Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Marine Occurrence Investigation No. 260
MO-2008–012
Final

Independent investigation into the rupture of a submarine gas pipeline by the Hong Kong registered container ship

APL Sydney

in Port Phillip, Victoria

13 December 2008

Australian Government

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Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Published by: Australian Transport Safety Bureau
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ISBN and formal report title: see 'Document retrieval information' on page v

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DOCUMENT RETRIEVAL INFORMATION

Report No.	Publication date	No. of pages	ISBN	ISSN
260	April 2010	80	978-1-74251-021-7	1447-087X

Publication title

Independent investigation into the rupture of a submarine gas pipeline by the Hong Kong registered container ship *APL Sydney* in Port Phillip, Victoria on 13 December 2008.

Prepared By

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Reference Number

JAN10/ATSB46

Acknowledgements

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Abstract

At 1428 on 13 December 2008, the Hong Kong registered container ship *APL Sydney*'s starboard anchor was let go in Melbourne anchorage. Four minutes later, the pilot left the bridge and by 1436, he had disembarked the ship. The 35 knot south-southwest wind was gusting to 48 knots. A submarine gas pipeline lay 6 cables (1.1 km) downwind.

By 1501, after dragging its anchor, the ship was outside the anchorage boundary. The master advised harbour control he intended to weigh anchor and was instructed to maintain position and wait for a pilot. At 1527, when weighing anchor was started after receiving permission from harbour control, the ship was within 50 m of the pipeline. While weighing anchor, the anchor dragged across the pipeline, snagged it at about 1544 and, subsequently, the anchor windlass failed.

At 1603, the pilot returned to the ship and, after discussions with the master and harbour control, he decided to dredge the anchor clear. At 1621, less than 1 minute after *APL Sydney*'s main engine was run ahead, the pipeline ruptured. There were no injuries and the pipeline was isolated.

The investigation found that the rupture was the result of attempting to dredge the anchor instead of slipping it. The anchor had also been let go too close to the pipeline in the poor weather conditions. The report identifies safety issues in relation to: the port's risk management with respect to the pipeline and anchorage boundaries and its shipping control procedures; the ship's safety management system with respect to passage planning, the master's authority, crew familiarisation and the working language; the pilotage company's procedures for anchoring and mobile telephone use; and the windlass failure. Safety actions to address all the issues have been taken or proposed by the relevant parties.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau 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 safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

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.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

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

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

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

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

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

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

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

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

EXECUTIVE SUMMARY

At 1200[1] on 13 December 2008, a Port Phillip pilot boarded the Hong Kong[2] registered container ship *APL Sydney* for its transit to the anchorage off Melbourne. At 1428, the starboard anchor was let go in the Outer Anchorage in a position about 0.6 of a mile[3] upwind of a submarine ethane gas pipeline. The wind was south-southwest at 35 knots[4] with gusts up to 48 knots. At 1432, having made a lee for the pilot boat on the port side; the pilot left the bridge and by 1436 had disembarked.

The ship drifted northwards while 5 shackles[5] of anchor cable were deployed in the 16 m deep water. As the ship swung into the wind to ride to its anchor, it closed on the anchorage boundary, which was about 500 m from the gas pipeline. At 1501, the ship was outside the anchorage and the master informed Melbourne harbour control of his intention to weigh anchor and move the ship into the anchorage.

At harbour control, the shipping control officer had been attending to other matters and had not actively monitored *APL Sydney*'s anchor position. He instructed the master to maintain position until a pilot boarded. By 1516, the same pilot was on his way back to the ship.

The master did not use the main engine or deploy additional anchor cable in an attempt to maintain the ship's position. By 1525, he realised that the anchor was dragging rapidly and that it would be some time before the pilot re-boarded. At 1527, after receiving the control officer's permission, he began to weigh anchor. The ship had moved 300 m closer to the pipeline, now about 40 m astern.

As the anchor cable was heaved in, the master used the engine and helm and *APL Sydney* made some progress away from the pipeline At 1536, he effectively lost control of the ship which swung until the wind was on its starboard beam and it was pushed rapidly northwards. At about 1544, the anchor snagged the pipeline.

At 1548, the master informed the pilot that he was waiting for him to board and had 1 shackle of anchor cable still in the water. The pilot asked him to heave the anchor home. As soon as the cable was heaved on, the windlass motor failed and the cable started running out. The windlass brake was quickly applied and when the cable stopped running out, there were 2 shackles of cable in the water.

After the pilot boarded *APL Sydney* at 1603, the master informed him that the anchor could not be weighed and was advised that the anchor cable would have to be released. At 1611, the pilot discussed the situation with the control officer, who suggested moving the ship south before agreeing with the plan to release the cable. He did not provide the pilot with relevant information from harbour control's monitoring equipment that indicated the ship's position in relation to the pipeline.

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1 All times referred to in this report are local time, Coordinated Universal Time (UTC) + 11 hours.

2 The Hong Kong Special Administrative Region (SAR), People's Republic of China.

3 A nautical mile of 1852 m.

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

5 One shackle equals 90 feet or 27.43 m.

The pilot plotted the ship's 1615 position on the chart and told the master that the anchor lay south of the pipeline. He then explained his new plan to drag the anchor clear to the master, who agreed, and at 1620, the engine was run ahead.

At 1621, there was an eruption of gas about 50 m from *APL Sydney*'s bow as the pipeline ruptured. The engine was immediately stopped and the pilot asked harbour control to have the pipeline isolated. There were no injuries as a result of the rupture.

At 1628, the pilot ran the engine astern and manoeuvred the ship away from the gas. By 1710, the ship was stopped in the Inner Anchorage, north of the pipeline. The pilot asked for the anchor cable to be released. At 2153, the cable was cut using gas cutting equipment and the anchor and 2 shackles of cable were left in the water.

APL Sydney safely berthed in Melbourne on 14 December and, after completing its cargo operations, sailed the next day bound for Sydney.

The ATSB investigation found that, in the prevailing poor weather, the ship's intended anchor position was too close to the gas pipeline, insufficient anchor cable was deployed and the lee to disembark the pilot increased the anchor dragging rate. The delay in harbour control permitting weighing of the anchor and the master not using the main engine and additional cable to maintain the ship's position, allowed it to get dangerously close to the pipeline. When weighing anchor, ineffective use of the main engine and helm then allowed it to drag across and snag the pipeline. Later, the pilot's assumption that the pipeline was not fouled, the master not expressing any concerns and the control officer suggesting moving the ship south, led to the decision to drag the anchor clear instead of slipping it.

The investigation identified safety issues with respect to the safety management systems of the port, the ship and the pilotage company; and the windlass failure. Safety actions to address all the issues have been taken or proposed by the relevant parties.

The Port of Melbourne Corporation carried out a risk assessment with regard to the anchorage. Its limits have been revised and individual berths charted. Measures to address weather and monitoring-related issues have been implemented. In addition, the corporation will review its safety and environment emergency plan and shipping control procedures to address the risk of an incident involving the pipeline.

APL Sydney's managers have decided to revise passage planning procedures to ensure anchoring risks are assessed. The company will brief masters before they join ships to ensure they are certain about their overriding authority to supplement existing measures to promulgate its policy. Additional measures will be put in place to ensure crew are familiar with anchor cable release arrangements and to improve the English language proficiency of Chinese crews.

Port Phillip Sea Pilots will review its pilotage safety management system to include appropriate anchoring-related guidance to prevent a further incident of this type. The pilotage company will also review its mobile telephone use policy and raise the issue with the Port of Melbourne Corporation.

The windlass manufacturer, TTS Kocks, advised that it has been working with the classification society, Germanischer Lloyd, to address windlass design and safety issues mainly through a change in class rules to prevent injury to operators.

1 FACTUAL INFORMATION

1.1 *APL Sydney*

APL Sydney is a 'Panamax'[6] sized, fully cellular container ship (Figure 1). At the time of the incident, the ship was owned by Strong Wise, Hong Kong, chartered and operated by American President Lines (APL), Bermuda, and managed by Bernhard Schulte Shipmanagement Company (Schulte), China. It was registered in Hong Kong and classed with Germanischer Lloyd (GL).

APL Sydney was built in 2006 by Shanghai Shipyard & Chengxi Shipyard Company, China. With an overall length of 230.90 m, the ship has a moulded breadth of 32.20 m and a depth of 18.80 m. At its summer draught of 12.00 m, the ship has a deadweight of 42,248 tonnes.

Figure 1: *APL Sydney* berthed in Melbourne after the incident

The gearless container ship has a cargo capacity of 3,534 TEU[7], of which 2,074 can be stowed on deck and stacked up to six high. The ship has a raised forecastle deck where TTS Kocks electro-hydraulic windlasses for its port and starboard anchors are located. Each anchor, an Admiralty Class 14 type, weighs 8,325 kg and is fitted with 12.5 shackles of 81 mm diameter 'grade 3'[8] chain cable.

Propulsive power is provided by a MAN B&W 7K90MC-C two stroke, single-acting diesel engine that develops 31,990 kW at 104 rpm. The main engine drives a single, fixed-pitch, right-hand turning propeller which gives *APL Sydney* a service speed of 22.7 knots. The ship is also fitted with a 1,200 kW bow thruster.

The ship's navigation bridge is equipped with navigational equipment consistent with SOLAS[9] requirements. The equipment includes two Furuno GP-90-Dual

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[6] A ship that is limited in size to the dimensions of the Panama Canal.

[7] Twenty-foot Equivalent Unit, a standard shipping container. The nominal size of ships in TEU refers to the number of standard containers that it can carry.

[8] Made from extra special quality steel, the strongest and lightest material used for anchor chains.

[9] The International Convention for the Safety of Life at Sea, 1974, as amended.

global positioning system (GPS) units and a SAAB automatic identification system (AIS) unit. The two, Furuno FAR-28x7 series, radars are equipped with automatic radar plotting aids (ARPA) and have GPS and AIS inputs. Other bridge equipment includes two Furuno FM8800 very high frequency (VHF) radios, an Anschutz STD22 gyrocompass and a Seiko Epson course recorder. A Broadgate VER3000 voyage data recorder (VDR) is also fitted.

At the time of the incident, *APL Sydney* was on a liner service between Australia and Asia. The ship had made a number of voyages on this service before the incident, regularly calling at the Australian ports of Melbourne, Sydney and Brisbane.

The ship's crew of 24 Chinese nationals held appropriate qualifications, issued in China. The master started his seagoing career in 1984 and obtained his master's qualifications in 2001. He had been in command for 6 years before the incident. In 2006, he joined Schulte and completed an assignment on *APL Sydney* before returning to it 4 months before the incident. It was his fifth visit to Melbourne on board the ship.

The chief mate had 19 years of seagoing experience, the last 2 years as chief mate. He had been on board *APL Sydney* for 6 weeks and had sailed on many similar container ships.

The pilot on board the ship at the time of the incident began his seagoing career with an Australian company as a deck cadet in 1980. He progressed through the ranks and obtained his Australian master's qualifications in 1991. He sailed on bulk carriers and tankers, including ships larger than Panamax size. In 2005, after 6 years in command, he started training as a pilot in Port Phillip. In September 2008, after 3 years of training and piloting ships of increasing size and draught, he obtained an unrestricted pilot's licence for Port Phillip.

1.2 Port Phillip

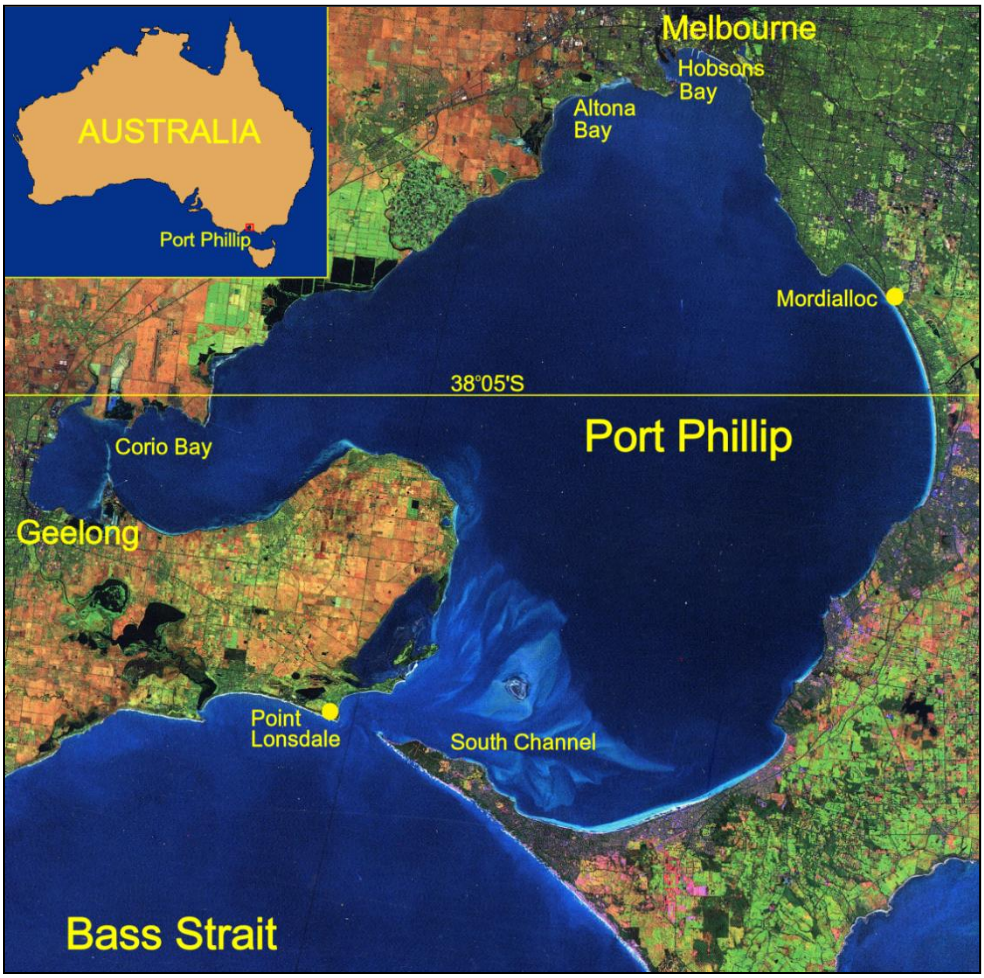
Port Phillip is an extensive bay, over 30 miles long from its entrance in the south, off Point Lonsdale, to Hobsons Bay at its northern end (Figure 2). The port of Geelong lies in Corio Bay on the western side of Port Phillip. The much larger port of Melbourne is situated at the head of Hobsons Bay.

Melbourne is Australia's busiest container port. For the financial year ending June 2009, the port handled 2.16 million TEU or about 36 per cent of Australia's container trade. During that period, of the 3,307 cargo carrying ships that visited Melbourne, 1,327 were container ships. Overall, a total of 29.1 million tonnes of containerised and bulk cargoes passed through the port.

Pilotage in Port Phillip is compulsory for every merchant ship over 35 m in length unless its master holds a 'pilot exemption' issued by the state maritime safety authority, Marine Safety Victoria (MSV). All pilotage services are provided by Port Phillip Sea Pilots (PPSP), a private company that operates subject to licensing by MSV and safety oversight by the port authority, the Port of Melbourne Corporation (PoMC).

In 2003, PoMC was established by the Victorian Government to be Melbourne's strategic port manager. It is also responsible for shipping movements within port waters, which include most of Port Phillip. Shipping movements are controlled by the harbour master through two shipping control centres, the Melbourne Shipping Management Centre (harbour control) and the Point Lonsdale Signal Station. The control centres together comprise what PoMC refers to as 'shipping control' with a stated objective of ensuring 'safe and efficient port operations'.

Figure 2: Annotated satellite image of Port Phillip



At the time of the incident, shipping control was in the final stages of the process to formally become a vessel traffic service (VTS[10]). Effective on 1 December 2008, MSV issued a determination that identified PoMC as the VTS authority, that is, responsible for managing, operating and co-ordinating the service. In practical terms, PoMCs shipping control had been functioning as the port's VTS for some time before the incident.

Harbour control monitors and controls shipping in port waters north of latitude 38º05'S, the northern sector. The Point Lonsdale Signal Station carries out the same functions in the southern sector, including the entrance to Port Phillip. Shipping control equipment includes radars, AIS, VHF radio, mobile and conventional telephones, closed circuit television, tide gauges, anemometers and wave rider buoys. Data from the equipment is continuously recorded at the control centres.

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10 The International Maritime Organization (IMO) Resolution A.857 (20) defines a VTS as a service implemented by a Competent Authority, designed to improve the safety of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and respond to traffic situations in the VTS area.

The two control centres are manned 24 hours a day by staff who are qualified and trained in accordance with requirements for VTS personnel. Each centre is manned by a VTS operator (communications officer). In addition, a shipping control officer (control officer) is on duty in harbour control at all times. All of the duty officers work 12-hour shifts that are completed at 0600 and 1800 daily. Their roster of two day-work shifts, then two night-work shifts followed by 5 days off, is in accordance with the PoMC fatigue and stress management plan.

According to shipping control procedures, duty officers are responsible for 'the due performance of and compliance with the provisions of the Harbour Master's Directions'. These directions describe the rules that masters and pilots should comply with when in port waters and they are included in the port's operations handbook[11]. Relevant extracts from the directions are contained in the Australia Pilot[12], a nautical publication that is required to be carried on board all ships for their intended voyage to Australia.

The control officer is also the duty assistant harbour master and is authorised to exercise the harbour master's powers. This includes the power to direct and control ships within port waters under which instructions or warnings can be issued to masters if necessary to ensure the safety of navigation or the environment.

At the time of the incident, the control officer on duty had worked in a similar role in Melbourne for 25 years. This had followed a seagoing career, including sailing as master while holding a New Zealand master class one certificate of competency. In addition to qualifications necessary for the VTS position, he maintained the validity of his seagoing qualifications. His recent training included completing a VTS operator's course in 2007.

1.2.1 Melbourne anchorage

At the time of the incident, the name Melbourne anchorage generally referred to two charted anchorages to the west of the Port Melbourne Channel (Figure 3). Designated as the Inner Anchorage and the Outer Anchorage, they were separated by a narrow corridor in which lay a submarine gas pipeline. Adjacent boundaries of the anchorages were parallel to and about 3 cables[13] (approximately 550 m) on either side of the pipeline's charted location.

The sea-bed in the anchorage area is composed of mud and shells. Water depths in the Inner Anchorage vary between 9 and 14 m and, in the Outer Anchorage, between 10 and 16 m.

The anchorage was regularly used by ships waiting for a berth in Melbourne or, in some cases, Geelong. Anchor positions were not allocated by harbour control and parts of the anchorages were not designated for specific purposes. A ship's anchor position was decided by its master and pilot based on factors such as its draught, size, type, destination, the weather conditions and the available swinging room.

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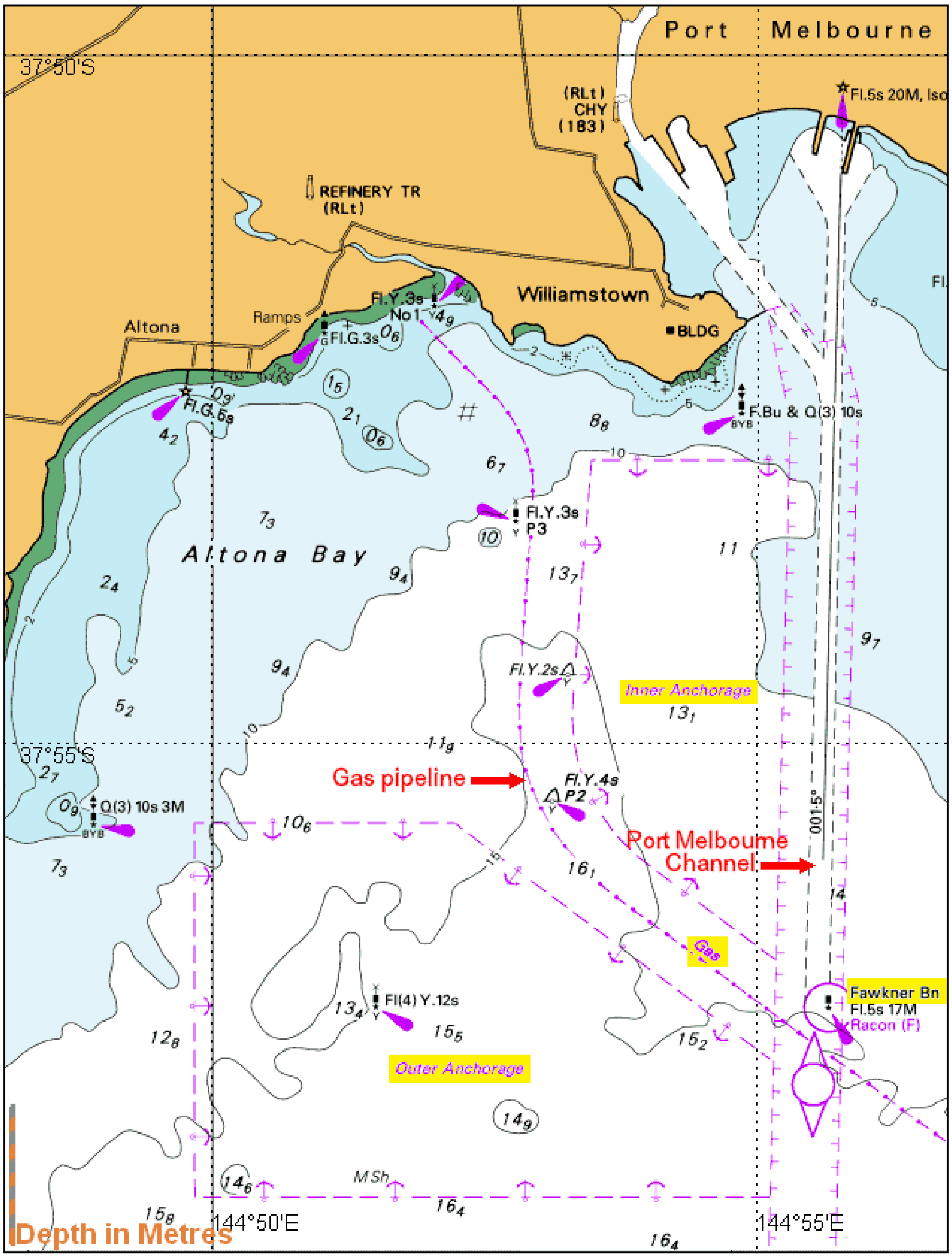
[11] Port of Melbourne Corporation, *Port Waters of Melbourne Operations Handbook 2006*, Section 3, P. 30-45, PoMC, 2006. Current handbook accessible via http://www.portofmelbourne.com/

[12] *Admiralty Sailing Directions*, Australia Pilot, Volume II, NP 14, Tenth Edition 2007.

[13] One cable equals one tenth of a nautical mile or 185.2 m.

Figure 3: Section of navigational chart Aus 143 showing anchorages off Melbourne at the time of the incident (yellow highlighting by ATSB)



After a ship is anchored, the anchoring time and position is reported to harbour control and this was usually given with reference to the Fawkner Beacon. A circular area, centred on the anchor position (guard ring), is then set up on harbour control's radar to monitor the ship's position. The control officer manually selects the guard ring radius and, if the ship drags its anchor, the radar display gives a visual indication of the situation. An audible alarm to alert the control officer if the ship moves out of the ring is not provided.

In accordance with the Harbour Master's Directions, a continuous listening watch on VHF channel 12 (harbour control's working channel) and 16 should be kept on board a ship at anchor. This is aimed at ensuring that communications with harbour control are maintained and local weather radio bulletins can be received.

The weather in Port Phillip is regularly affected by fronts associated with east moving depressions (low pressure weather systems) usually centred well south of the Australian coast. The Australia Pilot indicates that, on 35 to 40 occasions each year, these depressions create winds of gale force (34-40 knots) or greater strength offshore. Such weather is more than twice as likely during winter than in summer. While Port Phillip offers shelter from the swell and the wind is less intense than it is offshore, it can still be a significant factor for ships in the bay. Thunderstorms and line squalls can also produce strong local winds in Port Phillip.

1.3 Submarine gas pipeline

The submarine pipeline dividing the Inner and Outer Anchorages carries ethane[14] from Mordialloc, on the eastern shore of Port Phillip, to petrochemical plants at the head of Altona Bay (Figures 2 and 3). In the vicinity of the anchorages and the approach to Port Melbourne Channel, buoys and beacons provide an indication of the pipeline's general location.

The pipeline is owned and operated by Esso Australia (Esso) and was installed in 1972. It carries gas from a fractionation plant in Hastings to Mordialloc via a 45 km overland section and a 28 km long submarine section, which was laid in a trench about 2 m deep and allowed to silt over. The pipeline has a nominal diameter of 250 mm and its sections are made of carbon steel coated with coal tar enamel and an outer coating of concrete.

The pipeline is charted and a note on the chart states:

> Gas pipelines contain flammable gas under high pressure. Any ship damaging the pipeline would face an immediate fire hazard. Mariners are cautioned not to anchor or trawl in the vicinity of the pipeline.

The anchorages' boundaries lie at least 500 m from the pipeline's charted location. The Harbour Master's Directions stated that the master of a ship must not allow it to be anchored within 300 m of the pipeline or allow the ship to drag an anchor cable across it. According to Esso, anchoring within 150 m of the pipeline is prohibited.

1.4 The incident

At 0900 on 13 December 2008, *APL Sydney* arrived off Port Phillip, bound for Melbourne, after a voyage from Hong Kong. A Port Phillip pilot was expected to board at midday so the ship drifted a few miles east of the pilot boarding ground, which is located 5 miles southwest of Point Lonsdale. The ship had a draught of 8 m forward and 10 m aft with some containers bays on deck stacked four high.

At the time, weather conditions in the ship's location were moderate and recorded in its log book as a northeast wind at force[15] five (17-21 knots) with an overcast sky and clear visibility. Weather reports received on board the ship predicted worsening conditions outside Port Phillip and a storm warning for the coastal area had been

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[14] A by-product of petroleum refining and isolated from natural gas, ethane is a colourless, odourless, flammable gas that forms explosive mixtures in air.

[15] 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.

issued in the early hours of the morning. South-easterly winds of 25-35 knots, later becoming south to south-westerly and increasing to 30-50 knots, were forecast.

At 1106, a gale warning for the port of Melbourne was received on the ship's VHF radio. The wind in the ship's location, as forecast, had become south-easterly and increased to force seven (28-33 knots).

At 1112, *APL Sydney*'s main engine was started and the master turned the ship westwards to head towards the pilot boarding ground. The ship was in hand steering mode with the duty seaman at the wheel. At 1200, the ship was on a north-easterly course when the pilot boarded via a ladder rigged on its port side, the lee side.

At 1202, *APL Sydney*'s speed[16] was 9.4 knots with the main engine at slow ahead as it approached Port Phillip's entrance. On the bridge, the pilot discussed his plan for the 3-hour pilotage with the master, including the plan to anchor, as the ship was not expected to berth until 1945. The ship's passage plan was direct to the berth but otherwise similar to the pilot's and the master agreed to follow the pilot's plan. The pilot advised that he would provide other details during the transit. After exchanging other information, the two men signed off on each other's plans and documents. The pilot then took over the conduct of the ship, including communications with shipping control, and began increasing speed to full ahead.

By 1220, the ship was making good about 19 knots as it entered Port Phillip. The pilot reported to shipping control and advised an estimated time of arrival (ETA) of 1435 at the anchorage. The ship's course was then gradually altered towards the east, into the South Channel. The wind was now southerly at 27 knots with gusts up to 37 knots. A gale warning for Port Phillip was broadcast on VHF radio.

At 1300, *APL Sydney* exited the South Channel into the relatively open waters of Port Phillip. By 1304, the ship was on a northerly course towards Fawkner Beacon and in autopilot. The master advised the pilot and the second mate on watch that he was going to his cabin for a few minutes and left the bridge.

By about 1320, when the master had returned to the bridge, some drizzle and light rain that had earlier begun falling in parts of Port Phillip was being experienced. The southerly wind had increased to over 28 knots with gusts up to 40 knots.

At 1340, the pilot explained his anchoring plan to the master, stating that the Outer Anchorage offered better holding ground than the Inner Anchorage and was closer to Port Melbourne Channel's entrance. He reminded the master of the strong wind and indicated, on the chart, the northeast part of the Outer Anchorage where he planned to anchor *APL Sydney*. The tanker *HS Elektra*, anchored in the southeast part of the Outer Anchorage, was the only ship at anchor. The master agreed with the pilot's recommendation to use the starboard anchor with 5 shackles of anchor cable. The pilot asked for the engine to be ready for manoeuvring in 20 minutes.

The light rain persisted and the wind was now south-southwest at 34 knots with gusts exceeding 40 knots. The pilot asked for the pilot ladder, still rigged on the port side, to be adjusted lower in readiness for his disembarking. At about 1350, the pilot boat left its berth in Melbourne to pick up *APL Sydney*'s pilot. In planning the operation, the boat's skipper checked weather conditions with harbour control and the ship's intended anchor position with the pilot.

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16 All speeds referred to in this report are 'made good/over the ground'.

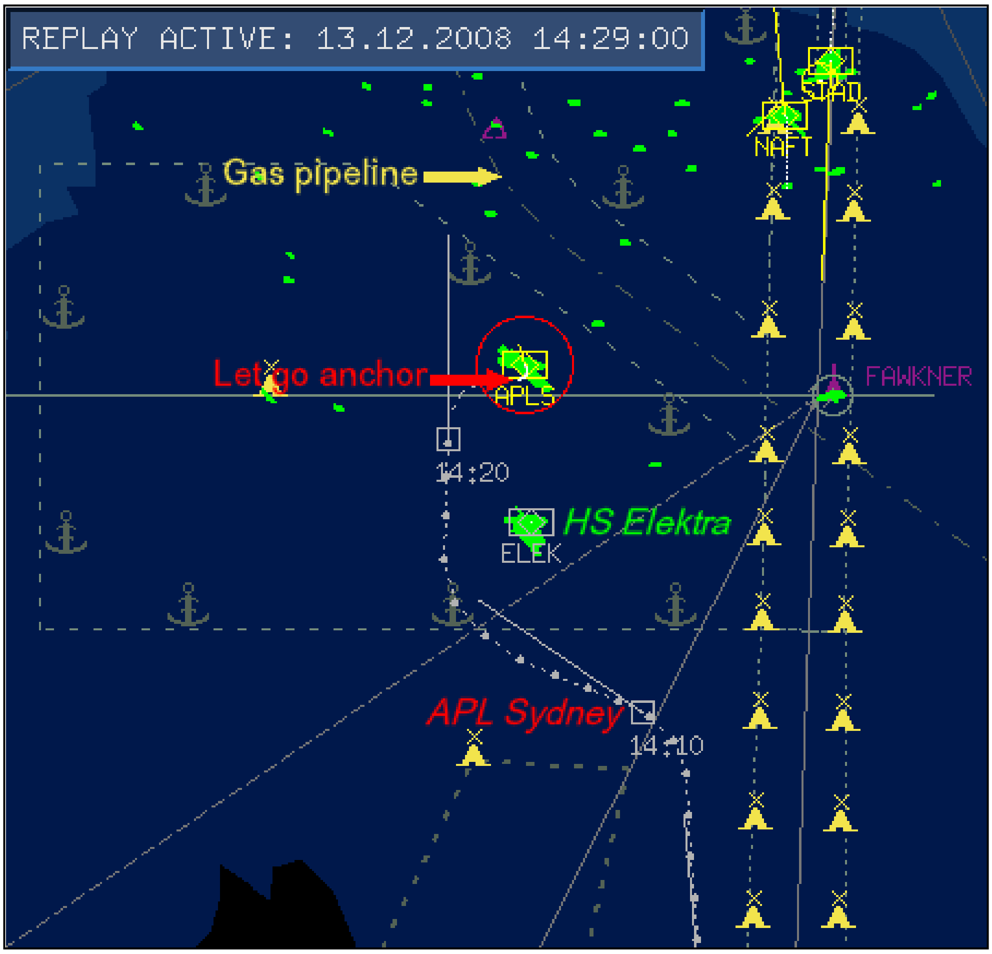
At 1400, the pilot ordered half ahead on the engine and asked that the ship's crew standby forward for anchoring. He advised the master that the ship would pass to the south and west of *HS Elektra* and come to a position to its north on an easterly heading and then let go the anchor. Indicating the gas pipeline on the chart, he advised the master that it was 'very important' for the ship not to drag its anchor and to 'keep a close anchor watch'. The master acknowledged the pilot's advice.

At 1407, with *APL Sydney* again in hand steering mode, the pilot began manoeuvring the ship as planned. Shortly thereafter, the chief mate on the forecastle reported via hand-held radio that the starboard anchor was ready for letting go. The boatswain and the deck cadet were also on the forecastle.

The ship's speed was gradually reduced and at 1423, as it approached the intended anchor position on an easterly heading, the engine was run astern. At about 1427, when the speed had reduced to 1.6 knots, the pilot ordered the engine stopped and the anchor let go.

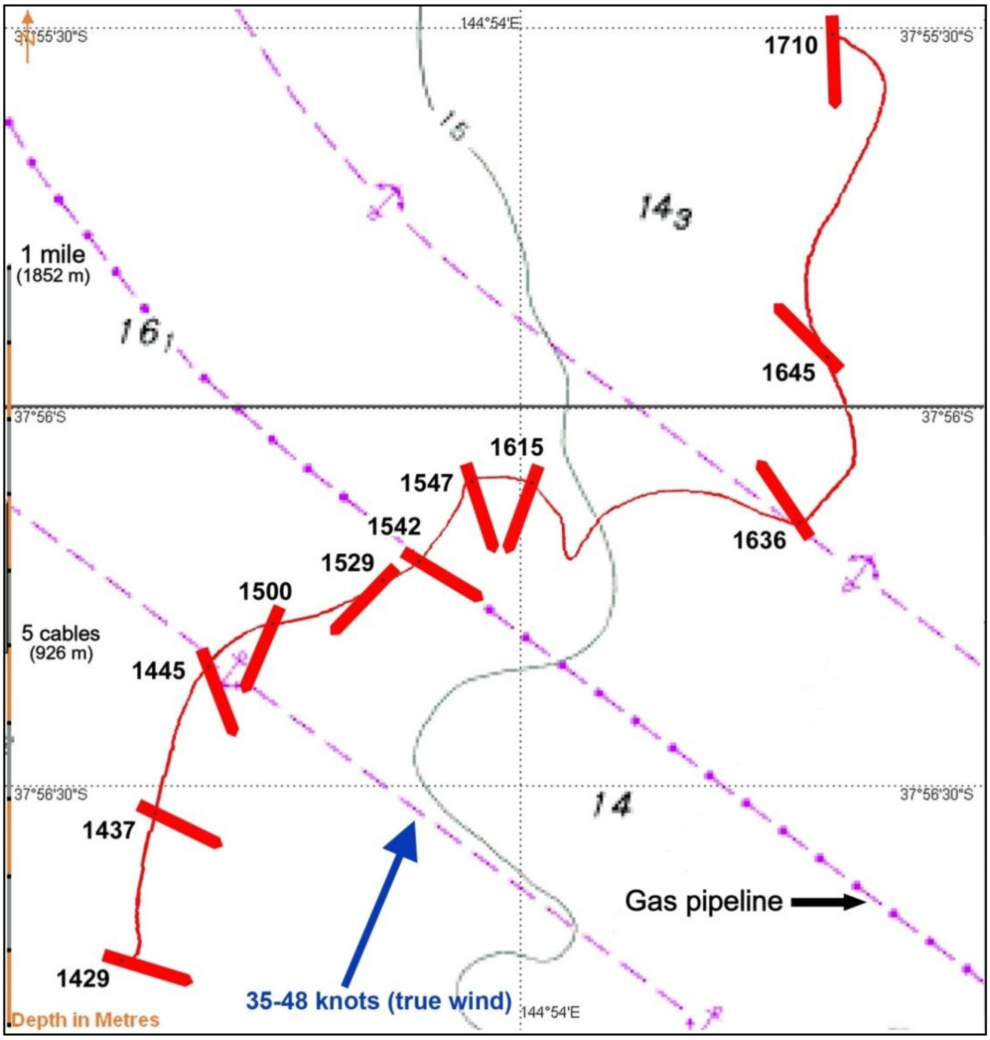
At 1428, when *APL Sydney*'s starboard anchor was let go, the ship's GPS unit indicated its position as 37º56.73'S 144º53.33'E, where the charted depth is about 16 m. The pilot advised the pilot boat's skipper that the ship had anchored 8 cables to the north of *HS Elektra*. At 1429, he reported to harbour control that the ship was anchored in a position 274º (T) x 1.8 miles from Fawkner Beacon (Figure 4).

Figure 4: Section of harbour control's radar display at 1429 on 13 December



At the time, the ship's heading[17] was about 108º and the 35 knot south-southwest wind, gusting to 48 knots, was on the starboard beam (Figure 5). The drizzle and light rain had continued.

Figure 5: Section of navigational chart Aus 155 with scale images of *APL Sydney*, aligned to its heading, at various times on 13 December



The pilot told the master that he would disembark while there was a lee for the pilot boat on the port side. At the time, there was 1 shackle of anchor cable in the water. The master asked if he should finish with 5 shackles in the water and then report to harbour control. The pilot confirmed 5 shackles, reiterated that the anchor position should be monitored 'very carefully' and advised it was not necessary to report to harbour control but to keep a listening watch. At 1432, he left the bridge, escorted by the second mate and by 1436, the pilot had disembarked.

The anchor cable was gradually run out as the weight came on it until there were 5 shackles in the water. As the ship slowly began to swing into the wind, the master monitored *APL Sydney*'s position using the radar while the chief mate reported the

[17] All ship's headings in the report are in degrees by gyro compass with negligible error.

cable direction and tension. At 1445, the ship was at the anchorage boundary and on a heading of 159º (Figure 5). It had still not 'brought up'[18] to the anchor.

A few minutes later, the ship had swung into the wind and its 1455 position, plotted on the chart by the second mate, was outside the anchorage. By 1500, the master noted that the ship was yawing[19] through 60º about its heading of approximately 200º in the 35 knot wind which was gusting to 45 knots. Concerned about the ship's proximity to the gas pipeline, he ordered the chief mate to prepare to weigh anchor.

At 1501, the master called harbour control and advised that *APL Sydney* was near the pipeline and that he wanted to weigh anchor and move ahead to keep clear of it since it was dangerous for the ship. The control officer said 'hold your position we'll get a pilot back out to you' and asked if he was managing to hold position. The master advised the coordinates of the ship's position and again said he wanted to shift position since it was near the pipeline. The control officer replied that if he wished to shift position, a pilot would need to be sent out. When the master said he just wanted to shift about half a mile ahead, he was advised a pilot was still required to shift. The master stated he did not need a pilot and asked if it was a 'problem' if he shifted the ship. The control officer confirmed that it was a 'problem' and to 'standby' until a pilot was sent out. The master repeated that he did not need a pilot and, if a pilot was required, the ship would remain in its position. He then advised the chief mate that weighing anchor was suspended until a pilot boarded.

The pilot, who was still on board the pilot boat which had just arrived at its berth, overheard the master's conversation with harbour control on the boat's VHF radio. At 1504, he called harbour control on his mobile telephone to check if *APL Sydney* was dragging its anchor. The control officer checked the radar and advised that the ship was at the north-eastern boundary of the Outer Anchorage. The control officer said that if the ship was maintaining its position, he did not want the master to move it. The pilot replied that if the ship was dragging its anchor then something should be done. It was agreed that the control officer would check with the master and if necessary, the pilot would return to the ship.

At 1506, the control officer asked *APL Sydney*'s master if the ship was maintaining its position. The master advised that it was and he would wait there and report again 'if there is a danger'. The control officer then spoke with the pilot who told him that the pilot boat's AIS indicated the ship was near the pipeline and asked the control officer to check this on his equipment. Harbour control's radar and AIS displays indicated that the ship was outside the anchorage boundary (Figure 6). The control officer checked the radar and advised the ship was near the anchorage boundary. He then checked the AIS display and told the pilot that it indicated that the ship was between the anchorage boundary and the pipeline. The pilot concluded that the ship must have dragged its anchor and it was agreed that he would return to the ship. It was 1511 and the pilot boat crew then prepared to depart the berth again.

At 1516, after checking with the pilot, the control officer informed the master that the pilot would board the ship in about 30 minutes and asked him to be ready to make a lee for the pilot boat. The master acknowledged this, updated the chief mate and asked the second mate to mark the pipeline on the radar using its mapping function (Figure 7).

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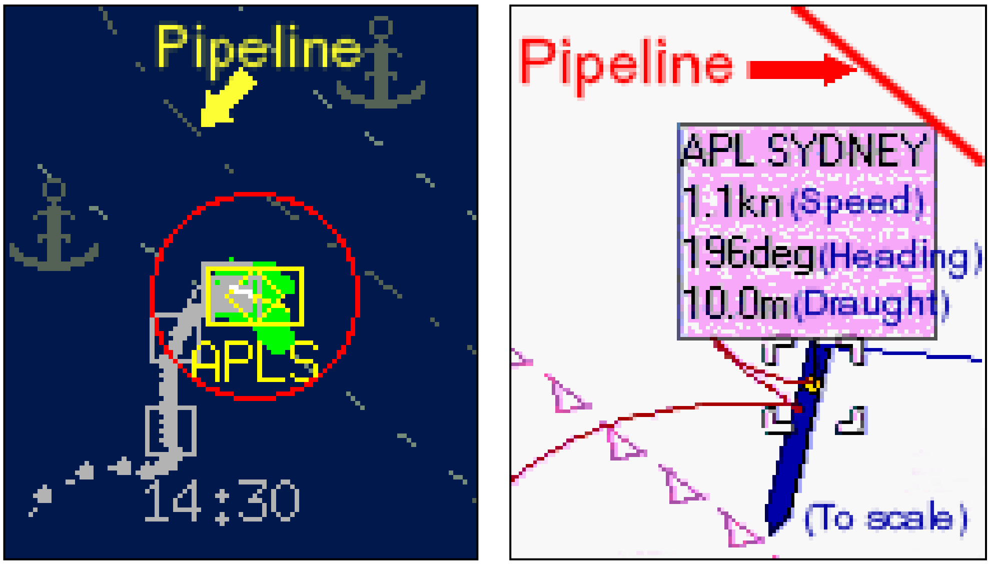
18 When a ship is riding to its anchor cable and the anchor is holding.

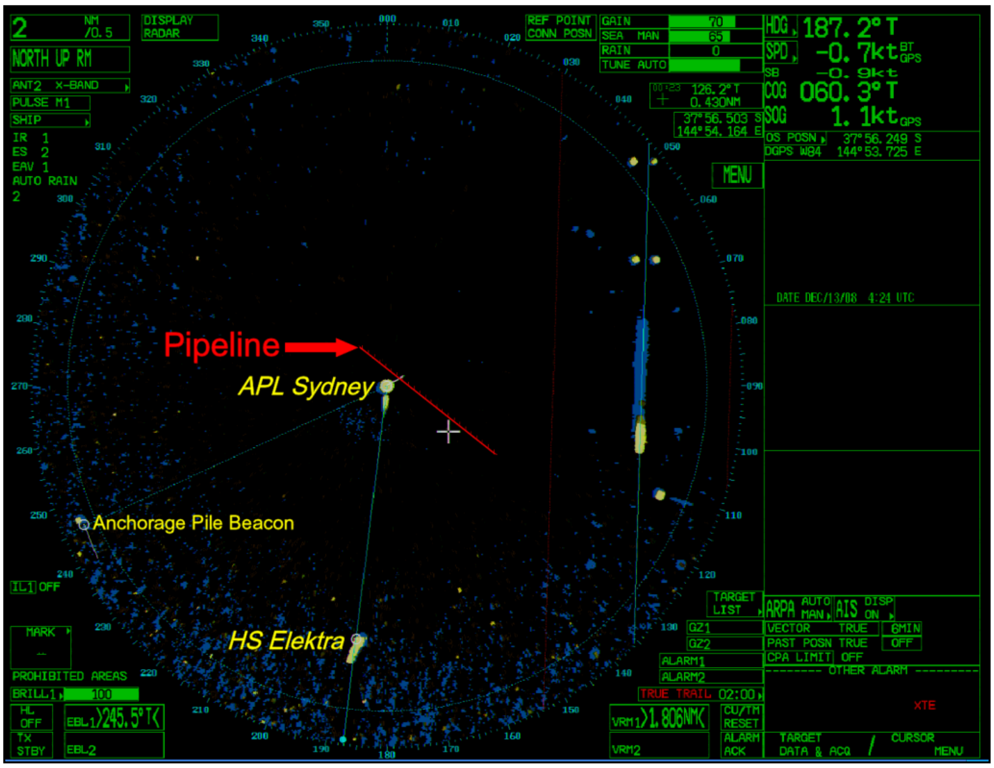
19 The ship's head swinging from one side to the other.

Figure 6: Sections of harbour control radar and AIS displays at 1506



APL Sydney’s yawing became more rapid and at 1524, the ship’s radar indicated that it was moving towards the pipeline at a speed of 1.1 knots. At 1525, alarmed that the anchor was dragging rapidly, the master called the pilot boat to check its ETA at the ship. He was given an ETA of 1600. Moments later, the control officer informed the master that it appeared the ship may be dragging its anchor and that the engine should be used to keep the ship clear of the pipeline. The master asked if he could move the ship half a mile ahead and this time the control officer replied ‘you have permission to shift your vessel’. Almost immediately, at 1527, the master put the engine dead slow ahead and ordered the chief mate to start weighing anchor.

Figure 7: *APL Sydney*’s radar screen at 1524 with pipeline astern of ship



At 1529, the master advised harbour control that he intended to move the ship to a position to its southwest. The control officer discussed with him a safe position for the ship and making a lee for the pilot boat. The crew continued heaving the anchor cable and the main engine was used, intermittently, at dead slow ahead with varied helm orders to relieve the weight on the cable. There was no swell to cause the ship to heave or pitch but the wind made conditions for weighing anchor difficult. As the cable shortened, the ship started to move away from the pipeline.

At 1535, having overheard the master's conversation with the control officer, the pilot called the master and asked him to heave the anchor all the way home without allowing it to drag towards the pipeline; and to move *APL Sydney* south, away from the pipeline. When the master replied he was 'heaving anchor and waiting for you', the pilot asked him to 'just heave the anchor all the way home'. The master then confirmed that he was 'heaving the anchor and waiting in anchorage for you'.

At about this time, the control officer telephoned the harbour master and made him aware of the ship's situation, including the information that the pilot was returning to the ship and that the master had been given permission to weigh anchor.

At 1536, *APL Sydney*'s heading was 180º when the ship began swinging rapidly to port. There were about 3 shackles of anchor cable still out. The engine, which was at dead slow ahead, was stopped but the rudder was left at port 10º. The ship's rate of turn remained about 20º per minute and by 1539, its heading was 140º. With the gale force wind now on the starboard beam, the ship began to be pushed bodily to port, towards the pipeline. At 1540, the engine was run at dead slow astern for about 1 minute with the rudder midships and then hard-over to starboard but the ship remained beam on to the wind.

At 1542, the pilot asked the master to confirm that the anchor was aweigh. The master informed him that there were 2 shackles of cable in the water. On its heading of 120º, the ship was now located directly above the pipeline and moving at a speed of 1.8 knots in a northeast direction (Figure 5).

At 1543, the engine was run dead slow astern and then slow astern. Weighing anchor had been suspended. Soon after, *APL Sydney*, now north of the pipeline, began swinging to starboard. About 2 minutes later, the engine was briefly stopped before being run dead slow astern again.

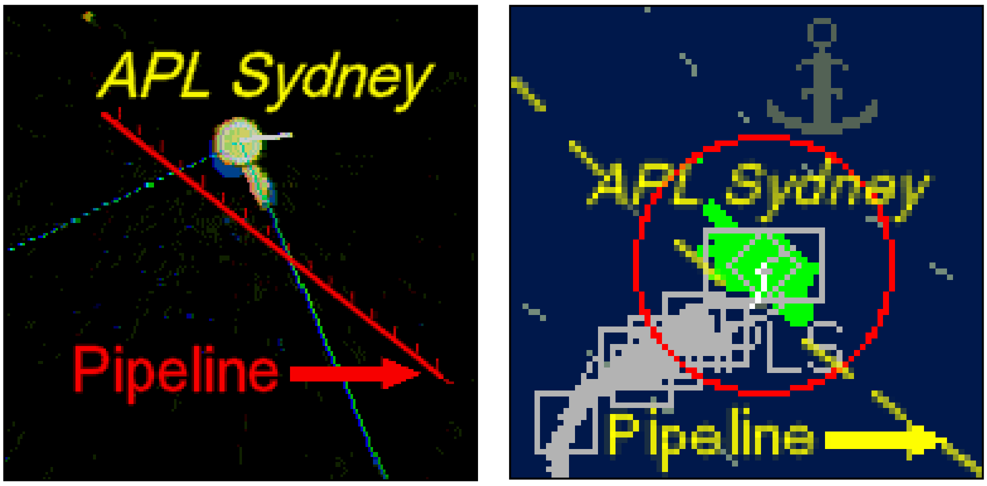
At 1547, the ship's heading was 160º. When its position, 37º56.09'S 144º53.92'E, was plotted on the chart, it indicated that the bridge was 1.5 cables (about 280 m) north of the pipeline. The engine was immediately stopped.

At 1548, the master advised the pilot that he was waiting for him to board and there was 1 shackle of anchor cable in the water. The pilot asked for the anchor to be heaved all the way home. There was already weight on the cable and as soon as it was heaved on, it suddenly began to run out. The boatswain quickly applied the windlass's manual friction brake and when the cable stopped running out, there were 2 shackles in the water. The cast iron casing of the windlass's hydraulic motor had shattered (Figure 8). Many of the motor's internal parts had been ejected from the casing. No one was injured by the ejected parts of the motor, fragments of the casing or debris from the cable as it ran out.

Figure 8: Shattered casing of windlass hydraulic motor

At 1549, the master informed harbour control that he was unable to weigh anchor and there were 2 shackles of cable in the water. The control officer asked that the engine be used to maintain a safe distance from the pipeline. The master told him that the engine could not be used because *APL Sydney* might be 'above' the pipeline and indicated that he did not know exactly where the pipeline was. The radar displays on board the ship and at harbour control indicated that the pipeline was slightly south of the ship (Figure 9).

Figure 9: Sections of the ship's and harbour control's radar displays at 1547



The control officer checked with the pilot that the pilot boat was 3 minutes from arriving at the ship. The pilot also said it was important to keep the anchor clear of the pipeline and that the ship should 'steam south'. The control officer then asked the master to weigh anchor as soon as possible and make a lee for the pilot boat. The master again stated he could not weigh anchor, nor would he use the engine. The master suggested that the pilot should board 'quickly'.

At 1553, the pilot boat arrived off *APL Sydney* and the pilot, after checking both sides of the ship, requested a pilot ladder on the starboard side. The master offered to make a lee on the port side and was told not to, in case the weight on the anchor cable increased. The pilot asked for the engine to be run at dead slow ahead until the cable was 'up and down' (slack) and then heaved. The master told him it could not be heaved and then informed harbour control that the windlass was 'broken'.

At 1558, while the crew were rigging the ladder, the pilot boat moved to near the ship's starboard bow. The pilot saw the cable was leading to port, over and across the bulbous bow at a sharp angle. By 1603, the ship's heading was 184º and with the port side now in the lee, the pilot quickly boarded the ship via the ladder there.

At 1606, when the pilot arrived on the bridge, the master told him that the windlass was broken. The pilot replied that since *APL Sydney* was in an unsafe position, the only option then was to release the anchor cable. The two men then discussed the situation and the master confirmed that the windlass could not be repaired. The pilot told him that the cable had to be released, with an anchor buoy attached, and asked him to decide whether to cut the cable (with gas cutting equipment), break the cable (by dismantling a 'kenter link'[20]) or slip it from the 'bitter end'[21].

At 1611, the pilot telephoned the control officer, explained the situation, his intention to release the cable, and that the master was checking with his 'principals'. He asked the control officer how deeply buried the pipeline was but the officer only had the charted information. When asked for suggestions to resolve the situation, the control officer agreed with the plan to release the cable and then inquired if the pilot thought that the ship was in the pipeline area. The pilot said the ship was to the north of the pipeline, the anchor to its south and even if it could be weighed, it was not known what damage might occur. The control officer then said 'unless you can steam to the other side'. When the pilot pointed out that the anchor 'might be all hooked around' and 2 shackles of cable would still be unrecoverable, the control officer agreed that the pilot's intention to release the cable was the best course of action and asked if the engine could be used to maintain the ship's position. The pilot indicated that he thought so and would progress the plan to release the cable.

At 1615, the control officer telephoned the harbour master with an update of the situation, including the pilot's plan to release the anchor cable. The harbour master told him to issue any 'directions' in order to protect the pipeline and agreed with the pilot's plan to release the cable. He asked the control officer to identify the parties to be notified in case the pipeline was affected.

APL Sydney was yawing about a heading of approximately 200º. The pilot noted the heading and at 1615, he plotted the ship's position on the chart using radar bearings. This position was 1.1 cables (about 200 m) north of the charted pipeline. The pilot explained to the master that the bridge was 200 m from the pipeline and to clear it, the ship had to be moved ahead in a 200º direction with its engine at dead slow ahead. The master accepted the new plan to dredge[22] the anchor and there was no discussion about discarding the initial plan to release the anchor cable. The master then confirmed that the cable was held on the windlass brake and leading on the starboard beam. At 1620, the pilot ordered dead slow ahead and requested that the chief mate inform the bridge when the anchor started to drag. The rudder remained at midships.

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20 A type of joining chain link commonly used to connect adjoining shackles of anchor cable.

21 The inboard end of the anchor cable that is secured to a strong point normally with some form of quick-release arrangement to allow the cable to be safely slipped in the event of an emergency.

22 Term used to describe the towing of an anchor at a short stay.

At 1621, less than 1 minute after the engine started to run ahead, there was an eruption of gas in the water about 50 m from the ship's starboard bow. The chief mate reported the bubbling wave-like turbulence and the master told the pilot that the pipeline had 'broken'. The sea surface appeared to the pilot as though it was boiling (Figure 10). The engine was stopped and the master asked the pilot to notify harbour control. The GPS unit indicated that the ship was in position 37º56.10'S 144º54.02'E.

Figure 10: Gas eruption as seen from the ship's bridge

At 1622, the pilot reported to harbour control that the pipeline had 'burst' and requested that the gas be 'turned off'. With *APL Sydney* downwind of the rupture location, the pilot asked the master to have ventilators on board the ship closed and for the crew to clear the deck.

Harbour control now started making telephone calls to notify Esso, the water police, the harbour master and other parties about the incident. As a precaution, the harbour master ordered that a tug with fire-fighting capability be placed on standby.

At 1627, the pilot explained to the master that *APL Sydney* had to be moved away from the gas cloud and that the pipeline could not, in any case, be damaged any further. At 1628, the engine was run slow astern and the bow thruster was used to turn the ship to a north-westerly heading. About 5 minutes later, the engine was run ahead and the ship was manoeuvred into the Inner Anchorage while dredging the anchor. The pilot notified Port Phillip Sea Pilots (PPSP) about the incident and updated harbour control.

At 1634, shortly after being notified, Esso activated the pipeline's emergency shutdown valves at Mordialloc and Altona.

At 1636, the pilot asked the master to arrange to 'break' the anchor cable. The master reported the situation to the Melbourne office of *APL Sydney*'s managers. The pilot was advised by PPSP that another pilot was being arranged to relieve him.

By 1640, the Melbourne water police had established a 1 mile radius exclusion zone centred on the location of the pipeline rupture. Warnings to shipping were broadcast on VHF radio by harbour control and the local volunteer coast guard. The water police asked the pilot to check that small vessels had left the area and the pilot boat then returned to Melbourne.

At 1645, after *APL Sydney* had moved further north, its engine was stopped. The pilot advised the master of his intention to use the port anchor after the starboard anchor cable was released. He suggested breaking the cable on the forecastle deck and the master ordered the chief mate to carry out the task.

By 1710, the ship had stopped, swung into the gale force south-southwest wind and brought up to the starboard anchor in position 37º55.51'S 144º54.56'E in the Inner Anchorage, about 9 cables to the northeast of the pipeline rupture position. The pilot remarked to the master that it was 'amazing' that 2 shackles of anchor cable were holding the ship where 5 shackles had failed to do so in the Outer Anchorage.

A kenter link was not located on the cable on deck at the time, so the crew had started to dismantle a link inside the chain locker.

At 1800, water police instructed the pilot boat, with the relieving pilot on board, to wait outside the exclusion zone. *APL Sydney* was still inside the zone.

About 1 hour later, the size of the exclusion zone was reduced and the pilot boat was permitted to proceed to the ship. The weather had moderated but the south-southwest wind was still force seven.

At 2011, harbour control advised the pilot that Esso had permitted the anchor cable to be cut if atmospheric checks did not detect any gas. The master advised the pilot that the crew were still working on the kenter link.

At 2018, after delays were experienced in rigging the pilot ladder, the relieving pilot boarded *APL Sydney*. Soon afterwards, two water police officers also boarded. On the bridge, the pilots and police officers discussed the situation. The police officers carried out their own assessment after which the exclusion zone was cancelled.

At about 2100, the master asked the pilot if the anchor cable could be cut in the chain locker where the crew had been unable to dismantle the kenter link. The pilot, unaware that the crew were working in the chain locker, replied that it would be dangerous to cut the cable there because it would 'fly over the gypsy[23]' and 'make a mess' and therefore should only be cut on deck.

At 2120, the pilot handed over to the relieving pilot and left *APL Sydney*. Preparations to cut the cable on the forecastle deck had been commenced and an anchor buoy had been connected. The chief engineer and the fitter were readying oxy-acetylene gas cutting equipment. Atmospheric checks by the chief mate with the ship's gas detector confirmed there was no gas on deck.

At 2140, the water police officers left the ship and shortly afterwards, the fitter began cutting the starboard anchor cable near the lip of the hawse pipe. By 2153, the cable had been cut and it safely fell through the hawse pipe. The pilot reported to harbour control that the ship was underway. Berthing was expected at 0330 the next day and the pilot decided not to anchor the ship but to steam slowly inside Port Phillip. He advised harbour control and the master of his plan and manoeuvred the ship southwards.

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[23] A wheel shaped to fit the anchor cable chain links that allows the windlass to heave in or pay out the cable.

At about 2330, harbour control advised that *APL Sydney* was now expected to berth at 1400 the next day. The pilot then turned the ship towards Melbourne anchorage.

At 0048 on 14 December, *APL Sydney*'s port anchor was let go in position 37º58.19'S 144º52.74'E in the southern part of the Outer Anchorage. The ship was on an easterly heading with the southerly force six (22-27 knots) wind on its starboard beam. *HS Elektra*, which had remained at anchor, was about 7 cables to the northeast. At 0054, after reporting to harbour control and advising the master to finish anchoring with 8 shackles in the water, the pilot left the ship.

By 0105, the ship had swung into the wind and *HS Elektra* was now about 4 cables away. Communications between the two ships followed to confirm that *APL Sydney* was not dragging its anchor. The master attended to this and remained on the bridge for another hour.

At 0225, harbour control called *APL Sydney* to advise that a pilot would board the ship after 1 hour since its berthing had come forward.

At 0330, a pilot boarded *APL Sydney* and by 0548, the ship was all fast at its berth, number one west Swanson Dock.

Representatives from the Australian Maritime Safety Authority (AMSA), the ship's managers, its owners and GL (the ship's classification society), amongst others, attended the ship while it was in Melbourne. Conditions of class with respect to the starboard windlass and anchor were imposed by GL.

On 15 December, after completing its cargo operations and following permission from GL, AMSA and its flag State to continue the voyage, *APL Sydney* sailed from Melbourne.

1.4.1 Events after 15 December

APL Sydney continued its voyage to Sydney and then to Brisbane, where it anchored on 18 December. By this time, Esso and other parties had commenced legal proceedings against the ship's owners in respect of the loss suffered and damage caused as a result of the incident. The ship was placed under court ordered arrest to remain at Brisbane anchorage.

Esso had started planning for the pipeline inspection and repair work soon after the incident. Two workboats had arrived in Port Phillip in preparation for this work by the time the ship had sailed from Melbourne. By 31 December, initial surveys and planning for the pipeline repairs, which were expected to take several months, had been completed.

On 10 January 2009, *APL Sydney*'s starboard anchor and cable were recovered from Melbourne anchorage.

On 22 January, after an agreement had been reached over legal matters, the ship was released from arrest.

On 12 February, after completing repairs following its cargo operations, *APL Sydney* sailed from Brisbane. Subject to pending conditions of class, the ship then resumed normal trading.

2 ANALYSIS

2.1 Evidence

On 14 December 2008, two investigators from the Australian Transport Safety Bureau (ATSB) attended *APL Sydney* in Melbourne. The master, chief mate and second mate were interviewed and provided their accounts of the incident. Copies of documents, including the navigational chart used, log books, bell book, main engine movement logger, course recorder chart, weather reports, passage plan, checklists and safety management system (SMS) procedures, were obtained.

The ATSB investigators temporarily retained the removable hard disk drive from the ship's voyage data recorder (VDR) to allow incident related navigational and audio data to be extracted.

The investigators verified that the ship's gyro compass, engine movement logger, automatic identification system (AIS) and global position system (GPS) units were in good working order. Photographs of evidence, including the damaged starboard windlass were also taken.

Later that day, the investigators attended the Melbourne Shipping Management Centre (harbour control) and interviewed the shipping control officer (control officer) on duty at the time of the incident. A copy of the Port of Melbourne Corporation (PoMC) shipping control safe operating procedures was obtained. Data recorded at harbour control from the AIS, radar, weather and voice communications equipment during the relevant period was also obtained.

On 15 December, the pilot was interviewed at the Port Phillip Sea Pilots (PPSP) office in Melbourne. Copies of documents, including his statement and PPSPs pilotage safety management system (PSMS) procedures were taken.

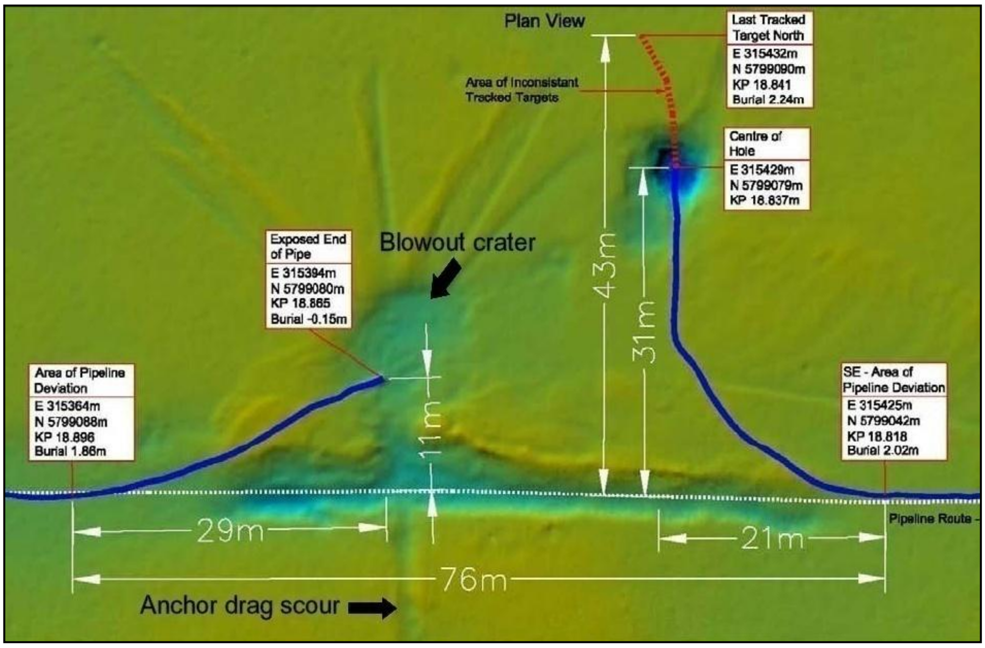
During the investigation, additional information was obtained from Esso Australia (Esso), PoMC, PPSP, Marine Safety Victoria (MSV), the Australian Bureau of Meteorology and the windlass manufacturer, TTS Kocks.

2.2 Gas pipeline rupture

At 1621 on 13 December, the submarine ethane gas pipeline in Port Phillip ruptured immediately after *APL Sydney*'s main engine was run ahead. An attempt was being made to dredge the ship's starboard anchor clear of the pipeline because the pilot thought that the anchor had not snagged the pipeline. However, about 35 minutes earlier, the ship had dragged its anchor cable across the pipeline and fouled it.

The preliminary survey of the ruptured pipeline revealed the anchor dragging scour mark, sections of the displaced pipeline and the blowout craters (Figure 11). This evidence is consistent with what is likely to have happened. The anchor's flukes are 2.5 m long and, when tripped, extend more than 1 m from the shank. The anchor, at more than 8 tonnes, would have sunk into the mud on the sea-bed and as it dragged, the flukes probably went under the pipeline and pulled it from its trench. The anchor then held the ship with its flukes hooked under the pipeline and the shank above it. When the ship's engine was run ahead, the pipeline was pulled with sufficient force to rupture it.

Figure 11: Plan view image from preliminary survey of the ruptured pipeline



2.2.1 Guidance to avoid pipeline rupture

A number of nautical publications, including the Australian Seafarer's Handbook[24], the Mariner's Handbook[25], the Australia Pilot, navigational charts and notices to mariners, provide appropriate guidance and information to avoid damage to submarine pipelines and cables. The main objective is to protect life and property and this can best be achieved by preventing a ship from fouling a pipeline or cable and, if fouled, minimising the damage. There are very high risks and costs associated with damage to submarine installations and, hence, avoiding such damage underpins all relevant guidance.

The following extract from the relevant Australian notice to mariners[26] summarises the guidance applicable to *APL Sydney*'s situation before the pipeline rupture.

> In the event of any vessel fouling a pipeline the anchor or gear should be slipped and abandoned without attempting to get it clear. Any excessive force applied to a pipeline could result in a rupture and, in the case of a gas pipeline, the consequential sudden release of gas at high pressure - somewhat like an explosion - could cause serious damage or loss of the vessel. There would be an accompanying severe and immediate fire hazard.

Similar notices to mariners, referring to submarine pipelines and cables, have been published by a number of hydrographic offices annually for several decades. Together with other nautical publications, relevant guidance has, therefore, been widely promulgated for a long period of time and forms the basis of recognised safe practice and guidance on this subject for mariners, ports and others.

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24 Australian Hydrographic Service, *Australian Seafarers Handbook*, p.118-119, Edition 1.0, 2004.

25 United Kingdom Hydrographic Office, *The Mariner's Handbook*, p. 80, Eighth Edition, 2004.

26 Australian Hydrographic Service, *Annual Australian Notices to Mariners 2008*, Notice Number 14 - Submarine Cables and Pipelines.

To afford greater protection to submarine cables and pipelines, and to avoid major disruption of services and very expensive repairs, a number of provisions exist to compensate shipowners for the relatively inexpensive gear sacrificed to avoid such damage. The notice to mariners[27], the Australian Seafarer's Handbook and the Mariner's Handbook include information for making such claims under applicable national legislation[28] and international conventions[29] which have been in place for a long period of time.

The Mariner's Handbook notes that if it is suspected that a ship has fouled a gas pipeline with its gear or anchors, excessive weight should not be placed on the gear as it could damage the pipeline and the ship 'could face an immediate hazard by loss of buoyancy due to gas aerated water or fire/explosion'. Given the high risk and because many pipelines were laid before GPS receivers became commonplace and accurate position information was so readily available, it would be prudent to be cautious rather than completely rely on the accuracy of their charted locations.

In essence, the only appropriate course of action if a ship has, or is suspected to have, snagged its anchor on a gas pipeline is to avoid placing weight on the anchor cable and to slip the cable as soon as possible. Had this been done in *APL Sydney*'s case, the ethane gas pipeline probably would not have ruptured.

2.3 Fouled pipeline

After *APL Sydney*'s anchor was let go, a number of opportunities to prevent the ship fouling the pipeline were missed. Although the windlass failure had some influence on later decisions, appropriate action that could have prevented the pipeline rupture was not taken. Subsequently, the process of releasing the anchor cable became unnecessarily prolonged and hazardous.

2.3.1 Anchor dragging

In a strong wind, an anchor position is commonly approached heading upwind so that leeway is reduced. After the anchor is let go, the required anchor cable is gradually laid out as the ship drifts astern and weight comes on the cable. This prevents the cable piling up in one position, possibly fouling the anchor. While such common practice allows a ship to bring up safely and efficiently, on 13 December it would have been unsuitable for making a lee to disembark *APL Sydney*'s pilot.

At 1428, the starboard anchor was let go with the ship on an easterly heading to ensure that the port side was in the lee for the pilot to safely disembark. Four minutes later, having reported to harbour control that the ship was anchored and after giving the master some final advice, the pilot left the bridge.

In submission, PoMC and the control officer jointly stated:

> At 1429 the pilot reported to harbour control that the vessel was anchored and that he was leaving the bridge, one to two minutes following the letting go of the anchor. He then appears to have descended to the deck for disembarkation in the

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27 ibid.

28 *Commonwealth Submarine Cables and Pipeline Protection Act, 1963.*

29 *Convention for the Protection of Submarine Cables, 1884* and *Convention on the High Seas, 1958.*

> pilot launch before the vessel was brought to anchor. ... The pilot left the bridge ... some two minutes after letting go the anchor and before the vessel was anchored and maintaining position.

While these statements are accurate, the pilot had a valid personal safety concern in making a lee to disembark. It is routine practice for pilots, when anchoring in rough weather, to make a lee and quickly disembark, leaving the master to complete anchoring. However, this is not the only option and a pilot should aim to complete the pilotage in a manner that ensures the ship's safety. It was important the leeway *APL Sydney* would experience in the prevailing conditions before bringing up to its anchor was appropriately considered in the pilot's anchoring plan. This may have assisted him in making prudent decisions with respect to the anchor position and if, when and how to safely disembark without increasing risks for the ship.

When anchoring with the ship heading across the wind, the increased leeway and the anchor dragging may not be particularly relevant if there is enough swinging room and sufficient clearance from hazards. However, this was not the case with *APL Sydney*'s intended anchor position in the north-eastern part of the Outer Anchorage. The rapid leeway experienced by the ship, immediately after the pilot disembarked, became a significant factor.

APL Sydney, like most ships when drifting, lay across the wind. When the pilot left the bridge there was 1 shackle of anchor cable in the water. It took about 15 minutes to lay out the planned 5 shackles of cable which indicates that this was done slowly. In the prevailing weather conditions, the anchor was dragging and tension on the cable would have been constantly changing and it was probably allowed to run out only when more weight came on it. The unintended delay in laying out the cable allowed the anchor to drag more than 400 m towards the anchorage boundary.

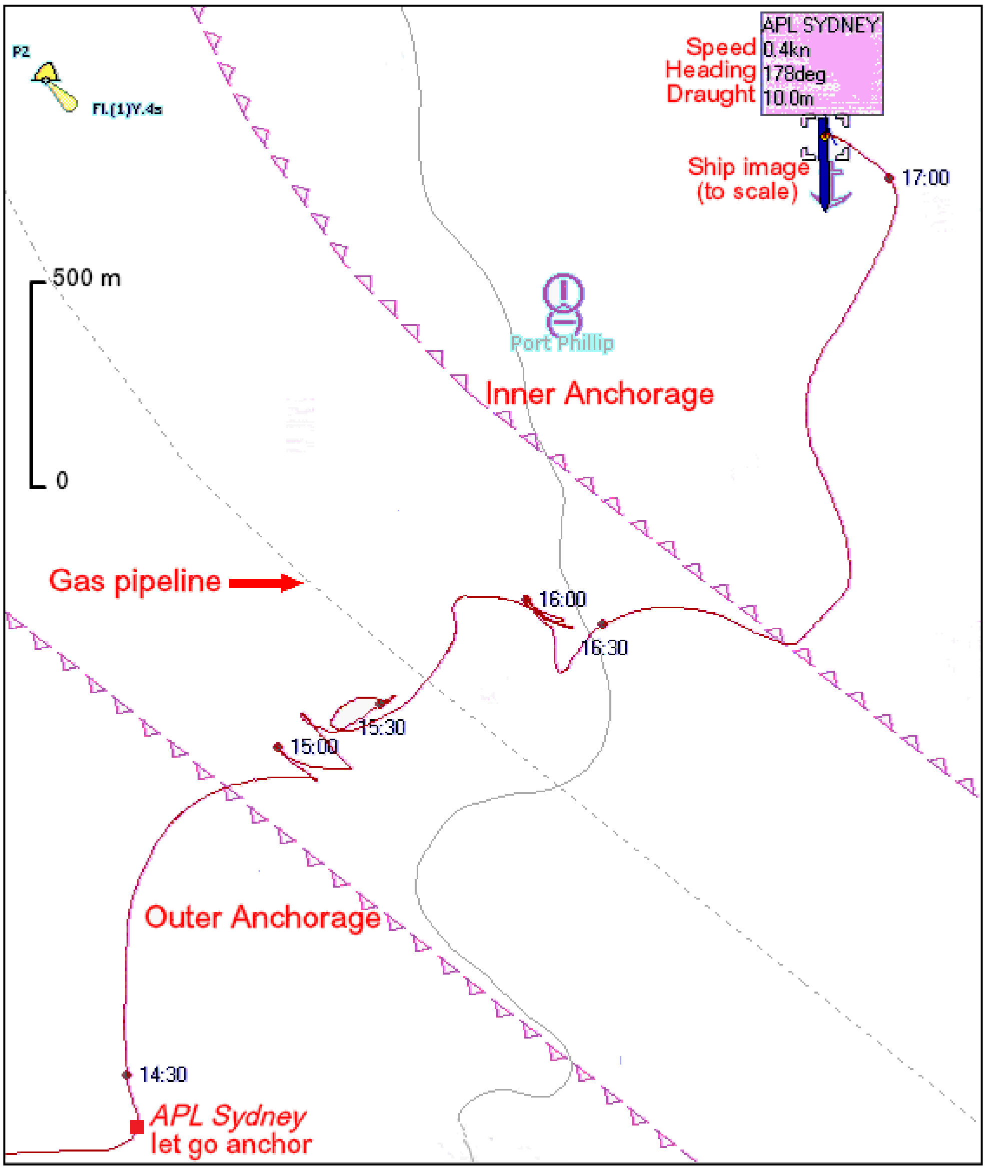
By 1450, the ship had swung into the wind to ride to the anchor and its bridge was already outside the anchorage. The master was monitoring its position and observed that the ship began to rapidly yaw through 60º. During the next few minutes, the anchor appeared to be holding but the yawing continued. Such yawing significantly increases the likelihood of the anchor breaking its hold in the sea-bed. At 1501, with the pipeline about 300 m astern of the ship, the master was sufficiently concerned to call and advise harbour control of his intention to weigh anchor and move the ship to a safer position within the anchorage.

At harbour control, the control officer had been occupied with communications to resolve other traffic issues when the pilot reported *APL Sydney* anchored, and had not set up a radar guard ring for the ship. When 5 shackles of anchor cable had been deployed, the master, following the pilot's advice, did not call harbour control. Hence, it was his call at 1501 that first directed the control officer's attention to the ship's situation. In submission, PoMC and the control officer advised that, at the time of anchoring, there were no communications that indicated to the control officer that the ship was in imminent danger which required his undivided attention to the monitoring of the anchorage.

Harbour control's equipment, the AIS in particular, allowed effective real-time ship traffic monitoring. The AIS display indicated *APL Sydney*'s GPS position, heading, speed and movement in relation to the pipeline (Figure 12). However, the control officer normally used AIS to monitor moving traffic and radar to monitor anchored ships. Shortly after 1501, he checked the radar and instructed the master to maintain position and wait for a pilot. At interview, he stated that he thought it was more prudent that the ship remain in its position rather than risk the anchor dragging more quickly as the cable shortened when it was weighed in bad weather and without a pilot on board. In submission, PoMC and the control officer advised that the master was requested to maintain position until a pilot could be sent back to the ship because pilotage is compulsory in Port Phillip.

However, the control officer made a decision based on an assessment of a situation he had not been appropriately monitoring, whereas the master had monitored the situation and was well placed to assess it. Although pilotage is compulsory, the pilot had left *APL Sydney* about half an hour earlier and it would take time to send a pilot back to the ship, which was now outside the anchorage, and immediate action on board was required to resolve the situation. In following the control officer's instructions, the master suspended his plan to weigh anchor and shift the ship but took no action or precaution to maintain its position. While the control officer had concerns with regard to shortening the cable, he had not suggested deploying more cable to the master. Their interaction at this stage resulted in no action being taken, when immediate and effective action on board the ship was necessary.

Figure 12: Section of harbour control's AIS display showing *APL Sydney*'s position and track from about 1420 to 1710 on 13 December



In the pilot boat, the pilot had been listening to the conversation between the master and the control officer. He was concerned because he felt that the control officer should have been fully aware of the situation and should have allowed the master to take any necessary action. However, the main outcome of his advice to the control officer that something should be done was the decision that the pilot return to the ship. It was only after this decision that the control officer set up a 250 m radius radar guard ring to monitor the position of the ship which was already about 300 m from the pipeline. Furthermore, the control officer never used the AIS equipment to effectively monitor the ship's position.

The control officer told the pilot more than once that he did not want the master to move the ship without a pilot on board. The master wanted to move the ship half a mile to the southwest, away from the pipeline, and at that time there were no other ship movements in the anchorage. This evidence suggests that the control officer did not consider the master was capable of handling the situation. His decision to not allow the master to move the ship at that time proved critical.

Shipping control procedures state that a master can choose to ignore instructions if necessary to ensure the safety of the ship. However, it is also an offence to fail to comply with directions or obstruct the harbour master. Even if *APL Sydney*'s master, who was ultimately responsible for the ship, was sure about his overriding authority and these possibly conflicting regulations, it is likely that the instructions from harbour control confused him and increased his uncertainty. While he became increasingly concerned, he appears not to have considered using the main engine and/or paying out more anchor cable in an attempt to reduce or prevent anchor dragging. Having decided to follow instructions and not weigh anchor, the master should have at least deployed more cable immediately and certainly no later than when he suspected that the anchor might be dragging.

By 1525, when the master called the pilot boat to check its ETA, the anchor was rapidly dragging. Moments later, the control officer, probably prompted by the radar guard ring, informed the master that the ship may be dragging its anchor.

In submission, PoMC and the control officer jointly stated:

> At 1525 it was the control officer who informed the master that he appeared to be dragging and told the master to use his engines to keep himself clear of the pipeline. As it was now apparent the master was not taking sufficient action to manoeuvre his ship he was instructed at this time by the control officer to shift his vessel.

Although the control officer did ask the master to use the main engine to keep clear of the pipeline, it was only after the master again asked if he could shift *APL Sydney* that the control officer gave him permission. More than 20 minutes had elapsed since the pilot had told the control officer that something should be done. This suggests that the control officer was focused on getting the pilot on board the ship, when immediate action to keep the ship's anchor clear of the pipeline should have been his highest priority. Had he properly assessed the situation after the master's initial call, he may have allowed the master to take action earlier. An assessment of the situation would have benefited from effective use of the AIS display.

The delay in weighing the anchor resulted in the ship moving a further 300 m towards the pipeline and its stern was now only about 40 m from it. At 1527, when the crew began weighing it, the anchor was less than 400 m (about 2 cables) from the pipeline. In the difficult weather conditions, this was a relatively short distance for the large ship. Very effective use of the main engine would be necessary to keep the anchor clear of the pipeline with little, if any, room for error.

In submission, PoMC and the control officer jointly stated:

> The report infers that the master's delay in weighing anchor was due to a delay in the control officer not giving permission to the master to raise his anchor. Any such inference is rejected by PoMC. Any delay was due to the master not using his main engines to steam up to his anchor and retrieve it.

Although the master took no action to maintain *APL Sydney*'s position, had he been permitted to shift the ship earlier, he intended to, and would have, weighed anchor. By the time weighing anchor was started, the ship had moved much closer to the pipeline. During the period in between, the lack of action suggests that neither the master nor the control officer detected that the anchor was dragging.

In the first 10 minutes of starting to weigh anchor, the main engine was run, intermittently, at dead slow ahead for about 6 minutes. The ship made progress away from the pipeline and the crew were able to heave in the anchor cable. However, effective use of the engine and helm, assisted by the bow thruster, was critical in the following period to keep the anchor clear of the pipeline. As the cable shortened, dredging the anchor became an option. It is unlikely that the master considered this because, like many masters on large ships, he was probably unfamiliar or uncomfortable with this increasingly rare practice[30].

At about 1530, the control officer again advised the master about making a lee for the pilot boat which suggests he remained focused on getting a pilot on board *APL Sydney*. On the other hand, the pilot was focused on the ship quickly moving away from the pipeline and at 1535, advised the master to move the ship south. Their communications with the master, although intended to assist and resolve the situation, were probably an unnecessary distraction for him at the time.

At 1535½, soon after speaking with the pilot, the master put the engine dead slow ahead. The rudder was left at port 10º and *APL Sydney* began swinging rapidly to port. The engine was stopped but the ship continued to turn and soon lay beam on to the wind and its anchor dragged even more rapidly. In that situation, only bold ahead movements of the main engine with maximum starboard rudder, assisted by the bow thruster, could have resulted in turning the ship into the wind.

However, by this stage, the master was probably reluctant to manoeuvre with the anchor on the sea-bed. Moreover, the fast pace of events in an unfamiliar, difficult situation meant his workload was high and any distractions, including the communications at the time, made errors more likely. After 1540, the astern engine movements with the rudder at midships and then hard-over to starboard appear to have been ordered in confusion as the ship was rapidly pushed downwind.

At about 1544, after its anchor snagged the pipeline, *APL Sydney* began swinging back to starboard, into the wind. There was 1 shackle of anchor cable in the water and heaving had been stopped. In less than 10 minutes, the situation had changed from one of relative control to a highly dangerous one.

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30 The increasing size of ships in the last few decades, the greater availability of suitable tugs and concerns about damage to anchoring equipment has led to the practice becoming less common. Less experience, in turn, has reduced the skills and confidence in dredging anchors.

Essentially, making a lee for the pilot boat and the delay in laying out the anchor cable ensured that before the ship could ride to the anchor, it had already dragged over 400 m. Subsequently, the delay in allowing the ship to shift and the lack of action to maintain position resulted in the anchor dragging at least another 400 m. With little sea room remaining, the action taken while weighing anchor was not sufficient to prevent it snagging the pipeline. Given there was 1 shackle of cable out, it is likely that, had weighing anchor started a little earlier, it would not have fouled the pipeline.

2.3.2 Windlass failure

At 1548, *APL Sydney*'s starboard windlass failed when the crew again heaved on the anchor cable. With the anchor snagged on the pipeline and 1 shackle of anchor cable out, there was significant weight on the cable as the ship yawed in the strong wind when it suddenly began to run out. It could not be determined if the windlass hydraulic motor shattered before or after the cable started running out.

In submission, the windlass manufacturer, TTS Kocks, advised that the hydraulic motor probably failed as a result of 'over speed' rotation in the opposite direction to its normal turning (heaving direction) due to 'enormous outer forces'. Such rotation progressively damaged and displaced the motor's internal parts and this process led to its casing shattering. This view is based on its 60 years of windlass development and manufacture and information obtained from its suppliers, hydraulic component makers and equipment operators.

According to TTS Kocks, a pressure relief valve in the hydraulic system is set at 280 bar[31] to comply with the relevant class rules. The valve relieves overpressure in normal conditions but operating the windlass in severe conditions will result in an excessive overload and the valve will not prevent the over speed rotation and failure mechanism described by TTS Kocks.

APL Sydney's destroyed windlass motor, even with the windlass still in gear, would have offered little resistance to the anchor cable running out. If the brake had not been quickly applied, much more than 1 shackle of cable would have run out. The 16 m water depth was probably not deep enough for it to immediately run out to the bitter end but the ship drifting downwind would have constantly put weight on the cable increasing its tendency to pay out, thus reducing the pull on the pipeline. Hence, had the brake not been instinctively applied, the outcome may have been better. In any case, the windlass failure had made it impossible to exert pull on the pipeline by heaving on the cable, even if heaving it were to be considered.

In recent years, similar catastrophic windlass failures have occurred on other ships and three, including the *APL Sydney* failure, have involved TTS Kocks equipment. Both of the other incidents resulted in serious injuries to the windlass operators who were struck by flying debris or projectiles from the shattered motors. The issue is, therefore, the subject of a recent safety bulletin[32] which is supported by the ATSB. The safety bulletin includes a summary of some prominent recent windlass failures, provides guidance to ships crews for avoiding such incidents and recommends that TTS Kocks identify the reasons for, and design solutions to prevent, such failures.

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[31] 1 bar - equals 100 KPa or approximately one atmosphere.

[32] Marine Accident Investigation Branch (MAIB), Safety Bulletin 1/2009, *Catastrophic Failure of High Pressure Anchor Windlasses*, MAIB, United Kingdom, 2009.

In submission, TTS Kocks advised that the classification society, Germanischer Lloyd (GL), had consulted TTS Kocks with regard to design and safety issues related to the recent failure of high pressure hydraulic windlass motors. Consultation by GL with TTS Kocks and other windlass manufacturers is aimed at obtaining information that it proposes to use to amend class rules and thus improve safety. The motor's failure mechanism due to over speed rotation, as indicated to it by TTS Kocks and other windlass manufacturers, is also supported by GL.

The destruction of *APL Sydney*'s windlass motor made the windlass irreparable and the anchor unrecoverable. Fortunately, debris from the motor did not cause injury. However, instinctively applying the windlass brake to control the cable inadvertently resulted in complicating the already dangerous situation and influenced subsequent events.

2.3.3 Attempt to dredge the anchor

Just after 1547, when *APL Sydney*'s master stopped the main engine, he may have suspected the pipeline was fouled. The 1547 position on the chart, the radar display and the ship's head swinging into the wind were indications of this. After the windlass failure, his firm resistance to suggestions to run the engine indicates that he thought, or at least strongly suspected, that the anchor had snagged the pipeline and decided to wait for the pilot to return to the ship. This action demonstrated reasonable caution. In particular, not running the engine when the pilot boat was near the bow greatly reduced the serious risk that the small boat would have faced from a loss of buoyancy had the pipeline ruptured at that time.

The pilot thought that the pilot boat's automatic identification system (AIS) unit was inexpensive and not very accurate. From about 1500, he had observed its display indicating that the ship was close to the pipeline. At 1553, when the boat arrived at the ship's location, its AIS display indicated that the ship was located nearly above the pipeline. Despite this observation and communications with harbour control and the master, he asked for the anchor to be heaved home and the engine to be run. The pilot thought that the anchor lay south of the pipeline and could be weighed without damaging the pipeline. He may have been affected by confirmation bias[33] and therefore pre-disposed to weighing anchor in the belief that the pipeline was not fouled.

At harbour control, it was only after 1501 that the control officer actively began to attend to *APL Sydney*. His subsequent actions indicate that limited use was made of harbour control's AIS display which showed a scale image of the ship, aligned to its heading, indicating its movement in real time and its proximity to the pipeline. The display also provided the ship's heading and speed data continuously.

The ship's rapid yawing and its anchor dragging were apparent on the AIS display well before the control officer advised the master, at about 1525, that the anchor may be dragging. After 1536, the ship began swinging to port and by 1542, was beam on to the wind and above the pipeline (Figure 13). At about 1544, its anchor had snagged the pipeline and by 1547, it was rapidly swinging back into the wind. The control officer did not suspect this and at 1549, when the ship was well north of

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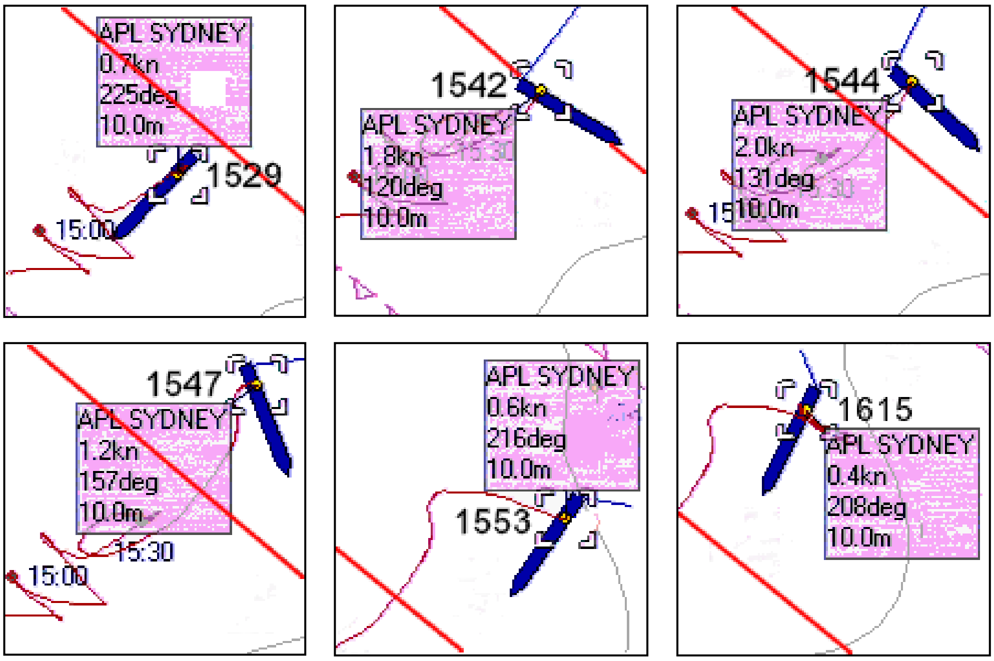
33 Confirmation bias, in human factor terms, involves a person seeking information to confirm an expectation or assumption and rejecting that information which conflicts with an expectation.

the pipeline, he asked the master to use the engine to keep clear of the pipeline. He then spoke to the pilot, before asking the master to weigh anchor and make a lee.

Figure 13: Sections of harbour control's AIS display at 1529, 1542, 1544, 1547, 1553 and 1615 (the pipeline is indicated in red)



By 1553, *APL Sydney* lay head to wind and its position in relation to the pipeline became constant. It was evident from the AIS display as the ship began yawing, that its anchor had probably snagged the pipeline and was holding the ship but the control officer appears not to have noticed this. At 1615, he advised the harbour master that the pilot thought the anchor 'could be' south of the pipeline although accurate information was readily available by interpreting the AIS display.

After boarding the ship at 1603, when the pilot was told about the windlass failure and knew it was no longer possible to weigh anchor as he had intended, he thought of releasing the anchor cable. While with hindsight this was the appropriate course of action, he was probably uncertain so, at 1611, he asked the control officer for suggestions. At interview, the pilot stated that he thought harbour control should have known exactly where the ship was. Therefore, when the control officer asked if he thought the ship was in the pipeline area without giving information from harbour control's monitoring equipment, it is likely that the pilot became more uncertain and possibly confused. Furthermore, the suggestion to steam south probably led him to having second thoughts about releasing the cable.

In submission, PoMC and the control officer jointly stated:

> The control officer can always expect the master and pilot of a vessel to have the most accurate information on the vessel's position, bearing in mind that this information is available to the master and pilot from the systems on the ship. [*APL Sydney*] is relatively new so has up to date technological systems.
>
> At 1611 the reference to the control officer suggesting the pilot could steam south is incorrect. The control officer and pilot were discussing options and the control officer was in agreement with the pilot's intentions. ... The control officer had been led to believe by the pilot that the anchor was to the south of the pipeline in clear

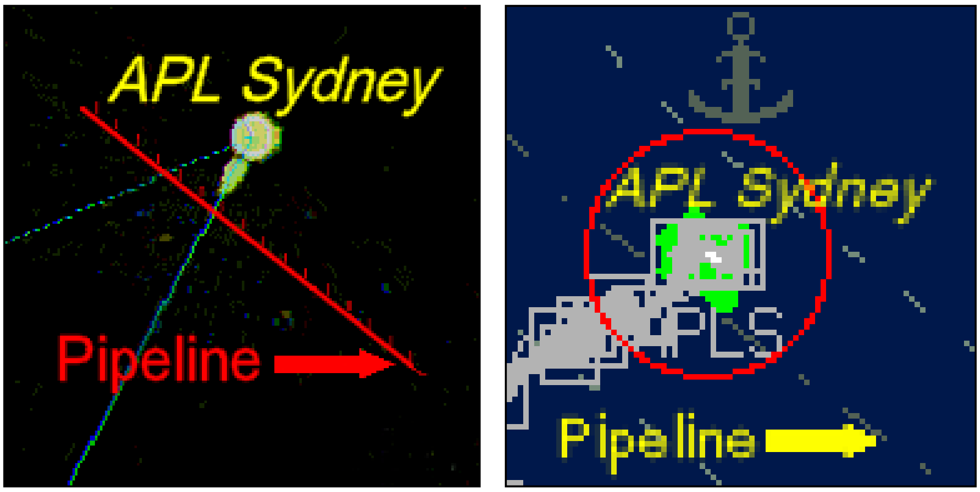
water and that the pilot could steam up to it. ... There is no indication ... that the pilot was confused following the conversation, in fact it was the pilot at 1548 who stated on VHF channel 12 that he needs to steam south.

Although *APL Sydney*'s radar and GPS provided sufficiently accurate position information to conclude that the ship was stationary just north of the pipeline with its anchor dangerously close to it, harbour control's equipment was equally accurate. Had information from the equipment ashore, the superior AIS display in particular, been provided to the pilot, it could have assisted his decision-making.

The pilot had ended his conversation with the control officer at 1614 advising that he would progress releasing the cable. Instead, he checked the ship's position and decided to dredge the anchor. This major change to his plan after communicating with harbour control indicates that it influenced his decision. With regard to the pilot's statements at 1548, they were in the context of replying to the control officer who had queried if he should ask the master to make a lee. The pilot, who had not yet re-boarded the ship, had said 'the main thing is to get the anchor clear of the pipeline' and 'he needs to steam south' indicating his priority at that time.

APL Sydney's charted position at 1547 and 1615 indicated that the ship's bridge had remained in nearly the same position. The ship's and harbour control's radars also indicated the ship's position in relation to the pipeline (Figure 14). This meant that the ship had brought up to the anchor with 2 shackles of cable out and lay head to wind. However, the pilot concluded that the bow was located above the pipeline and the anchor lay just south of it. He was assuming that the accuracy of the ship's 1615 position that he had plotted on the chart (Aus 155, Scale 1:37,500) and that of the charted pipeline, was within metres and could be relied upon.

Figure 14: Sections of the ship's and harbour control's radar displays at 1615



The pilot's conclusion was consistent with his earlier thoughts and may have made the control officer's suggestion of steaming south seem an acceptable option. While he had earlier considered damage to the pipeline and tried, unsuccessfully, to check how deeply buried it was and thought of the anchor being 'hooked around', he now rejected those considerations. He discarded his plan to release the cable and instead, decided to dredge the anchor clear. It is likely that the pilot was more affected by confirmation bias and it probably did not occur to him that the anchor was far too close to the pipeline and that it was much too late to attempt dredging the anchor.

In any case, as the situation had developed, the decisions of the pilot and the control officer had been based entirely on their own knowledge and judgment; contrary to recognised guidance. The procedures of their respective organisations provided them with little, if any, guidance for the situation that they found themselves in.

According to the pilot, the master was content for him to make all the decisions and readily accepted his plan to dredge the anchor. While the master had earlier resisted using the engine and should have voiced any concerns he had about the plan, he probably thought that the pilot and harbour control, earlier, were making appropriate decisions. It was reasonable for him to expect proper advice, based on local knowledge, from a pilot he had been instructed by harbour control to wait for.

By 1620, when *APL Sydney*'s engine was run ahead, there were indications that its anchor had snagged the pipeline. The ship had remained in almost the same position for more than half an hour, riding to 2 shackles of cable in gale force winds.

However, the pilot assumed the anchor lay just south, and clear, of the pipeline. The control officer had little appreciation of the situation and instead of providing the pilot with useful available information, he may have confused him. The master may have earlier suspected that the pipeline was fouled but he now assumed the pilot had the necessary information and had decided to take appropriate action. In the actual circumstance, however, dredging the anchor was not reasonable or safe and the only appropriate course of action was to safely slip the anchor cable.

2.3.4 Slipping the anchor cable

Slipping *APL Sydney*'s starboard anchor cable from its bitter end was the safest option to avoid the pipeline rupture and reduce the risk of injury. While the master stopped the main engine just after 1547, the rapid sequence of events made it unlikely that slipping the cable could have been considered at that stage. At 1606, the master appeared not to comprehend the pilot's suggestion to slip the bitter end. Although the windlass had failed, it did not prevent slipping the bitter end while using the windlass brake and the main engine to control the cable. This option had not been considered even about 6 hours later, when the cable was cut using oxy-acetylene cutting equipment.

The ship's anchor cable bitter end slipping arrangement, similar to most modern ships, is located outside the chain locker and can be accessed from the forecastle store. After removing a protective cover, the bitter end can be slipped by knocking out its securing pin with a hammer. This is the safest and quickest way of releasing the cable. However, precautions should include ensuring that there is no weight on the bitter end and clearing the crew from the forecastle in good time.

According to Danton[34], a ship's crew should quickly acquaint themselves with the bitter end slipping arrangement on their ship since the need to slip the cable may be both unexpected and urgent. The evidence indicates that *APL Sydney*'s crew were either unaware of, or unfamiliar with, the slipping arrangement on board their ship.

Cutting the cable

After the pipeline rupture, the pilot moved *APL Sydney* away from the gas and at 1645, he asked for an anchor cable kenter link to be dismantled on the forecastle

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[34] Danton, G 1996, *The Theory and Practice of Seamanship*, 11th Edition, p.13, Routledge, London.

deck. He assumed that since the windlass had failed, this was the quickest way to release the cable. A kenter link was not located on deck, so instead of easing out the cable to position one on deck, the crew located a link inside the chain locker and set about dismantling it.

A chain locker is designed to self stow the cable. It is dangerous to enter or work in the enclosed space and one of the main risks is the cable accidentally running out. An external bitter end release arrangement is specifically intended to make it unnecessary to enter the chain locker to slip the cable. It should not normally be necessary to enter the locker except for maintenance which is usually done when the cable is ranged[35] in dry dock.

APL Sydney's crew were exposed to a high risk as they tried, unsuccessfully, for several hours to dismantle the kenter link. The link was located on the cable leading vertically up to the spurling pipe, so its suspended position and limited access in the locker full of cable also made the work arduous.

In any case, a kenter link can be difficult to dismantle. It has four parts, including a tapered pin (spile pin) which holds all the parts together and is driven out in the direction opposite to its taper. Other than on board ships where links are routinely dismantled, their parts often become frozen. Moreover, familiarity in dismantling a link with suitable tools is useful. *APL Sydney*'s crew were probably not familiar or experienced at such work and the kenter link's parts were probably frozen.

It was only after 2100, when the pilot realised the crew was working in the chain locker, that the dangerous work was stopped. Again, slipping the bitter end was not considered. At interview, the pilot acknowledged that he had not known what was wrong with the windlass and it might have been better for him to have gone forward to inspect the damage himself. He might then have been better able to consider the options, including the possibility of safely slipping the bitter end and allowing the cable to run out.

By the time the cable was cut at 2153, *APL Sydney*'s crew had been exposed to high risks for many hours attempting a task that could have been safely completed in a matter of minutes by slipping the bitter end. The risky, arduous and unnecessary attempt to dismantle the cable was the result of the crew's lack of knowledge and familiarity with their ship and the ill informed decisions of the master and pilot.

2.4 Anchoring

APL Sydney's swinging circle, centred on the position where its anchor was let go at 1428 on 13 December, had a radius of 2 cables (Figure 15). The circle lay within the Outer Anchorage and, at its closest, was 1.3 cables from the anchorage boundary and 4 cables clear of the gas pipeline.

The pilot chose the position because he usually anchored Melbourne bound ships of a similar size and draught to *APL Sydney* in that location. His reasons for preferring this position included better holding ground and less distance to numbers one and two buoys from where the ship would enter Port Melbourne Channel. According to the control officer, the ease of access to the channel is probably the reason why the eastern part of the anchorage was used more often.

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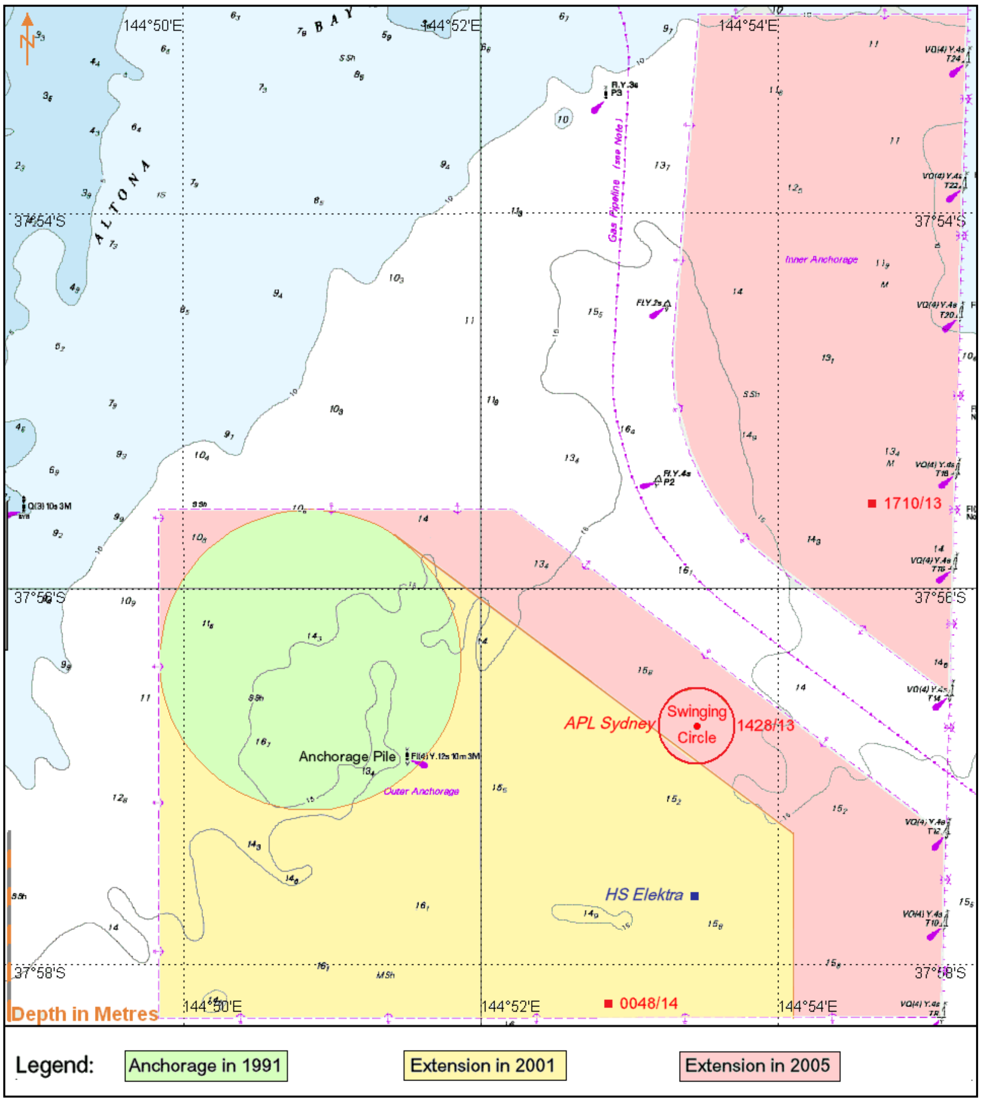
35 To lay out the cable on deck, or a wharf, or a dry dock.

At interview, the pilot stated that while no part of the Outer Anchorage was designated for a specific purpose, its southern section was generally used to anchor Geelong bound tankers. Therefore, he had never considered anchoring *APL Sydney* there and decided to use the position where he normally ‘parked’ ships.

2.4.1 Anchorages off Melbourne

Since the gas pipeline was laid in 1972, there have been a number of changes to the anchorages off Melbourne. Their names and limits have continued to evolve with the port’s changing needs and increasing ship size and traffic (Figure 15).

Figure 15: Section of navigational chart Aus 155 showing changes to Melbourne anchorage between 1991 and the time of the incident



In 1970, a circular Outer Explosives Anchorage with a radius of 5 cables existed in the northwest part of what later became the Outer Anchorage. At the time, there was also an Inner Explosives Anchorage. Their limits were defined in nautical publications but not charted. Those anchorages evolved into three explosives anchorages until 1985, when changes were made and two anchorage areas again defined.

In 1991, the Outer Explosives Anchorage was renamed the Explosives Anchorage and its circular area was enlarged to a radius of 8 cables and charted. About 5 years later, its name was changed to the Outer Anchorage and in 2001, the anchorage was extended towards the south and east and became a polygonal shape. Its north-eastern boundary was parallel to and 8 cables from the gas pipeline. The Anchorage Pile beacon, which had been at the centre of the previously circular anchorage, was moved towards the middle of the new anchorage.

In late 2005, about 3 years before the incident, the Outer Anchorage's was again extended. The boundaries were moved closer to the gas pipeline and to the edge of Port Melbourne Channel to enlarge the anchorage, which occasionally had five or six ships anchored inside it. At the same time, the small, uncharted Inner Anchorage was enlarged and charted. The anchorage boundaries adjacent to the pipeline were now about 3 cables from it.

2.4.2 Risks on 13 December

On 13 December, the pilot identified the risk of dragging anchor and took some steps to address it. However, this did not include reconsidering the anchoring position for *APL Sydney* in the prevailing poor weather.

The pilot decided 'not to get too close' to *HS Elektra* in case its anchor dragged. When *APL Sydney*'s anchor was let go, the tanker was 8 cables off. However, he should have adequately considered that if *APL Sydney* were to drag its anchor in the prevailing weather conditions, the gas pipeline was not only closer to the ship than the tanker but also downwind. Simply pointing out to the master that there was a risk of the ship dragging anchor towards the pipeline in the strong wind did not reduce the likelihood of its anchor dragging or adequately address the risk.

At the time, the 35 knot (gale force) wind was gusting to 48 knots (storm force). According to the pilot, the weather was not adverse or unusual enough for him to reconsider his anchoring plan. He stated that, while he would not have anchored a car carrier since he felt that the windage[36] of that type of high-sided ship made it much more susceptible to strong winds, he decided to anchor *APL Sydney* in his preferred position and deploy 5 shackles of anchor cable instead of the 4 shackles that he normally would have recommended.

The Australian Bureau of Meteorology records indicate that the average frequency of winds of over 22 knots (force six and greater) at Fawkner Beacon is more than 9 per cent. Such strong winds are about two times more likely during winter months than they are in summer. Storm force wind gusts at Fawkner Beacon have been recorded, on average, about three or four times a year. In December, the wind blows from between southeast and southwest about 60 per cent of the time, including the 2 or 3 days in the month when the wind is over 22 knots. Wind conditions in other summer months are similar and hence the pipeline often lies downwind of ships anchored in the Outer Anchorage. Therefore, while strong winds regularly prevail in Port Phillip, the gale force winds on 13 December cannot be described as usual and were strong enough to have been of concern for any ship at anchor.

An anchor is not designed, and should not be expected, to hold a ship in rough weather and gale force winds. Its holding power largely relies on the shank lying horizontal with the flukes embedded in the sea-bed. This is only possible when the

36 The surface area of a ship's hull and superstructure that is exposed to the wind.

anchor cable nearest to the anchor also lies on the sea-bed. In rough weather, the increased load on the cable tends to lift it off the sea-bed. Deploying additional cable can reduce the chance of an anchor dragging but may not prevent it. Bad weather has been a significant factor in a number of anchor dragging incidents[37].

According to IACS[38], if the weather is not rough, a scope[39] of anchor cable of 10 is considered normal while a scope of not less than six is acceptable for a high holding power anchor such as *APL Sydney*'s. The Admiralty recommended formula[40] indicates the minimum length of cable to lay out when anchoring in 16 m deep water in calm weather and a tidal stream or current of up to 5 knots, is 5.7 shackles. On 13 December, the ship's hawse pipe was 9 m from the sea surface so, based on the water depth, deploying 5 shackles of cable in the water provided a scope of six and the length of cable laid out was close to the calm weather minimum.

In deciding the length of anchor cable to deploy, *APL Sydney*'s pilot generally used a rough rule of thumb to lay out between three and eight times the water depth in length of cable. According to Danton[41], this rough rule is haphazard. Due to the weather at the time, the pilot decided to increase the length of cable deployed to 10 times the water depth, which he thought was reasonable. However, the scope of cable deployed was only the recognised minimum for good weather.

When choosing an anchor position, the risk of weighing anchor in rough weather should be considered. If it becomes necessary to do so, shortening the anchor cable will make the anchor drag more quickly. The proximity of hazards downwind then becomes critical and a poorly chosen anchor position can result in running out of time and sea room to avoid an incident. There is also an increased risk of damaging the anchoring equipment in such situations. Many modern ships are large and have powerful engines that quickly generate large forces. As a result, in bad weather, the rapidly changing anchor cable lead and tension increases the likelihood that the equipment will be subjected to shock loads. Equipment failure, like that of *APL Sydney*'s windlass, can further complicate a situation.

On 13 December, the pilot's choice of anchor position was based on habit. He often anchored there and probably felt safe since there had been no previous adverse outcomes. His preferred position was closer to Melbourne than other parts of the Outer Anchorage. In rough weather, less distance is quite relevant to the pilot boat's transit time, the effect of rough seas on the boat's motion and the level of comfort for its occupants. Though the pilot did not indicate that distance to Melbourne was a factor, it is possible he may have considered this when, as a trainee pilot, he first began anchoring in the preferred position after the anchorage was extended in 2005.

However, the exposure to risk in the chosen position, due to its proximity to the pipeline, was higher than other parts of the nearly vacant anchorage. At interview, the pilot acknowledged that, with hindsight, *APL Sydney* should have been anchored further south and it would have been better to deploy more cable.

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37 ATSB Marine Investigation Report Number 243, the grounding of *Pasha Bulker* on 8 June 2007.

38 International Association of Classification Societies (IACS), *Requirements concerning mooring, anchoring and towing*, IACS Req. 2007.

39 The length of cable deployed, from the hawse pipe to the anchor, divided by the vertical distance between the hawse pipe and the sea-bed.

40 The length of special steel cable to lay out equals 39 x $\sqrt{D}$ (metres), where D is the water depth.

41 Danton, G 1996, *The Theory and Practice of Seamanship*, 11th Edition, p.19, Routledge, London.

At interview, the master stated that he did not know why the pilot had chosen that anchor position. However, he had accepted the pilot's plan without querying the position or scope of cable and acknowledged his advice with regard to the weather, anchor dragging and the pipeline without expressing any concerns.

According to the pilot, he had little input from the master who appeared to him to be inclined to relax if a pilot was on board and not participate in making decisions. However, it is possible that the master was reasonably trusting of the pilot's advice about anchoring since pilots are employed for their comprehensive knowledge of the local area and their expertise in handling ships. In any case, as the joint manager of the pilotage, a high risk venture, the pilot should have been more cautious and done more than just point out the risks to the unquestioning master.

In the prevailing conditions, the risk of *APL Sydney* dragging its anchor was high. There was an increased risk of it snagging the pipeline. These risks should have been considered when deciding if anchoring in the first place was reasonably safe and if so, determining an anchor position that reduced the risk as much as possible.

2.5 Managing the risk of pipeline rupture

Risk identification is the process of determining what, where, when, why and how something could happen[42]. Effectively managing a risk to prevent or reduce its adverse impact on objectives should include the systematic application of policies, procedures and practices to the tasks of identifying, analysing, evaluating, treating, monitoring and reviewing the risk.

The location of the submarine ethane gas pipeline near the entrance to the port of Melbourne means that there is always some risk of a ship fouling and rupturing it. Ships anchoring near the pipeline and adverse weather conditions increase the likelihood of such an incident. Although low, the possibility of an incident due to the accidental letting go of an anchor on or near the pipeline also cannot be excluded. In any case, a rupture is reasonably foreseeable, will have serious adverse consequences for a range of parties and the risk should be effectively managed.

The Port of Melbourne Corporation (PoMC) has the statutory objective to manage the port and carry out its functions in a manner that is, amongst other things, safe, effective and efficient. With regard to shipping within the port, PoMC has a safety role which is administered through the harbour master, whose functions and powers are specified in the relevant legislation[43]. In practice, for managing traffic, these functions and powers are exercised through shipping control, which describes the operation of the shipping control centres.

Compulsory pilotage in Port Phillip is intended to reduce shipping-related risk to an acceptable level for the port and its users and, as such, is primarily a risk management tool for the port. The objective of Port Phillip Sea Pilots (PPSP) is to provide effective, efficient and safe pilotage services for the port and, hence, PPSP should be actively involved in managing the risk of pipeline rupture.

Therefore, PoMC and PPSP have the responsibility and the means to put in place appropriate and adequate measures to avoid a pipeline incident involving a ship

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42 Standards Australia/Standards New Zealand, *Risk Management*, AS/NZS 4360:2004.

43 The *Marine Act 1988* (Victoria) and the *Port Services Act 1995* (Victoria).

and, if an incident does occur, mitigate the consequences. These measures should include policies, plans, procedures and regulations which are consistent with recognised guidance on the subject.

2.5.1 The PoMC safety and environmental plan

In June 2005, PoMC put in place a safety and environmental management plan (SEMP). The plan states that its activity-based risk management approach to identify, assess and control risks within the port, is consistent with Australian Standard 4360 Risk Management (2004). The plan's objectives include identifying hazards and risks associated with the port's operation, assessing their likely impact on the port and specifying strategies to prevent or reduce those risks and hazards.

The SEMP identifies various port activities and a number of risk scenarios for each activity. Shipping operation activities include the control, navigation, piloting and anchoring of ships. However, there is no reference in the plan to the ethane gas pipeline or a potential incident involving it. This suggests that the significant risk that the gas pipeline can pose had not been appropriately considered.

The plan is periodically reviewed and amended. Before the incident, amendments to the plan were made on three occasions, most recently in March 2008. This indicates that even the significant changes to Melbourne anchorage in late 2005 did not result in the pipeline being identified as the source of a risk that needed to be managed.

2.5.2 The 2005 changes to Melbourne anchorage

The changes to Melbourne anchorage were initiated by PoMC and on 22 September 2005, a meeting was held to discuss the proposed changes and other issues. The meeting was attended by the harbour master and five other PoMC officers, three representatives from PPSP and four representatives, including pilotage-exempt masters, from coastal shipping companies. The meeting minutes indicate that the proposed changes to the anchorage were accepted but there were no notes relating to any associated risk assessment being carried out. No reasons for enlarging the anchorages were documented.

It is not known what risks were considered when proposing and accepting the 2005 changes and it is unclear why the area to the south of the Outer Anchorage was not utilised for its expansion. The proposed 3 cable limit from the pipeline must have been considered safe and, hence, accepted. This distance is almost twice the 300 m clearance that is required by the Harbour Master's Directions. However, it is also about one-third of the previous limit of 8 cables (1482 m) and, with the new limit, the anchorage boundaries were 5 cables (926 m) closer to the pipeline.

With regard to the proximity of hazards, the limits of an anchorage should take into account the size, type and manoeuvrability of ships using the anchorage and the readiness of their main engines. These factors become even more significant in bad weather. Based on the 3 cable limit accepted, the anchorage boundaries were charted 2.7 cables (Outer Anchorage) and 3.3 cables (Inner Anchorage) distant from the pipeline. The limit of 2.7 cables (500 m) was only about twice the length of *APL Sydney*, which has similar dimensions to many existing container ships. In a strong wind, a clearance of two or three ship's lengths from hazards may be insufficient.

In submission, PoMC advised that anchorages off Melbourne were set in accordance and in keeping with relevant International Maritime Organization

(IMO) guidelines. It should be noted, however, that charting anchorage boundaries suggests that those limits are viewed as safe by responsible authorities and thus increases confidence. While it would still be prudent for mariners to review the risks before anchoring, particularly in adverse weather conditions, this may not always be adequately done.

APL Sydney's intended anchor position was outside the Outer Anchorage's pre-2005 boundary. The existing boundary allowed the pilot to anchor the ship about half a mile closer to, and about half the distance from, the pipeline than would have been possible with the previous limit.

The proposal and ready acceptance of the changes indicates a perception of low risk posed by the pipeline. However, the new anchorage limits allowed, and probably encouraged, masters and pilots to anchor much closer to the pipeline than they had previously. Their perception that authorities had considered the risks involved with the reduced limit before charting it may have led to overconfidence and possibly made them less cautious than they otherwise might have been with a 3 cable limit.

Anchoring incidents

The *APL Sydney* incident is the first occasion where a ship's anchor has snagged the ethane gas pipeline. The previous recorded anchoring incident[44] in Melbourne anchorage occurred on 17 November 1996 when the container ship *Columbus Victoria* dragged its anchor in 30-35 knot winds and collided with *Sampet Hope*, a tanker also anchored in the Inner Anchorage.

The above indicates a 12-year period with no reported anchor dragging incidents. However, it is possible that some incidents, with no notable consequences, may not have been reported to PoMC, MSV or others and, hence, have not been recorded. According to PPSP, dragging anchor in Melbourne anchorage is quite rare although it did not keep records of such incidents. In any case, its records mainly comprise incidents reported by pilots who do not normally remain on board anchored ships.

With regard to Melbourne anchorage, the Australia Pilot does not advise of any specific caution other than references to the pipeline. The holding ground is described as mud and shells and the chart indicates that mud, sand and shells lie on the sea-bed. That reported anchor dragging incidents have been rare suggests the holding ground is reasonable. According to *APL Sydney*'s pilot, the collective experience of pilots is that the holding ground in the Outer Anchorage is better than that in the Inner Anchorage. However, other than the 1996 incident, there is no documented evidence that supports this view.

The pilot found it amazing that *APL Sydney*'s anchor dragged with 5 shackles of cable in the Outer Anchorage yet, with little change in water depth or wind, it held with just 2 shackles in the Inner Anchorage. It is possible that the composition of the sea-bed in the area is not uniform. It should also be noted that certain types of mud, such as the soft mud in Corio Bay, are known to provide poor holding ground.

The anchors of *APL Sydney* and *Columbus Victoria*, in the 1996 incident, dragged the last 3 cables in 20 minutes. In *APL Sydney*'s case, this average speed of about 1 knot doubled as the ship closed on the pipeline. In both of these incidents, 3 cables in the strong wind conditions proved to be insufficient clearance from hazards.

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[44] ATSB, Marine Incident Investigation Unit (MIIU) Report Number 102, 1997.

Although recorded incidents of dragging anchor are rare, strong winds are regular and the 3 cable limit should not be considered safe. Had the limit been greater, *APL Sydney* would have been anchored further from the pipeline and, with more sea room and time to take avoiding action, may not have fouled it.

2.5.3 Shipping control procedures and guidance

To assist shipping control centre staff in performing their functions, PoMC has documented safe operating procedures[45] (SOPs). The procedures, combined with the port operations handbook which includes the Harbour Master's Directions, should provide the staff with the necessary guidance and information to safely manage traffic.

With respect to the gas pipeline, the SOPs did not provide any specific guidance that could have assisted the control officer in his decision-making before the pipeline rupture and his knowledge of the pipeline was limited to the charted information. While the procedures refer to the port operations handbook, it contained little of relevance other than the anchorage limits and the restrictions with regard to ships anchoring less than 300 m from the pipeline or dragging an anchor cable across it. Neither of those documents specifically includes any of the recognised guidance to avoid a pipeline rupture (see section 2.2.1 of this report).

The SOPs contain emergency response guidance for shipping control and refer to the PoMC emergency and incident notification & response activation (EINRA) manual. Those documents do not refer to the gas pipeline or provide emergency contact telephone number/s or details for its operator, Esso.

At 1624 on 13 December, 2 minutes after *APL Sydney*'s pilot requested the gas be turned off, shipping control staff called PoMCs port emergency management coordinator, as required by the procedures, and asked for the pipeline to be shut down immediately. The coordinator could not confirm who he intended to contact but advised that he would make every effort to make contact with relevant parties. Consequently, shipping control staff continued telephoning various parties in an attempt to obtain contact numbers to have the pipeline isolated.

In the meantime, the coordinator called the fractionation plant in Hastings and at 1629, notified a duty operator there. The operator briefed the shift supervisor and at 1634, the emergency shutdown valves on the pipeline at either end of the bay were activated. However, it was not until 1646, that the coordinator was able to confirm this to shipping control, where the staff had made many calls in an unsuccessful attempt to contact Esso and other parties to have the pipeline isolated or confirm that it had been isolated.

Had a direct emergency contact number for Esso been available at shipping control, the pipeline could have been isolated earlier to remove the main risk from this foreseeable, albeit unlikely, incident. This would have assisted in reducing the risks involved as early as possible and, hence, the response could have been better managed from the beginning.

The situation that developed on 13 December, while being foreseeable, had not been properly identified by PoMC. Consequently, the risk had not been

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45 Port of Melbourne Corporation, *Shipping Control Safe Operating Procedures*, 1 November 2007.

appropriately assessed and adequate procedures and guidelines that could be effectively used by shipping control staff were not in place.

2.5.4 Pilotage procedures

The port's pilotage procedures are contained in PPSPs pilotage safety management system (PSMS). The document states that its objectives are to promote safety at sea, prevent injury or loss of life and avoid damage to the environment and to property.

Although the PSMS came into effect in June 2008, more than 2 years after Melbourne anchorage's significant expansion, none of its procedures refer to the gas pipeline. At interview, *APL Sydney*'s pilot confirmed that PPSP had not provided him with any information about the pipeline or the action to take to avoid a rupture. From his training, he was only aware of the pipeline's location and did not know if it was buried.

While the pipeline is listed as a navigation hazard on PPSPs website, this does not indicate that an appropriate risk assessment has been carried out. In fact, the lack of relevant guidance in the PSMS suggests that individual pilots are expected to make their own assessment. Given the pipeline's location, pilots encounter the hazard daily and PPSP should have ensured that they had clear guidance to avoid fouling the pipeline and the necessary action to take in the event of its fouling.

The situation which *APL Sydney*'s pilot faced had not been foreseen by PPSP. As a result, an appropriate risk assessment, that could have led to effective procedures and guidance, had not been carried out. Had this been done, the pilot would have been better informed about pre-considered best solutions to avoid and/or manage the difficult situation.

2.6 Safety management systems

On 13 December, the master, the pilot and the control officer, and their respective organisations, had a shared objective; the safe completion of *APL Sydney*'s passage to Melbourne. The experienced mariners, acting in different roles, were responsible for taking action to achieve that objective. Their organisations had some measures in place, including safety management system (SMS) procedures, aimed at ensuring safe operations. Collectively, there should have been sufficient resources in place to have prevented the incident.

However, the risk of pipeline rupture had not been effectively identified or addressed and a number of inappropriate decisions were made, individually and jointly. Some decisions were based on what the individuals involved considered was appropriate or were in accordance with their usual practice. Others were made with uncertainty in an unfamiliar situation with no guidance. Had the relevant SMS procedures and training provided adequate guidance, the individuals probably would have been better placed to make appropriate decisions, particularly in an unfamiliar situation.

2.6.1 *APL Sydney*

APL Sydney's SMS procedures required a berth-to-berth passage plan. The ship's passage plan for the voyage to Melbourne was direct to the berth. A checklist in the standard planning form indicates that anchorages were taken into account but the plan contained no anchoring information. It is possible the checklist was completed on the basis that anchoring to wait for a berth was unlikely and, since Melbourne anchorage lies inside the pilotage area, it was thought that if anchoring was required, the pilot would anchor the ship and provide the necessary guidance and advice.

However, if the possibility of anchoring had been appropriately considered when planning, a suitable anchor position could have been identified. Safe clearance from the pipeline and the scope of cable and limits for weather may have been amongst the factors assessed. Appropriate information and limits could then have been agreed and necessary details included in the passage plan and relevant item/s on the checklist ticked. Had such planning been done, the master may have shown greater interest in the pilot's anchoring plan and discussed its details. When the pilot drew his attention to the risk of dragging anchor towards the pipeline in the strong wind, he may also have voiced the concerns that he expressed after the incident.

The passage plan noted that the Australia Pilot had been consulted. In addition to the chart and notices to mariners, current editions of the Australian Seafarers Handbook and the Mariners Handbook were also available on the bridge. These publications could have provided the master and crew with adequate information and guidance with respect to the anchorages and the pipeline. However, the absence of details in the passage plan and the lack of discussion of the pilot's plan amounted to inadequate planning and risk assessment on the part of the ship's crew.

While the ship's anchor watch procedures were later followed, the SMS was not effective in certain other respects. The master was uncertain about his overriding authority and responsibility to take action with respect to the safety of the ship in the anchorage. Instead, he followed harbour control's instructions. Even after the ship fouled the pipeline, the master was never quite sure of the appropriate course of action. Unquestioningly, he continued to follow all of the pilot's advice.

APL Sydney was in a compulsory pilotage area, controlled by the port authority. The master would probably have considered the consequences of contradicting the pilot's advice and ignoring harbour control's instructions. Had the master acted independently and an adverse outcome resulted, it is likely that he would have been held accountable by some parties. Nevertheless, despite this dilemma, the master should have carefully considered the consequences of simply doing as he was told.

The master contacted the ship's local agents and managers a few times both before and after the pipeline rupture. The advice, support or approval he could have been seeking or may have received did not result in an appropriate response. This suggests that any advice he may have received from ashore could have been influenced by a dilemma similar to his own, particularly because a pilot was on board the ship. If this was the case, it highlights the importance of an SMS not only providing necessary guidance about a master's overriding authority but the ship's managers also emphasising this so that a master is certain of his authority and can rely on the managers' support when taking actions for which he is responsible.

An SMS should also aim to ensure that a ship's crew is familiar with its equipment and provide the guidance necessary for the crew to be able to perform their duties as safely as possible, including in emergencies. However, it is evident that no one on board *APL Sydney* was familiar with safely slipping the anchor cable's bitter end.

Had the standard passage planning format included effective checks aimed at ensuring anchoring was adequately considered, an independent, unhurried and appropriate risk assessment is likely to have been completed beforehand. This could have led to better and safer decisions later. Similarly, had the SMS been effective with regard to the master's overriding authority and the crew's familiarity with ship's equipment; advice and instructions given to the master by the pilot and from ashore may have been more carefully considered and unnecessary risks may not have been taken on board the ship.

2.6.2 Port Phillip Sea Pilots (PPSP)

Regulators, port authorities, ship owners and masters rely on PPSP for the provision of a safe pilotage service in Port Phillip. As such, there is a valid expectation that the pilotage company has rigorous processes and a robust system in place to achieve this. Its pilotage safety management system (PSMS) is a principal tool in this regard and includes standard operating procedures which include pilotage, pilot training and auditing.

The procedures provide limited guidance for anchoring off Melbourne. They state that efficient use of the anchorages is required to 'avoid wastage of the area'. Lighter draught ships are to be anchored closer to the breakwater and larger, deeper draught ships in a position appropriate for approaching the channel so that time is not lost due to a 'poorly chosen' position. Other than in the context of making a lee for the pilot boat, there is no reference to weather considerations. The procedures do not refer to other relevant factors, including holding ground, scope of anchor cable, windage, swinging room, clearance from the gas pipeline with regard to weather conditions and action in case an anchor snags, or may snag, the pipeline.

APL Sydney's pilot could not recall exactly how he came to the decision to move the ship at 1620 but, at the time, he had considered it a priority. Earlier, he had thought that if the pipeline was not buried it could be damaged if the anchor cable was released on top of it. With hindsight, he stated that it might have been better to have released the cable to prevent the rupture. It was only later that he realised the anchor 'must have been wrapped around' the pipeline and when the ship moved ahead, the anchor 'dug up and ruptured it'.

Those comments by the pilot, and the ones with regard to anchoring the ship further from the pipeline and deploying more cable, indicate that with adequate guidance from the PSMS procedures and training, he could have had the confidence and foresight to make prudent decisions rather than view, in hindsight, what he should have done. The PSMS does, however, have incident reporting and system review procedures to learn from incidents and near misses and better manage risk.

The PPSP pilotage procedures and training did not provide *APL Sydney*'s pilot with adequate guidance for anchoring off Melbourne or the gas pipeline. In this respect, the PSMS was ineffective and, on 13 December, did not achieve its objectives.

2.6.3 Port of Melbourne Corporation (PoMC)

The shipping control safe operating procedures (SOPs) are an important part of PoMCs system to safely manage shipping within its area of responsibility. The SOPs can only be effective if they include necessary aspects of shipping control's operations, including its safety oversight of pilotage and of Melbourne anchorage, and provide shipping control staff with adequate guidance to perform their functions.

The control officer is authorised to exercise the power to 'direct and control shipping' and the SOPs define this term as 'managing traffic'. Therefore, the control officer performs a vital function with the responsibility for making critical decisions and issuing appropriate instructions or warnings when necessary.

At interview, the control officer stated that his decisions with regard to *APL Sydney* were based on his judgement and, according to him, were prudent. Again, according to him, it was unusual for masters to want to shift anchor position and the SOPs did not provide any guidance for the situation. He thought that the situation was being resolved until the ship's windlass failed. However, by that time the pipeline had already been snagged and this indicates his limited understanding of the situation.

APL Sydney's large echo on the radar display was not as clearly distinguishable from the pipeline as its scale image was on the AIS display. The delay in setting up the radar guard ring and the ship's proximity to the pipeline when the ring was set up, limited its effectiveness in providing an appropriate warning. The control officer continued using mainly the radar even as the situation became increasingly serious over the next hour or so until the pipeline rupture. This suggests that his training and procedures had not prepared him to effectively use all the available equipment.

Since the SOPs contain no mention of the pipeline or actions to avoid its rupture, the control officer had no procedural guidance in this respect. Furthermore, his understanding of the procedures relating to the exercise of powers to direct and control traffic resulted in inappropriate instructions being issued.

In submission, PoMC advised that the SOPs adhere to the relevant international guidelines for VTS operations, were comprehensive and clearly outlined the responsibilities of the control officer, who was appropriately trained, well equipped to deal with traffic situations and provide advice to the master.

However, the control officer was poorly equipped to manage the situation. With little procedural guidance, being occupied with other matters and the ineffectual utilisation of resources, he issued inappropriate instructions to the master and provided confusing information and uncertain advice to the pilot. Had recognised guidance to avoid a gas pipeline rupture been reiterated by PoMCs procedures, the control officer may have been better placed to perform his functions.

2.7 Communications

A notice posted on *APL Sydney*'s bridge stated that, in accordance with SOLAS, the ship's working language was English. The aim of a common language is to ensure that bridge team communications, including during pilotage, are understood. This is reiterated in the Bridge Procedures Guide[46] with regard to occasions when a pilot is on board a ship and when there are communications with external parties.

At the time of the incident, VDR audio evidence and harbour control recordings indicate that the master's communications with the pilot and harbour control were in English. However, other communications that took place on the bridge between

46 International Chamber of Shipping, *Bridge Procedures Guide*, p.20, section 1.2.11, Fourth Edition, London, UK, 2007.

the master and crew were in Chinese, indicating that the working language procedure had not been effectively implemented on board the ship.

At interview, the pilot stated that the master's communications with him were poor. His perception is partly attributable to the fact that there was little communication between them. Significantly though, the master understood and followed his advice with regard to anchoring and dredging the anchor. However, the use of Chinese by the master and crew, particularly when they were working in the chain locker, effectively kept the pilot out of the loop.

It was the master's responsibility to ensure that English, as required by the ship's procedures, was used on the bridge. He should also have been fully conversant with the principles of bridge resource management (BRM) and the need for effective communication. Using English, or at least regularly updating the pilot with events on deck, may have prevented misunderstandings and led to safer operations.

From the pilot's perspective, the increased vigilance required on his part due to the language issue would have been reduced had only English been used on *APL Sydney*'s bridge. Although the issue was not easy to resolve, any action by bridge team members to appropriately remain in the communications loop would have been helpful. Both the pilot and the master should have asked more questions of each other to better manage the situation. Safer and more efficient operations to slip the anchor cable may then also have been possible.

According to the control officer, he had problems communicating with the master and considered the language difficulties when giving instructions to him. However, recordings of their conversations show that, for the most part, the master understood the control officer's communications and he responded and acted accordingly.

APL Sydney's master did not indicate that he had any trouble communicating with the pilot or harbour control and his responses to them, based on the audio evidence obtained by the ATSB, confirm that he had a reasonable command of English. In submission, PoMC acknowledged that the master 'apparently understood the information provided to him by the pilot and control officer'.

The control officer and the pilot made some assumptions based on the master's communications, which included almost no challenge to their directions. However, any perception of his proficiency in English and his standard of communications had little to do with his ability.

In essence, with respect to the incident, communication or language difficulties did not contribute to the decisions with respect to the choice of *APL Sydney*'s intended anchor position, the delay in weighing the anchor or the attempt to the dredge it clear of the snagged pipeline. However, the use of Chinese by the crew was detrimental to communications since it kept the pilot out of the loop and increased some risks, particularly those associated with releasing the anchor cable.

2.7.1 Cultural awareness

As mariners dealing with foreign ships' crews nearly every day, it was important for the pilot and the control officer to consider cultural differences when interacting with foreign crews. Since the 1990s, BRM training has included the key subject of cultural awareness to promote an understanding of various cultural influences on individual behaviour and to teach some methods to deal with these issues.

Hofstede[47], an authority on cultural influences, defines power distance index (PDI), one of his five cultural dimensions, as the extent to which less powerful members of organisations or institutions accept and expect that power is distributed unequally. In BRM terms, a high PDI culture is associated with persons accepting that not everyone is equal and expecting to be told what to do. In contrast, a low PDI culture is associated with an expectation to be consulted because people, regardless of their formal positions, interact more as equals. China has one of the highest PDI rankings and Australia has one of the lowest.

APL Sydney's master probably perceived the control officer, the port authority's representative, and the pilot, the local knowledge expert, as being in higher positions of power and authority than himself in the context of his ship's situation in port waters. Based on this, he probably expected to be told what to do by them and was likely to accept their advice or instructions with little hesitation.

The control officer concluded he did not want the master shifting his ship on his own. An adequate appreciation of the master's role and responsibilities may have resulted in a conclusion, similar to the pilot's, that the master should be allowed to take any action that he felt was necessary. Furthermore, the master's acceptance of instructions did not necessarily mean that he agreed with them and could have been the result of his likely expectations based on his Chinese culture.

The pilot assumed *APL Sydney*'s master's unquestioning agreement with his advice and lack of input was due to his inclination to relax when a pilot was on board and not participate in decision-making. However, the master's actions could also be partly explained by his high PDI culture. If the pilot expected to be consulted and challenged as much as he could have expected, for example, by an Australian master, then he should have considered encouraging more challenge.

The master should also have been familiar with the recognised BRM principle of cultural awareness. He should have realised that persons from a low PDI culture such as Australia's expect to be consulted and challenged and a lack of such feedback could result in them assuming he was in full agreement. Except for his initial resistance to running the main engine after fouling the pipeline, he readily complied with the advice and instructions given by the pilot and the control officer. In any case, appropriate cultural awareness may have assisted all of them in working with each other more effectively to manage the situation.

2.7.2 Mobile telephone use

At 1614 on 13 December, *APL Sydney*'s pilot completed a mobile telephone call to the control officer, indicating that he would progress his plan to release the anchor cable. Instead of briefing the master, he plotted the ship's position and explained the plan to dredge the anchor. The master accepted this plan without discussing reasons for discarding the plan to release the cable that he had earlier been advised about.

The master should have challenged the pilot but possibly assumed that the pilot had provided him the necessary information when explaining the new plan and that it was based on appropriate advice obtained during the telephone call. Although it is unlikely the master would have rejected the plan, the pilot should still have briefed him about what was discussed during the telephone call to keep him in the loop.

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47 Hofstede, G 1967-2009, Geert Hofstede ™ Cultural Dimensions, Itim International, <http://www.geert-hofstede.com/>.

Had the VHF radio been used, all members of the bridge team would have been better informed at this critical time.

When bridge team members have different information they do not have a shared mental model; which is central to effective BRM and its goal of reducing risk due to single-person errors. In the difficult and unfamiliar situation, the pilot probably overlooked briefing the master, or expected him to challenge if he had any concerns. The master should have, in any case, asked the pilot what advice or information he had obtained and from whom.

The PPSP PSMS provides only the following guidance for mobile telephone use:

> The use of a mobile telephone whilst piloting, must be kept to an absolute minimum. At no time shall it interfere with safe navigation of the vessel whilst under pilotage.

According to PPSP, this policy reflects a risk assessment based approach to allow pilots to make appropriate decisions and the policy supplements the training and experience of its pilots. However, the term 'absolute minimum' can be interpreted differently by individuals and the objective 'shall not interfere with safe navigation' is more difficult to achieve without defined procedures. Such procedures identify the risks, include defences to mitigate them and can be followed by every pilot.

APL Sydney's pilot had made two short outgoing calls, unrelated to the pilotage, during the ship's inbound passage and these had no apparent adverse effect. Later, when he was in the pilot boat, he used his mobile telephone a few times to call harbour control to discuss the ship's situation. This avoided blocking VHF channel 12 with *APL Sydney*-related communications that potentially could have confused the master. When the pilot re-boarded, he used his telephone at 1611 to call harbour control. It was the only occasion before the rupture that he had used his telephone to call harbour control instead of using the ship's VHF radio. In this instance, it made bridge team communications less effective as described above.

A recent safety bulletin[48] includes an example of the adverse effect of mobile telephones on communications. It notes that the finding of an investigation into a collision between two piloted ships in England stated 'pilots' mobile telephones were used as the means of communication between the two vessels before and after the accident, resulting in the masters being excluded from the information exchange regarding their own ships'.

The inappropriate use of mobile telephones interfering with safe navigation is well documented and based on lessons learned from related incidents in recent years. Some of the available guidance[49] includes considering prohibiting their use in the approaches to ports, harbours and anchorages. In Australia, an advisory note[50] recommends that pilots turn off their telephones or have them in silent mode and also comply with the ship's policy.

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48 Department of Ecology - State of Washington, Safety Advisory Bulletin 09-02, *Mobile Phone (Cell Phone) Use and Marine Operations*, United States of America, October 2009.

49 Maritime and Coastguard Agency, Marine Guidance Note MGN 299 (M+F), *Interference with safe navigation through inappropriate use of mobile phones*, MCA, United Kingdom, 2005.

50 Australian Maritime Safety Authority, Advisory Note to Coastal Pilots, *Use of Mobile Phones*, Pilot Advisory Note 11/07, AMSA, June 2007.

An increasing number of shipboard and pilotage safety management systems include procedures and guidelines for the appropriate use of mobile telephones. In general, these restrict mobile telephone use with the aim of preventing distractions or adversely affecting communications and BRM. Their use on the bridges of some ships is not permitted or is restricted to certain areas and circumstances.

Defined procedures and guidelines on the appropriate use of mobile telephones to supplement the objective of a policy for safer operations can assist in achieving that objective. Effectively implemented, these can prevent interference with navigation and improve communications and BRM in normal and emergency situations.

3 FINDINGS

3.1 Context

At 1428 on 13 December 2008, the container ship *APL Sydney*'s starboard anchor was let go in Melbourne anchorage. At 1432, the pilot left the bridge to disembark the ship. The 35 knot south-southwest wind was gusting to 48 knots and a submarine gas pipeline lay 6 cables (1.1 km) downwind.

By 1501, after dragging its anchor, the ship was outside the anchorage boundary and about 350 m from the pipeline. Harbour control instructed the master to maintain position and wait for a pilot. At 1527, the pipeline was about 50 m away and the pilot had not boarded when weighing anchor began. Control of the ship was effectively lost and at about 1544, the anchor snagged the pipeline.

At 1603, the pilot re-boarded and having first intended to slip the anchor, decided to dredge it clear. At 1621, less than 1 minute after *APL Sydney*'s main engine was run ahead, the pipeline ruptured. There were no injuries and the pipeline was isolated.

From the evidence available, the following findings are made with respect to the pipeline rupture in Port Phillip. They should not be read as apportioning blame or liability to any particular organisation or individual.

3.2 Contributing safety factors

- At 1428 on 13 December 2008, *APL Sydney*'s intended anchor position was unnecessarily close to the pipeline in the prevailing adverse weather conditions. Creating a lee when anchoring so that the pilot could disembark the ship increased the rate of its anchor dragging and the length of anchor cable deployed was barely sufficient for calm weather.
- At about 1501, when the master advised that he intended to weigh anchor and move the ship away from the pipeline, the shipping control officer, who had not monitored the situation, instructed him to maintain position and wait for a pilot.
- The master took no precautions and made no attempt to maintain the ship's position by using its main engine and/or deploying more anchor cable. By 1527, the ship had closed to within 50 m of the pipeline and the pilot had not boarded when harbour control gave the master permission to shift the ship and he began weighing the anchor.
- When weighing anchor, the main engine and helm were not used to effectively control the ship and prevent its anchor and cable dragging across the pipeline.
- At about 1611, the lack of appropriate information from harbour control about *APL Sydney*'s position in relation to the pipeline, and possible options being discussed without definite advice that slipping the anchor cable was the only safe option, probably increased the pilot's uncertainty.
- At 1621, the gas pipeline ruptured when the attempt to dredge the ship's anchor clear of the fouled pipeline was made. The pilot had assumed that the anchor was not snagged and did not advise the master a reason for changing his initial plan to slip the anchor cable. The master accepted the plan to dredge the anchor without querying the change of plan or expressing any concerns.

- The Port of Melbourne Corporation's safety and environmental management systems did not adequately address the risk of an incident involving the ethane gas pipeline and shipping. *[Significant safety issue]*
- An appropriate risk assessment to determine safe limits for the Melbourne anchorage boundaries from the gas pipeline had not been carried out. The events of 13 December 2008 indicate that a limit of about 3 cables was not a safe clearance for all ships in all conditions. *[Significant safety issue]*
- *APL Sydney*'s standard berth to berth passage plan form did not make adequate provision to consider anchoring-related details. The ship's plan did not contain any detail for anchoring off Melbourne indicating that an appropriate, independent and unhurried risk assessment for anchoring was not completed beforehand. As a result, the pilot's anchoring plan was accepted without properly assessing all the risks. *[Significant safety issue]*
- *APL Sydney*'s safety management system did not adequately ensure that the master was certain about his overriding authority and responsibility with respect to decisions and actions aimed at ensuring the safety of the ship. *[Significant safety issue]*
- The ship's crew were not sufficiently familiar with its anchoring equipment, including the anchor cable bitter end release arrangement and hence undertook an unnecessarily dangerous operation to sever the anchor cable. *[Significant safety issue]*
- The Port Phillip Sea Pilots pilotage safety management system did not provide *APL Sydney*'s pilot with adequate guidance with regard to anchoring in Melbourne anchorage or the risks associated with the gas pipeline. *[Significant safety issue]*
- The Port of Melbourne Corporation's shipping control safe operating procedures, the port operations handbook and shipping control staff training did not provide the control officer with adequate guidance and information to allow him to safely manage the events of 13 December 2008 and give appropriate instructions, advice and information to *APL Sydney*'s master and pilot. *[Significant safety issue]*

3.3 Other safety factors

- *APL Sydney*'s windlass failed and its hydraulic motor casing shattered as a result of heavy load when the crew attempted to heave in the anchor shortly after it had snagged the pipeline. Fragments and debris from the shattered motor casing had the potential to cause injury. *[Significant safety issue]*
- The ship's working language, English, was not used by its crew for all communications on the bridge indicating that the procedure had not been effectively implemented on board the ship. This limited the pilot's awareness, impeded teamwork, caused delays and increased risks, particularly those associated with releasing the anchor cable. *[Significant safety issue]*
- The Port Phillip Sea Pilots pilotage safety management system policy to prevent mobile telephone use from interfering with safe navigation did not refer to any standard procedures or guidelines which could be followed by its pilots. *[Significant safety issue]*

3.4 Other key findings

- On 13 December 2008, once *APL Sydney*'s anchor had snagged the gas pipeline, the only appropriate course of action was to avoid placing weight on the anchor cable and to slip it as soon as possible.
- Communication or language difficulties did not contribute to the decisions with respect to the choice of *APL Sydney*'s intended anchor position, the delay in weighing the anchor or the attempt to dredge the anchor clear of the snagged pipeline. In this respect, the master clearly understood the information, advice or instructions that he was given.

4 SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety 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 responsible organisations for the safety issues identified during this investigation were given 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.

4.1 Port of Melbourne Corporation

4.1.1 Safety and environmental management

Significant safety issue

The Port of Melbourne Corporation's safety and environmental management systems did not adequately address the risk of an incident involving the ethane gas pipeline and shipping.

Response from the Port of Melbourne Corporation MO-2008-012-NSA-052

The Port of Melbourne Corporation has advised the ATSB that its safety and environmental emergency plan will be reviewed to ensure the specific risk of an anchor drag incident resulting in a vessel fouling the ethane pipeline is highlighted.

ATSB assessment of response

The ATSB is satisfied that the action proposed by the Port of Melbourne Corporation will adequately address the safety issue.

4.1.2 Anchorage boundaries

Significant safety issue

An appropriate risk assessment to determine safe limits for the Melbourne anchorage boundaries from the gas pipeline had not been carried out. The events of 13 December 2008 indicate that a limit of about 3 cables was not a safe clearance for all ships in all conditions.

Action taken by the Port of Melbourne Corporation MO-2008-012-NSA-051

The Port of Melbourne Corporation (PoMC) has advised the ATSB that as a result of the incident a formal risk assessment was undertaken to address matters related to this safety issue. A review of the risks, in consultation with Port Phillip Sea Pilots (PPSP) and Maritime Heritage Victoria, was completed in April 2009. The review took into account the circumstances of another recent incident[51] and focused on a number of shipboard and external issues and a wide range of hazards were considered and practical solutions identified for implementation.

In April 2009, interim measures were introduced by PoMC to address the risks until intended safety actions could be fully implemented. The measures included a requirement for ships to anchor no closer than 8 cables from the gas pipeline and for the vessel traffic service (VTS) to confirm anchored ships had received strong wind warnings. These requirements supplemented existing risk controls in the form of Harbour Master's Directions, services provided by VTS and PPSP and guidance available in marine notices, publications and shipboard safety management systems.

A significant outcome of the risk assessment was the implementation of agreed changes to the anchorages. In September 2009, the location of the Inner and Outer Anchorages was revised to increase the margin of safety from environmentally and commercially sensitive areas and infrastructure such as historic wrecks, submarine pipelines and spoil grounds. The revised locations were endorsed by Marine Safety Victoria. The ATSB has included a chart section[52] showing the changes (Figure 16).

In addition to revising the anchorages, a number of related measures have been implemented. These include a requirement for masters and pilots to report their intended anchorage berth to VTS. It is expected that marking berth boundaries on VTS electronic displays will enable improved traffic monitoring and control by VTS officers since a ships position, in relation to its berth, should be readily apparent. Individual berth boundaries are also expected to provide masters a clear indication of the specific area in which their ships should remain. The southern outer berths are anticipated to be used by ships requiring long-term anchorage.

To address weather related issues there is now a requirement for the harbour master to be informed when winds exceed 30 knots so that a comprehensive dynamic risk assessment is undertaken before navigating the inner port. This is in addition to the procedures to confirm strong wind warnings are received on board anchored ships.

Risk control measures to be considered by PoMC include a review of VTS operator training for monitoring anchored ships so that an early warning can be given to any that do not maintain position. The introduction of standard procedures for anchoring ships in heavy weather is also to be considered and agreed with PPSP.

ATSB assessment of action

The ATSB is satisfied that the action taken by the Port of Melbourne Corporation adequately addresses the safety issue.

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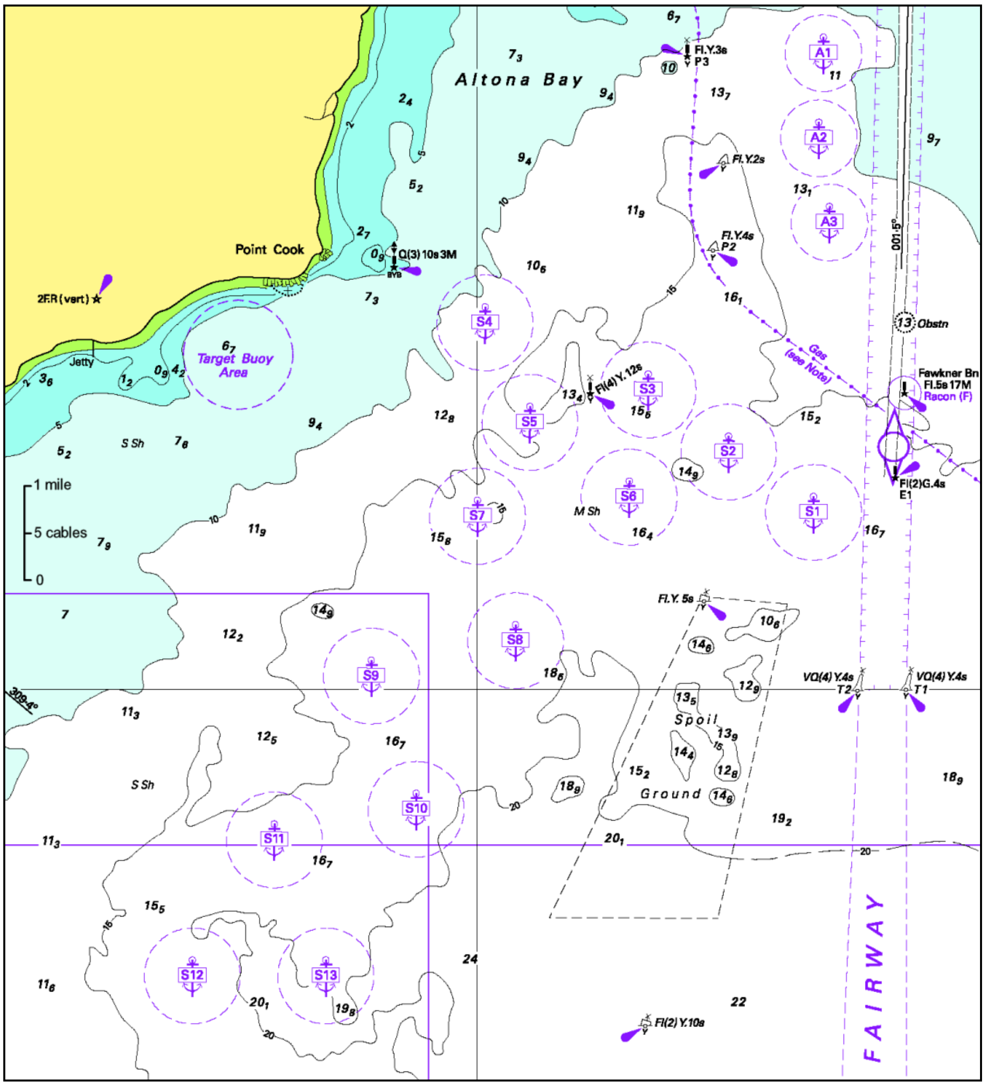
51 On 14 March 2009, in winds of about 55 knots, another container ship dragged its anchor about 5 cables from its position in the north-eastern part of the Outer Anchorage. The ship moved to a position north of the gas pipeline before it was steamed up to the anchor. After a pilot boarded, the anchor was weighed without damaging the pipeline or the ship's equipment.

52 The section shows all sixteen circular, numbered anchorage berths off Melbourne. The diameter of the inner berths is 8 cables and that of the outer berths is 1 mile. The boundaries of the berths nearest to the ethane gas pipeline are at least 8 cables from it.

Figure 16: Section of navigational chart Aus 143 showing revised anchorages



4.1.3 Shipping control

Significant safety issue

The Port of Melbourne Corporation's shipping control safe operating procedures, the port operations handbook and shipping control staff training did not provide the control officer with adequate guidance and information to allow him to safely manage the events of 13 December 2008 and give appropriate instructions, advice and information to *APL Sydney*'s master and pilot.

Response from the Port of Melbourne Corporation MO-2008-012-NSA-053

The Port of Melbourne Corporation has advised the ATSB that the current vessel traffic service operations manual introduced as a result of the Marine (Vessel Traffic Services Standards) Determination 2008 (effective 1 March 2009) will be reviewed to confirm the guidance given to control officers adequately equips them for their task.

ATSB assessment of response

The ATSB is satisfied that the action proposed by the Port of Melbourne Corporation will adequately address the safety issue.

4.2 Bernhard Schulte Shipmanagement Company, China

4.2.1 Passage planning and anchoring

Significant safety issue

APL Sydney's standard berth to berth passage plan form did not make adequate provision to consider anchoring-related details. The ship's plan did not contain any detail for anchoring off Melbourne indicating that an appropriate, independent and unhurried risk assessment for anchoring was not completed beforehand. As a result, the pilot's anchoring plan was accepted without properly assessing all the risks.

Response from Bernhard Schulte Shipmanagement Company, China MO-2008-012-NSA-054

Bernhard Schulte Shipmanagement Company has advised the ATSB that it will issue 'fleet instructions' to revise passage planning procedures and practices to include anchoring in berth to berth plans.

ATSB assessment of response

The ATSB is satisfied that the action proposed by Bernhard Schulte Shipmanagement Company will adequately address the safety issue.

4.2.2 Master's authority and responsibility

Significant safety issue

APL Sydney's safety management system did not adequately ensure that the master was certain about his overriding authority and responsibility with respect to decisions and actions aimed at ensuring the safety of the ship.

Response from Bernhard Schulte Shipmanagement Company, China MO-2008-012-NSA-055

Bernhard Schulte Shipmanagement Company has advised the ATSB that to supplement the current practice of posting the master's overriding authority policy statement from the safety management system policy manual in prominent locations on board ships, masters will be reminded about their authority, as described in the policy statement, during briefings at its Shanghai office before they join ships.

ATSB assessment of response

The ATSB is satisfied that the action proposed by Bernhard Schulte Shipmanagement Company will adequately address the safety issue.

4.2.3 Crew familiarity with equipment

Significant safety issue

The ship's crew were not sufficiently familiar with its anchoring equipment, including the anchor cable bitter end release arrangement and hence undertook an unnecessarily dangerous operation to sever the anchor cable.

Response from Bernhard Schulte Shipmanagement Company, China MO-2008-012-NSA-056

Bernhard Schulte Shipmanagement Company has advised the ATSB that although crew, appropriate to their responsibility on board the ship, are aware of the anchor cable release procedure; placards with clear directions to release the cable will be posted at bitter end locations and chief mates will personally familiarise all deck department crew with the procedure.

ATSB assessment of response

The ATSB is satisfied that the action proposed by Bernhard Schulte Shipmanagement Company will adequately address the safety issue.

4.2.4 Ship's working language

Significant safety issue

The ship's working language, English, was not used by its crew for all communications on the bridge indicating that the procedure had not been effectively implemented on board the ship. This limited the pilot's awareness, impeded teamwork, caused delays and increased risks, particularly those associated with releasing the anchor cable.

Response from Bernhard Schulte Shipmanagement Company, China MO-2008-012-NSA-057

Bernhard Schulte Shipmanagement Company has advised the ATSB that to supplement regular English language classes conducted ashore for Chinese masters and crew, it will follow up with classroom sessions on board ships. The company's sees its current practice of Chinese and other nationalities sailing together on ships as a practical way to improve the conversational English of Chinese crews.

ATSB assessment of response

The ATSB is satisfied that the action proposed by Bernhard Schulte Shipmanagement Company will adequately address the safety issue.

4.3 Port Phillip Sea Pilots

4.3.1 Guidance for anchoring

Significant safety issue

The Port Phillip Sea Pilots pilotage safety management system did not provide *APL Sydney*'s pilot with adequate guidance with regard to anchoring in Melbourne anchorage or the risks associated with the gas pipeline.

Action taken by Port Phillip Sea Pilots MO-2008-012-NSA-058

Port Phillip Sea Pilots (PPSP) has advised the ATSB that the guidance in its pilotage safety management system with respect to anchor positions will be reviewed taking into account the existing qualifications and training of pilots and the need to prevent a further incident of this type.

In relation to this safety issue, PPSP also advised that since the incident it has worked with the Port of Melbourne Corporation to mitigate risks associated with anchoring off Melbourne. It confirmed that the changes to the anchorages off Melbourne were a direct result of the *APL Sydney* incident in December 2008 and the other anchor dragging incident in March 2009. According to PPSP, the anchorage berths were developed to position them away from the pipeline and ensure appropriate manoeuvring room for ships. It noted that rather than designating large areas for general anchorage, the new system provides an anchor position for each ship.

ATSB assessment of action

The ATSB is satisfied that the action proposed by Port Phillip Sea Pilots will adequately address the safety issue.

4.3.2 Mobile telephone use

Significant safety issue

The Port Phillip Sea Pilots pilotage safety management system policy to prevent mobile telephone use from interfering with safe navigation did not refer to any standard procedures or guidelines which could be followed by its pilots.

Response from Port Phillip Sea Pilots MO-2008-012-NSA-059

Port Phillip Sea Pilots has advised the ATSB that its pilotage safety management system will be reviewed with regard to its policy for mobile telephone use. The matter will also be raised with the Port of Melbourne Corporation at the next navigational safety quarterly meeting.

ATSB assessment of response

The ATSB is satisfied that the action proposed by Port Phillip Sea Pilots will adequately address the safety issue.

4.4 TTS Kocks, Germany

4.4.1 Windlass failure

Significant safety issue

APL Sydney's windlass failed and its hydraulic motor casing shattered as a result of heavy load when the crew attempted to heave in the anchor shortly after it had snagged the pipeline. Fragments and debris from the shattered motor casing had the potential to cause injury.

Response from TTS Kocks, Germany MO-2008-012-NSA-060

The ATSB has been advised by TTS Kocks that its view that *APL Sydney*'s windlass failure probably resulted from over speed of its hydraulic motor's internal parts is supported by the classification society, Germanischer Lloyd (GL), which has consulted TTS Kocks with the aim of addressing this safety issue by considering changes to class rules.

According to TTS Kocks, the windlass complies with current class rules and even if these were changed it would be impossible to make hydraulic windlass motors fail-safe in all conditions. Increasing equipment and pressure relief valve limits will have limited success since it would be impractical to allow for the enormous loads placed on anchor cables in extreme conditions. Therefore, it agrees with a proposal by GL to provide protection covers for windlass operators and has suggested that another option would be the provision of a remote control stand in a safe position.

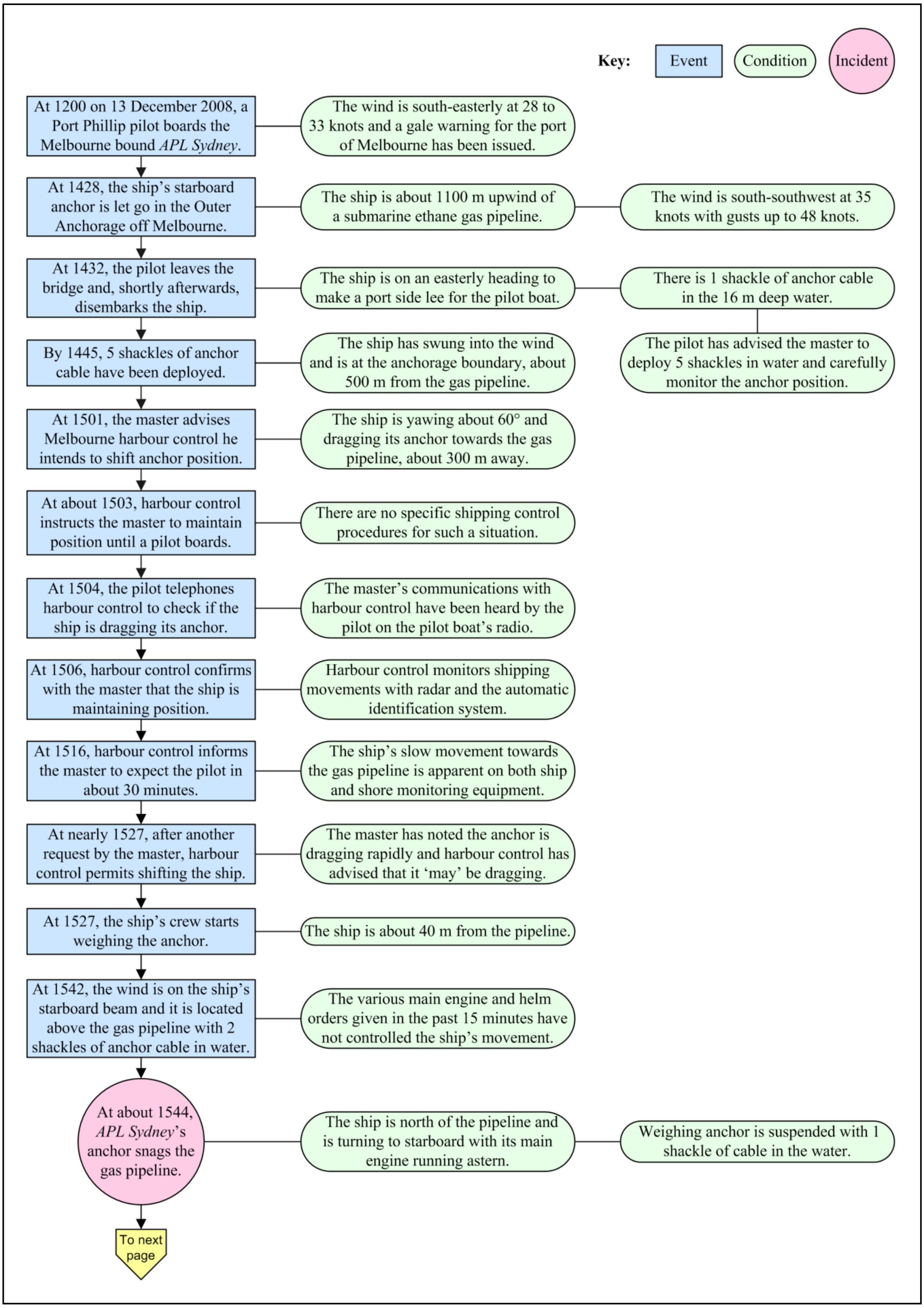
In addition, TTS Kocks has advised that the only way to avoid excessive loads on windlasses is to operate them using basic seamanship bearing in mind that they are not designed to hold a ship at anchor like a chain stopper is. However, the company is prepared to emphasize such operational considerations through instructions for operators of its windlasses.

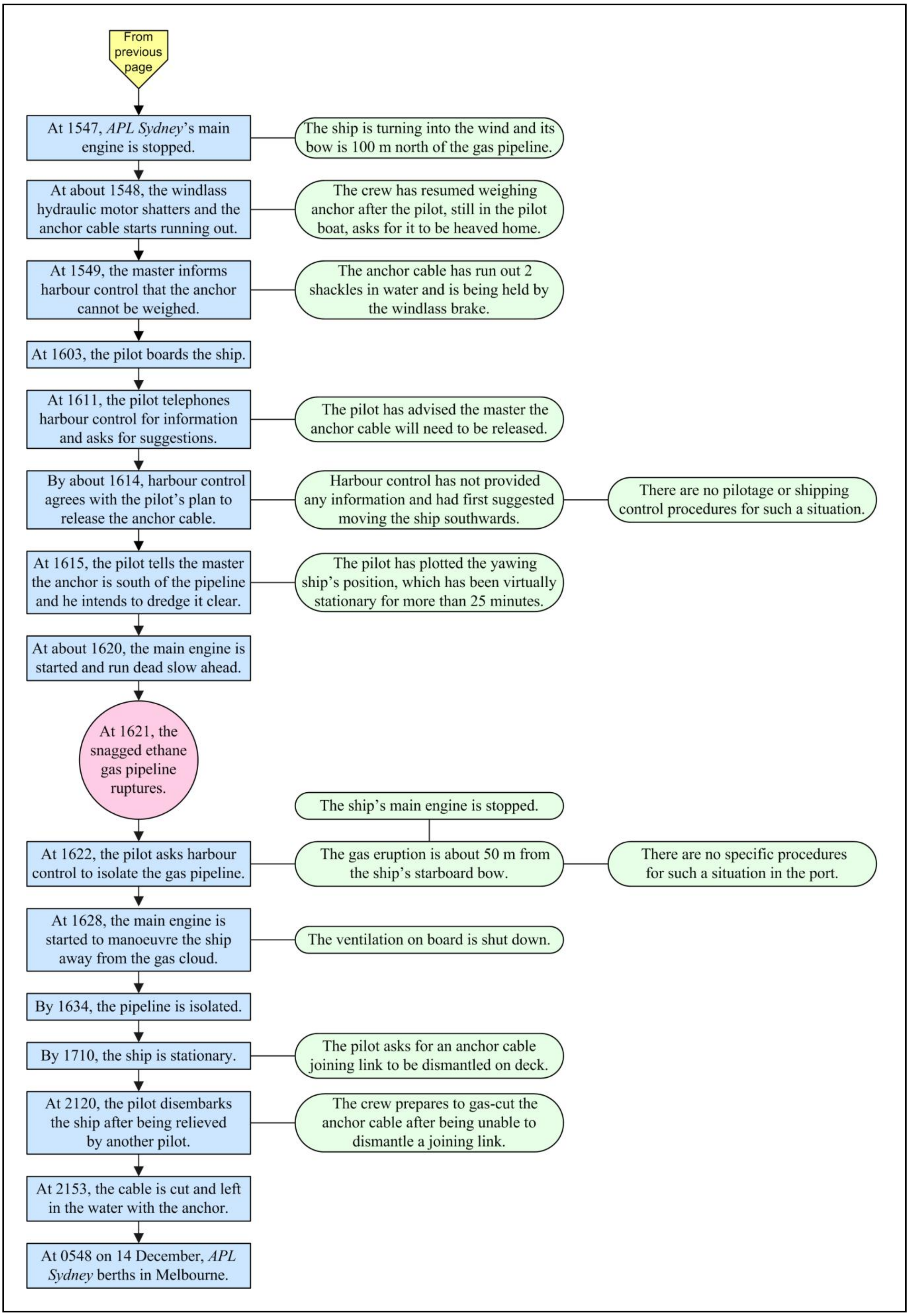
Consultation by GL with TTS Kocks and other windlass manufacturers indicates that progress in addressing this safety issue is possible through a change in class rules to supplement guidance to ships crews included in the Marine Accident Investigation Branch's Safety Bulletin 1/2009 and from TTS Kocks and other windlass manufacturers.

ATSB assessment of response

The ATSB is satisfied that the action taken and proposed by TTS Kocks will adequately address the safety issue.

APPENDIX A: EVENTS AND CONDITIONS CHART




From previous page
At 1547, APL Sydney's main engine is stopped.
The ship is turning into the wind and its bow is 100 m north of the gas pipeline.
At about 1548, the windlass hydraulic motor shatters and the anchor cable starts running out.
The crew has resumed weighing anchor after the pilot, still in the pilot boat, asks for it to be heaved home.
At 1549, the master informs harbour control that the anchor cannot be weighed.
The anchor cable has run out 2 shackles in water and is being held by the windlass brake.
At 1603, the pilot boards the ship.
At 1611, the pilot telephones harbour control for information and asks for suggestions.
The pilot has advised the master the anchor cable will need to be released.
By about 1614, harbour control agrees with the pilot's plan to release the anchor cable.
Harbour control has not provided any information and had first suggested moving the ship southwards.
There are no pilotage or shipping control procedures for such a situation.
At 1615, the pilot tells the master the anchor is south of the pipeline and he intends to dredge it clear.
The pilot has plotted the yawing ship's position, which has been virtually stationary for more than 25 minutes.
At about 1620, the main engine is started and run dead slow ahead.
At 1621, the snagged ethane gas pipeline ruptures.
The ship's main engine is stopped.
At 1622, the pilot asks harbour control to isolate the gas pipeline.
The gas eruption is about 50 m from the ship's starboard bow.
There are no specific procedures for such a situation in the port.
At 1628, the main engine is started to manoeuvre the ship away from the gas cloud.
The ventilation on board is shut down.
By 1634, the pipeline is isolated.
By 1710, the ship is stationary.
The pilot asks for an anchor cable joining link to be dismantled on deck.
At 2120, the pilot disembarks the ship after being relieved by another pilot.
The crew prepares to gas-cut the anchor cable after being unable to dismantle a joining link.
At 2153, the cable is cut and left in the water with the anchor.
At 0548 on 14 December, APL Sydney berths in Melbourne.

APPENDIX B: SHIP INFORMATION

APL Sydney

IMO Number	9328493
Call sign	VRCF5
Flag	Hong Kong, China
Port of Registry	Hong Kong
Classification society	Germanischer Lloyd (GL)
Ship Type	Container ship
Builder	Shanghai Shipyard & Chengxi Shipyard Company, Shanghai, China
Year built	2006
Owners	Strong Wise, China
Ship managers	Bernhard Schulte Shipmanagement Company, China
Gross tonnage	35,991
Net tonnage	15,938
Deadweight (summer)	42,102 tonnes
Summer draught	12.00 m
Length overall	230.92 m
Length between perpendiculars	214.20 m
Moulded breadth	32.20 m
Moulded depth	18.80 m
Engine	MAN B&W 7K90MC-C
Total power	31,990 kW
Speed	22.7 knots
Crew	24

APPENDIX C: SOURCES AND SUBMISSIONS

Sources of Information

Master and crew of *APL Sydney*

Port Phillip Sea Pilots

Port of Melbourne Corporation

Bernhard Schulte Shipmanagement Company, China

Esso Australia

TTS Kocks, Germany

Marine Safety Victoria

Australian Bureau of Meteorology

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Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the 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 *APL Sydney*'s master, chief mate and the ship's managers, Bernhard Schulte Shipmanagement Company (Schulte), Port Phillip Sea Pilots (PPSP) and *APL Sydney*'s pilot, the Port of Melbourne Corporation (PoMC) and the shipping control officer, Esso Australia (Esso), Germanischer Lloyd (GL), TTS Kocks, the Australian Maritime Safety Authority (AMSA), Marine Safety Victoria (MSV), the Hong Kong Marine Department (MARDEP) and the Marine Accident Investigation Branch (MAIB), United Kingdom.

Submissions were received from *APL Sydney*'s master and the chief mate, Schulte, PPSP and the pilot, PoMC and the shipping control officer, Esso, GL, TTS Kocks, AMSA, MSV, MARDEP and MAIB. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

APPENDIX D: MEDIA RELEASE

Port Phillip gas pipeline rupture final safety report released

The ATSB has found that the submarine ethane gas pipeline rupture in Port Phillip on 13 December 2008 was the result of attempting to clear the container ship *APL Sydney*'s anchor, which had snagged the pipeline.

The Australian Transport Safety Bureau investigation found the ship's anchor had been let go too close to the pipeline in the gale force winds and insufficient anchor cable was deployed. The anchor dragged towards the pipeline and snagged it because appropriate avoiding action was not taken.

At 1428 on 13 December, *APL Sydney*'s anchor was let go in Melbourne's Outer Anchorage, about 1 km upwind of the pipeline and shortly afterwards, the pilot left the ship. By 1501, the ship had dragged its anchor and was located outside the anchorage, about 350 m from the pipeline. The master advised Melbourne harbour control of his intention to weigh anchor and shift the ship but was instructed to maintain position and wait for a pilot.

By 1525, the pilot had not boarded and the ship, after continuing to drag its anchor, was about 50 m from the pipeline. Harbour control then gave the master permission to shift the ship. Weighing anchor was started but after a few minutes, control of the ship was effectively lost. At about 1544, the anchor snagged the pipeline and a little later, the anchor windlass also failed.

The pilot re-boarded *APL Sydney* at 1603 and after first considering releasing the anchor cable, discussed the situation with harbour control. At 1615, he concluded the anchor was south of the pipeline and decided to drag it clear. The master accepted his plan and at 1620, the ship's main engine was started. At 1621, the gas pipeline ruptured. There were no injuries and the pipeline was isolated.

The investigation identified safety issues in relation to: the port's risk management with respect to the pipeline and anchorage boundaries and its shipping control procedures; the ship's safety management system; the pilotage company's safety management system; and the windlass failure.

The ATSB is pleased to report that safety actions to address all the safety issues have been taken or been proposed by the relevant parties to prevent similar incidents in the future. The risk assessment of the anchorage conducted by the Port of Melbourne Corporation and the implementation of measures, including revised anchorages with individual ship berths, is one of the significant actions taken.

Independent investigation into the rupture of a submarine gas pipeline by the Hong Kong registered container ship *APL Sydney* in Port Phillip, Victoria on 13 December 2008.