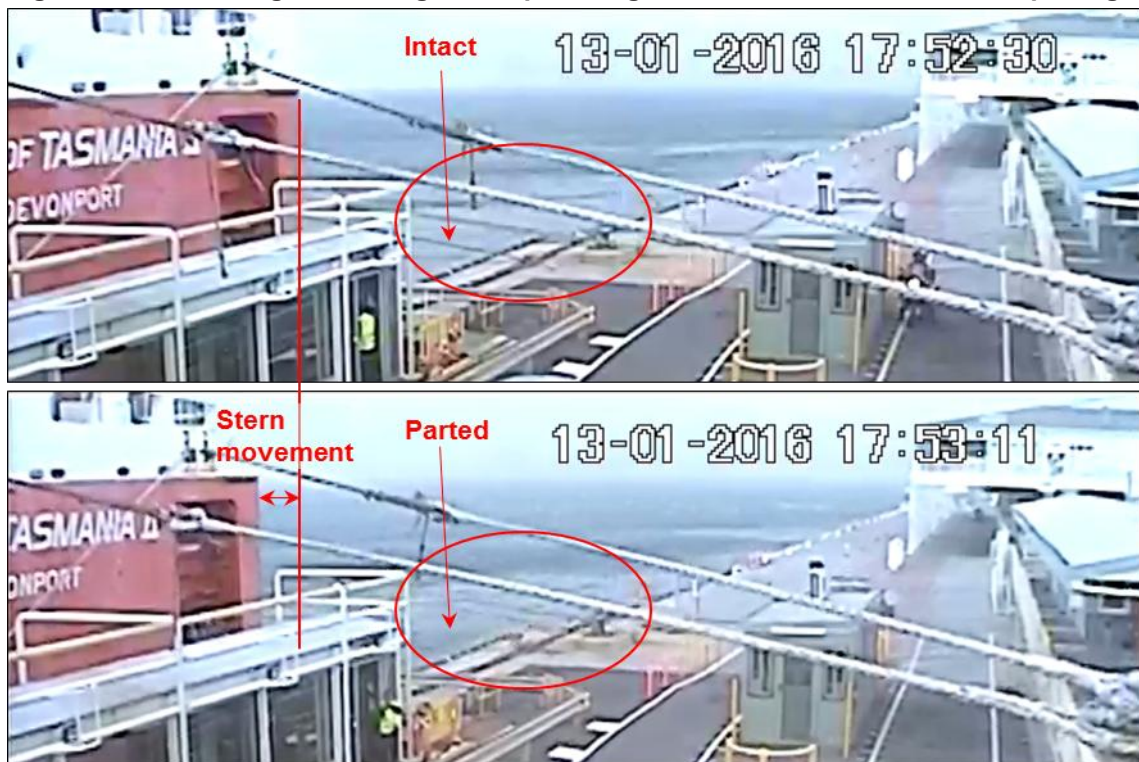


Source: Google Earth, with annotations by ATSB

At the time of the breakaway, all stern lines were held on the winch brake. The winches holding both aft breast lines were set to self-tension. The self-tension setting was reported to have been between 80 and 100 per cent of the winches' rated pull²³ of 15 t.

The CCTV footage from 1752 shows *Spirit of Tasmania II*'s stern moving off the wharf and its aft mooring lines stretching due to the wind loading (Figure 11). By 1753, as the wind was peaking at about 60 knots, the ship's stern was over 4 m off the wharf with the lines considerably stretched as the winch brakes held. Moments later, the shortest stern line parted when it could not stretch any further. As the load transferred to other stern lines, they parted in quick succession.

Figure 11: CCTV images showing the ship moving off the wharf and the first line parting



Source: TT-Line Company, with annotations by ATSB

As the ship's stern was breaking away, the winches holding the breast lines payed out. However, as the ship's movement gathered speed, those lines parted. Two of the three forward head lines also parted during the breakaway.

²³ Rated pull is pull that the mooring line can develop at the rated winch speed on the first layer.

Based on the pattern of the aft mooring lines (not including the spring) their combined static load capacity was approximately 200 t, as set-up.²⁴ The forces from the wind loading on *Spirit of Tasmania II* cannot be calculated exactly because of the buildings and structures above and below Station Pier. However, if these and other complexities are ignored, a force of approximately 190 t could have been acting on the ship when the wind speed peaked.

In theory, therefore, the aft moorings should have prevented the breakaway. The moorings did hold until the wind speed reached 60 knots. Possible reasons for the failure of the mooring lines include:

- unequal tension in mooring lines (before the sudden increase in wind speed)
- not all lines were held on winch brakes (some winches on self-tension)
- unknown mooring line defects
- sudden dynamic forces (six-fold increase in wind loading)
- dynamic loading (ship's momentum as it rapidly moved off the wharf).

It is possible that the breakaway might have been prevented had the precautions for adverse weather been more carefully considered. For example, had the breast lines been held on winch brakes, the increased static load capacity of the aft mooring line pattern may have prevented the first stern line parting. Similarly, had the ship's propulsion been ready for immediate use, the stern thruster (maximum 15 t transverse thrust) could have been used to counteract some wind loading to prevent the first line parting.

While the standard mooring line pattern had been successfully used for many years, the breakaway indicated that the risk could have been further reduced to be better prepared for such unusual circumstances. The number, type and strength of mooring lines, winch brake testing, use of self-tension winches, bollard location and other items to improve leads for mooring lines and line tending practices are amongst the areas where enhancements may reduce risk.

²⁴ That is, with three stern lines held on the winch brake (maximum line tension 69 t), two breast lines on self-tension (maximum line tension 15 t) and accounting for the various line lead angles to the wharf.

Findings

From the evidence available, the following findings are made with respect to the breakaway of *Spirit of Tasmania II* that occurred at Station Pier, Melbourne on 13 January 2016. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance.

A safety issue is an event or condition that increases safety risk and (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 operating environment at a specific point in time.

Contributing factors

- At 1753 on 13 January, the wind speed suddenly increased from about 25 to 60 knots during a thunderstorm resulting in a six-fold increase in the wind loading force acting on *Spirit of Tasmania II*.
- The exponential increase in the wind loading force pushed the ship's stern off the wharf, stretching its aft mooring lines.
- Soon after 1753, the shortest of the three stern lines (all held on winch brakes) stretched beyond its limit and parted. As the load transferred to the remaining stern lines, they parted in quick succession.
- The two breast lines aft (held on self-tension winches) paid out before parting, allowing the stern to breakaway.
- While the weather experienced, in general, was forecast well in advance, the thunderstorm was not specifically predicted until 15 minutes before the breakaway leaving little time for the ship's crew to respond.
- **The adverse weather procedures for TT-Line Company ships when alongside did not take into account all the necessary factors to provide effective defences against significant, short-term weather events such as thunderstorms and squalls. [Safety issue]**

Other factors that increased risk

- **The Port of Melbourne vessel traffic service (VTS) procedures for adverse weather were not comprehensive and, hence, its response on 13 January was only partially effective. One important consequence was that VTS's advance warning of storm force winds did not reach all relevant parties, including *Spirit of Tasmania II*'s master. [Safety issue]**
- **While TT-Line Company's standard mooring line pattern for ships at Station Pier had been successfully used for many years, the breakaway indicated the risk could have been further reduced to better prepare for such unusual circumstances. [Safety issue]**

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of these safety issues and actions are repeated separately on the ATSB website to facilitate monitoring by interested parties. Where relevant the safety issues and actions will be updated on the ATSB website as information comes to hand.

TT-Line Company procedures

Number:	MO-2016-001-SI-01
Issue owner:	TT-Line Company
Operation affected:	Marine: Shipboard operations
Who it affects:	All ship masters and deck officers

Safety issue description:

The adverse weather procedures for TT-Line Company ships when alongside did not take into account all the necessary factors to provide effective defences against significant, short-term weather events such as thunderstorms and squalls.

Proactive safety action taken by TT-Line Company

Action number: MO-2016-001-NSA-001

TT-Line Company (TT-Line) advised the ATSB that subsequent to the company's initial internal investigation, safety action focused on three areas:

Procedures

TT-Line has updated and expanded procedures in relation to weather preparations and responses at Station Pier. This includes:

- all mooring lines to be held on the winch brake, not in self-tension
- for winds over 30 knots (in the backing quadrant – between NxE to SxE) the bridge is to be manned and passenger and cargo operations scaled back
- the stern thruster will be engaged for winds over 35 knots (NW to S)
- the wind alarm fitted outside the master's cabin will trigger instantaneously at 35 knots
- the wind alarm can only be disabled if the bridge is constantly manned.

The procedural review is ongoing and changes are to continue based upon the outcomes of the ongoing mooring investigations.

Weather notifications

TT-Line's safety action in this area has included a range of measures to improve shipboard and company procedures, and the reliability of weather and associated warning notification.

The company has entered into agreements with the Bureau of Meteorology (BoM) and a third party weather warning company to provide forecasts and warnings for areas in which company ships operate. Masters and chief mates, as well as the designated person ashore (DPA), have each been issued with a dedicated smart phone for receipt of weather related information and warnings.

The BoM will provide direct email notice of wind and storm warnings along with local waters and thunderstorm forecasts for the Melbourne area to nominated company addresses. The third party weather warning company will provide specifically tailored forecasts as well as 'push alerts' (SMS warnings with audible alerts) for winds over 25 knots.

In addition, TT-Line has provided internet access from the computers on ships' bridges.

Mooring arrangements

Shortly after the incident, TT-Line commenced an in-depth review and analysis of berthing ships at Station Pier. This has included engaging external maritime consultants to conduct assessment, analysis and simulations of the mooring conditions and arrangements.

Current status of the safety issue

Issue status: Adequately addressed

Justification: Enhancements to ship operating procedures should improve the ability to hold the ship alongside and provide for swifter response to changing weather conditions. In addition, improved analysis and notification of weather conditions, forecasts and warnings should allow ships' crew to be better informed and hence better prepared. The review of the mooring arrangements should further inform and complement these changes.

Melbourne vessel traffic service procedures

Number:	MO-2016-001-SI-02
Issue owner:	Victorian Ports Corporation (Melbourne)
Operation affected:	Marine: Shore-based operations
Who it affects:	Port of Melbourne vessel traffic service and all users of the port

Safety issue description:

The Port of Melbourne vessel traffic service (VTS) procedures for adverse weather were not comprehensive and, hence, its response on 13 January was only partially effective. One important consequence was that VTS's advance warning of storm force winds did not reach all relevant parties, including *Spirit of Tasmania II*'s master.

Proactive safety action taken by Victorian Ports Corporation (Melbourne)

Action number: MO-2016-001-NSA-002

The Victorian Ports Corporation (Melbourne) advised the ATSB that it had issued Victorian Notices to Mariners number 032-2016 advising that Melbourne vessel traffic service will broadcast Bureau of Meteorology weather warnings on VHF channel 12. All masters of ships in port waters, including at berth or anchorage, are to ensure a listening watch is maintained at all times.

A Port Information Notice (PIN number 08/2016) was also issued for passenger ships at Station Pier to ensure adequate mooring lines are used throughout the ships' stay. Masters are reminded that the berth is exposed to strong winds and inclement weather. They are to keep a listening watch on VHF channel 12.

Current status of the safety issue

Issue status: Adequately addressed

Justification: The notice to mariners and the port information notice clarify the responsibility of ship's masters to actively and continuously monitor weather and related vessel traffic service communications via VHF radio.

Mooring at Station Pier

Number:	MO-2016-001-SI-03
Issue owner:	TT-Line Company
Operation affected:	Marine: Shipboard operations
Who it affects:	All ship masters and deck officers

Safety issue description:

While TT-Line Company's standard mooring line pattern for ships at Station Pier had been successfully used for many years, the breakaway indicated the risk could have been further reduced to better prepare for such unusual circumstances.

Proactive safety action taken by TT-Line Company

Action number: MO-2016-001-NSA-003

TT-Line Company (TT-Line) advised the ATSB that subsequent to the initial internal investigation, TT-Line focused on three areas:

Mooring arrangements

TT-Line advised the ATSB that it has commenced an in-depth review and analysis of berthing ships at Station Pier. This has included engaging external maritime consultants to conduct assessment, analysis and simulations of the mooring conditions and arrangements. The aim is to achieve recommendations on the optimal operating parameters including changes to berthing arrangements and infrastructure if necessary.

TT-Line also advised that the initial consultant's mooring analysis report had verified the mathematical model used for computer simulations, which had confirmed the details and sequence of the incident. The ongoing analyses will define operational parameters and propose necessary changes to ship berthing arrangements and/or infrastructure.

In addition to these analyses, all mooring lines have been changed to the same type and specifications, with breaking load of 96 t.

Procedures

TT-Line has updated and expanded procedures in relation to weather preparations and responses at Station Pier. This includes advising ships' crews that all mooring lines are to be held on the winch brake, not in self-tension.

The procedural review is ongoing and changes are to continue based upon the outcomes of the mooring investigations.

Weather notification

TT-Line advised the ATSB that it has improved the ship and company procedures and reliability of weather and associated warning notification.

ATSB comment/action in response

The ATSB acknowledges the proactive safety taken by TT-Line, which has partially addressed the safety issue. The ATSB considers that the company's mooring analysis, when completed, and safety action as a result of that analysis have the potential to adequately address the issue. Therefore, the ATSB has issued the following recommendation.

ATSB safety recommendation to TT-Line Company

Action number: MO-2016-001-SR-005

Action status: Released

The Australian Transport Safety Bureau recommends that TT-Line Company take necessary action to adequately address the safety issue following the completion of its mooring analysis.

Current status of the safety issue

Issue status: Partially addressed

Justification: In addition to the proactive action taken to date, further action by TT-Line following the completion of its mooring analysis has the potential to adequately address the safety issue.

Additional safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Proactive safety action taken by the Bureau of Meteorology

The Bureau of Meteorology (BoM) advised the ATSB that it had ensured that the subscription service with Victorian Ports Corporation (Melbourne) was working and up-to-date. BoM had also continued to upgrade its marine weather analysis and information services.

The BoM has developed a marine weather knowledge centre that is accessible through its website. The centre provides a one-stop webpage for marine weather education and information and enhances accessibility to existing marine and ocean services. The BoM has also launched a mobile telephone application which provides access to weather services including warnings.

General details

Occurrence details

Date and time:	13 January 2016 — 1753 AEDT (UTC +11)	
Occurrence category:	Serious incident	
Injuries	Nil	
Primary occurrence type:	Breakaway	
Location:	Inner East berth, Station Pier, Melbourne, Victoria	
	Latitude: 37° 50.61' S	Longitude: 144° 55.93' E

Ship details

Name:	<i>Spirit of Tasmania II</i>
IMO number:	9158434
Call sign:	VNSZ
Flag:	Australia
Classification society:	American Bureau of Shipping
Ship type:	Passenger / Roll on – Roll off
Builder:	Kvaerner Masa-Yards, Turku, Finland
Year built:	1998
Owner(s):	TT-Line Company, Australia
Manager:	TT-Line Company, Australia
Gross tonnage:	29,338
Deadweight (summer):	5,651 t (1,400 passengers, 113 crew, 110 trailers, 140 cars)
Summer draught:	6.440 m
Length overall:	194.30 m
Moulded breadth:	25.00 m
Moulded depth:	9.10 m
Main engine(s):	4 x Wartsila NSD, Sulzer 16ZA40S
Total power:	42,240 kW
Speed:	33.0 knots
Damage:	Ship: Parted mooring lines (8) and minor damage to bow ramp and doors. Shore: Extensive damage to elevated roadway and ramp arrangement on wharf and minor damage to wharf structures.

Sources and submissions

Sources of information

On 14 January 2016, investigators from the Australian Transport Safety Bureau (ATSB) attended *Spirit of Tasmania II* while the ship was in Melbourne, Victoria. The master and directly involved crewmembers were interviewed and each provided their account of the occurrence. Photographs of the ship and copies of available, relevant documents were obtained.

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Submissions

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

A draft of this report was provided to TT-Line Company, the master and chief mate of *Spirit of Tasmania II*, the Australian Maritime Safety Authority, Victorian Ports Corporation (Melbourne), American Bureau of Shipping and the Bureau of Meteorology.

Submissions were received from TT-Line Company, the master and chief mate of *Spirit of Tasmania II*, the Australian Maritime Safety Authority, Victorian Ports Corporation (Melbourne), American Bureau of Shipping and the Bureau of Meteorology. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Appendices

Appendix A – Bureau of Meteorology weather service and terms

The Bureau of Meteorology (BoM) provides the maritime community with weather forecasts, warnings and observations for coastal waters areas around Australia.

Marine and local waters forecasts

Forecasts for wind speed and direction, and sea and swell heights are issued routinely every 12 hours. When a marine wind warning is in force, these forecasts are updated routinely every 6 hours. These forecasts provide information on mean wind, sea height, swell height and direction and weather conditions:

- local waters - areas such as bays, harbours and inland waters on which frequent boating activity occurs
- coastal waters – areas within 60 miles of the coast

The following terminology is used to describe time periods in these forecasts:

- Early in the morning - expected to occur before 0600
- In the morning - expected to occur between 0700 and 1000
- Middle of the day - expected to occur between 1100 and 1300
- During early afternoon - expected to occur between 1400 and 1500
- In the afternoon - expected to occur between 1600 and 1800
- During the evening - expected to occur between 1900 and 2000
- Later in the evening - expected to occur after 2100

All BoM marine forecasts and warnings predict wind speed as the average (or mean) speed expected over any given 10 minute period at a height of 10 m above the ground. Hence, marine forecasts provide a summary of the average wind speed expected within the forecast area, not the maximum wind gust expected.

Wind warnings are only issued when mean winds (winds speed averaged over 10 minutes) are expected to exceed 25 knots for an extended period of time across more than 10 per cent of the marine area. A wind warning is not issued for individual wind gusts, which typically last seconds.

In the absence of severe weather, such as thunderstorms or squalls, it is normal for wind speed to vary by up to 40 per cent over a 10 minute period. Hence, a statement is added to BoM marine forecasts to remind users that wind gusts at any time can be 40 per cent higher than the mean wind predicted in BoM marine forecasts and warnings. Wind gusts can be much higher than 40 per cent during severe weather, such as thunderstorms or squalls.

Mariners should refer to the weather section of the coastal or local waters forecast to determine the likelihood of thunderstorms occurring. They should also be aware that there is a risk of damaging wind gusts occurring with any thunderstorm and should actively monitor weather conditions when thunderstorms are forecast.

For operations near the shore, BoM's severe thunderstorm warning service should also be used. These warnings provide short-term advanced notice of thunderstorms that are likely to be accompanied with wind gusts in excess of 48 knots, as well as other hazardous conditions that can accompany thunderstorms.

Recipients are further cautioned that maximum wave heights may be up to twice the height of those forecast (average). More information is available from the BoM website <www.bom.gov.au>

Marine weather warnings

Marine weather warnings are issued whenever strong winds, gales, storm force or hurricane force winds are expected. The following warnings are provided:

- coastal waters wind warnings
- ocean wind warnings – issued to ships at sea whenever gale, storm or hurricane force winds are expected
- severe weather warnings – provided for potentially hazardous or dangerous weather that is not directly related to severe thunderstorms, tropical cyclones or bushfires.

Gust speed can be 40 per cent greater than the predicted wind speed

Marine wind warnings aim to provide a 24-hour lead-time and are normally reviewed every 6 hours and issued every 12 hours.

Wind speed warnings

These warnings are issued whenever strong winds, gale, storm or hurricane force winds are expected. They provide around 42 to 24 hours' notice and are updated every 6 hours. The wind warning statement is included in all the coastal waters and local waters forecasts affected by the warning. A state-wide marine wind warning summary is also available and lists all the coastal waters and local waters affected by warnings for that day and the following day (listed on the BoM's National warnings summary webpage).

These warnings are based on expected 10 minute mean winds (not maximum wind gusts) and are only issued if mean winds are expected to exceed thresholds for extended periods. The following 10 minute mean thresholds are used:

- strong wind warning: 26 to 33 knots, force 6 to 7²⁵
- gale warning: 34 to 47 knots, force 8 to 9
- storm force wind warning: 48 to 63 knots, force 10 to 11
- hurricane force wind warning: 64 knots or more, force 12.

Wind direction is given using the eight compass points for forecasts and 16 points for observations and is the direction the wind is coming from.

Severe thunderstorm and severe weather warnings

Severe thunderstorm warnings provide short-term advance warning of the likelihood of severe thunderstorms impacting on the region and are updated every three hours. A severe thunderstorm can produce any of the following:

- a tornado
- large hail (2 cm in diameter or larger)
- damaging wind gusts (generally wind gusts exceeding 48 knots)
- heavy rainfall which may cause flash flooding.

Severe weather warnings are issued for the following conditions:

- sustained winds of gale force (34 knots or more) wind gusts of 48 knots or more
- very heavy rain abnormally high tides
- unusually large surf waves expected to cause dangerous conditions on the coast.

²⁵ 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.

The BoM's forecasters determine which warnings to issue to best inform the public about the hazards – for example, a severe weather warning may not be issued if a severe thunderstorm warning has already been issued.

While both the severe thunderstorm and severe weather warnings are land-based products, people undertaking marine operations near the shore should also consider these warnings.

Terms used

Wind speed is the average speed of the wind over a 10-minute period at a height of 10 m above the surface level.

Gusts are increases in wind speed lasting for just a few seconds. Wind gusts are typically 40 per cent stronger than the average wind speeds provided in marine forecasts. However, thunderstorms and squalls may produce much higher gusts.

A squall is an abrupt and large increase in wind speed that usually only lasts for minutes then diminishes rather suddenly. The gusts in a squall may exceed 40 or 50 knots.

More information is available from the BoM website.

Appendix B – Bureau of Meteorology weather monitoring tools

The Bureau of Meteorology (BoM) provides a great deal of information and weather monitoring tools to users via its website <www.bom.gov.au>. In addition to its official warnings and marine forecasts, the BoM provides the following weather monitoring and forecast tools.

Australian weather watch radar

The BoM provides a system of dedicated and part-time weather watch radars with images available online.²⁶ The images are updated about every 10 minutes for the dedicated system. The primary image display is of rainfall rates.

There are fifteen levels of rainfall intensity shown on the images - each level provides an approximate indication of the rainfall rate in millimetres per hour. Rain radar is not an indicator or predictor of the wind speed although there is some correlation between the severity or concentration of the displayed rain pattern and associated weather events (such as localised storms) and wind strength.

Thunderstorm precipitation cells can appear as isolated cells or in clusters or lines. Fast moving cells, rapidly growing cells, a bow in the direction of the movement of a line of cells and/or a long-lived cell moving in a markedly different direction to others may indicate the potential for severe weather (large hail, damaging winds and/or very heavy rain).

Where available, the individual weather radar is able to display Doppler wind data. Unlike the rain radar images, the Doppler wind data can be difficult to understand and interpret. Due to the complexities of interpretation, the BoM warn that care should be taken when using this data.

The information displayed on radar images is always historical being at least 10 minutes old and is based on average rather than instantaneous readings.

MetEye™

MetEye™ is an online²⁷ weather-mapping tool which displays forecasts, in three-hourly blocks, for weather features including wind speed and direction. MetEye™ allows animation of a range of official BoM forecast grids including rainfall, temperature and wind. These forecasts are updated twice daily. The system also allows information from other sources such as latest weather information including rain radar and wind speed and direction to be overlaid.

The wind forecast maps show the averaged 10 minute wind speed and direction for the time selected, based on a 10 m standard height. As wind speeds vary with gusts and lulls during a 10 minute period so the wind gusts experienced may be 40 percent stronger than the average speeds presented on the map.

MetEye™ is not a suitable real-time weather tracking or monitoring tool, especially for short-term weather events such as squalls and thunderstorms, as it is based upon forecasts from 10 minute average readings taken as much as 3 hours before the current time. Data refresh times vary and the most recent information is at least 6 minutes old. For this reason, care must be taken when using the tool for weather-based decisions.

Marine wind forecast

The BoM also provides computer generated marine wind forecast maps. The maps show average wind speeds and should be used in conjunction with official BoM marine weather forecasts as additional information and forecaster expertise are used to generate the official forecasts.

²⁶ <http://www.bom.gov.au/australia/radar/>

²⁷ <http://www.bom.gov.au/australia/meteye/>

Accessing marine forecast and warning services

All BoM forecasts and warnings are available on the BoM website. In addition, there are a number of communication methods mariners can use to check BoM marine services, forecasts, warnings and observations:

- Email subscription service – interested parties can subscribe to and receive a range of BoM services as they are released, including forecasts and warnings.
- MarineLite (marine weather services (lite): includes high seas, coastal and local waters forecasts and warnings in text-only format, making them faster, more affordable and more accessible for slow data links.
- VHF voice radio: inshore, broadcasts at scheduled times, provided by local marine organisations.
- HF voice radio: off-shore, broadcast continuously 24/7, provided by BoM.
- Inmarsat: global satellite communications for high seas warnings and forecasts, some coastal forecasts, provided by BoM for Australian high seas and coastal areas.
- Telephone weather services: pre-recorded coastal and local waters forecasts and warnings for each State/Territory.
- Marine weather knowledge centre – this web-based service provides a one-stop webpage for marine weather education information. The site includes a range of educational material to support the improved understanding of, and accessibility to, the existing information on BoM's Marine & Oceans webpage.
- Mobile phone application, BoM Weather – users can view weather information (forecasts, warnings, rain radar, wind) for any location.

Note that severe thunderstorm warnings are not provided on HF radio or Inmarsat.

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 operations involving the travelling public.

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.