Australian Government

Australian Transport Safety Bureau

Safe Transport

MARINE SAFETY INVESTIGATION
No. 171

Independent investigation into the equipment failure aboard the Hong Kong flag container vessel

Maersk Tacoma

in Bass Strait
8 August 2001

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Media Release

Ship imperilled in Bass Strait

The engineers placed themselves in danger to save a ship in gale force weather conditions in Bass Strait after its main engine became disabled according to an Australian Transport Safety Bureau (ATSB) investigation report released today. The ATSB report states that the Hong Kong registered container ship, *Maersk Tacoma*, spent 19 hours adrift before being taken in tow on 8 August 2001.

The incident is still the subject of legal action in London between the ship's owners and various other parties. The ATSB waited for 34 months to obtain the engineering report from the owner's representatives on the main engine failure.

Maersk Tacoma had departed Melbourne in the afternoon of 7 August 2001 heading to Brisbane. In the early hours of 8 August one of the ship's main engine bottom end bearings failed which left the ship drifting in Bass Strait in deteriorating westerly weather conditions. After being informed of the situation, the ship's management company in Hong Kong implemented their emergency response plan to arrange the salvage of the ship.

While awaiting the towing vessel, *Maersk Tacoma* drifted 45 miles eastward passing very close to both Cutter Rock and the Hogan group of islands. On both occasions the damaged main engine had to be run for short periods to prevent the ship from grounding. By 2125 on 8 August, *Pacific Conqueror*, an offshore towing and supply vessel based in Gippsland, had taken the ship in tow. By the following afternoon, the ship had been towed to a safe anchorage on the eastern side of Wilson's Promontory.

The ATSB report concludes that main engine was disabled when the main engine bottom end bearing failed as a result of its pre-existing condition in combination with reduced lubricating oil flow. It also concludes that *Maersk Tacoma*'s engineers placed themselves in significant danger by running the damaged main engine to save the ship on two occasions and that Australian authorities should have been notified of the ship's situation sooner.

The report recommends that ship owners and operators should ensure that they have procedures for notifying local rescue coordination authorities promptly if their ship becomes disabled.

Copies of the report can be downloaded from the internet site at www.atsb.gov.au, or obtained from the ATSB by telephoning (02) 6274 6478 or 1800 020 616

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1 SUMMARY

At 1100 on 7 August 2001, the Hong Kong flag container vessel *Maersk Tacoma* departed Melbourne en route to Brisbane. The ship was loaded with containers and had a mean departure draught of 11.10 m. By 1524, the ship had cleared Port Phillip Bay, and was running at sea speed heading eastward through Bass Strait.

Between 1608 and 2200 on 7 August, the main engine was stopped four times in response to low Lubricating Oil (L.O.) alarms. After the stoppage at 2200, the engineers inspected the main engine crankcase and found that number twelve bottom end bearing had failed. The fuel to number twelve cylinder was turned off and the main engine was restarted at 0114 on 8 August. The intention was to proceed at reduced speed to a safe anchorage where the damage to the main engine could be better assessed.

At 0152 the main engine was stopped again after another low L.O. pressure alarm. The chief engineer found that he was having difficulty maintaining the lube pressure and informed the master that he could not use the main engine. The master then contacted the ship's managers in Hong Kong to inform them of the situation. *Maersk Tacoma* was approximately 13 nautical miles west of Rodondo Island and, with the wind from the north-west at force five, started drifting south-east at 2.5 knots.

By 0500 the weather had deteriorated with the wind force seven from the north-west and the vessel's rate of drift had increased to 3.0 knots in an easterly direction.

During the next four hours the weather continued to deteriorate as the ship drifted towards Cutter Rock which has a charted depth of 7.4 m. By 0900 the distance to Cutter Rock had closed to 1.8 miles on a bearing of approximately 135°(T). The master was very concerned that the ship would ground on Cutter Rock and asked the chief engineer if he could have the main engine again for what ever time was possible. At 0910 the main engine was started dead slow ahead with one of the engineers controlling the main engine from the engine side control stand as the remote control system was unserviceable. At 0928 the main engine was stopped again after another low L.O. pressure alarm but in the 18 minutes that the engine had run the ship had tracked far enough north to clear Cutter Rock by 0.8 miles.

At 0946, the Rescue Coordination Centre (RCC) in Canberra was contacted by the ship's charterers who reported *Maersk Tacoma*'s situation.

At 1026 the starboard anchor was lowered in an attempt to slow the ship's rate of drift. A short time later it was apparent that *Maersk Tacoma*'s drift had slowed to 2.5 knots but the ship was now drifting east-north-east towards the Hogan group of islands some 16 miles away. The master was now concerned about the possibility that the ship would ground on one of the Hogan islands. Two attempts by the crew to raise the anchor after this time were unsuccessful.

Maersk Tacoma was contacted by Swire Pacific Offshore at 1225. They indicated that the salvage vessel *Pacific Conqueror* had departed from Barry Beach and would take approximately four hours to arrive at the ship's position. The master was still concerned that *Maersk Tacoma* would ground on one of the Hogan islands before

Pacific Conqueror arrived to take the ship under tow. The RCC was also concerned and made arrangements for two helicopters to stand-by on Hogan Island if it became necessary to evacuate the ship's crew.

At 1505 *Maersk Tacoma* was six miles from Hogan Island when the main engine was started again in an attempt to save the ship despite the certain knowledge that the main engine would be damaged further. At 1618 the engine was stopped with *Maersk Tacoma* 4.3 miles north-west of Hogan Island and out of immediate danger.

Pacific Conqueror was sighted on the starboard beam by the crew of *Maersk Tacoma* at 1646 and was alongside the ship by 1706. By 1822 *Pacific Conqueror* had taken the ship in tow by hooking the ship's anchor cable using a 'J' hook. The tow then proceeded without significant incident until 1300 on 9 August when the two vessels arrived at a safe anchorage off Sealers Cove on the eastern side of Wilson's Promontory.

By 12 August the weather had moderated sufficiently to allow *Maersk Tacoma* to be towed to Melbourne. On 14 August, the ship arrived at Swanson Dock where it remained until 17 October 2001 while damage to the main engine was repaired.

The report's conclusions include:

- The ship's main engine was disabled when number twelve bottom end bearing failed.
- It is likely that the bottom end bearing failure was the result of its pre-existing condition in combination with reduced L.O. flow.
- *Maersk Tacoma*'s engineers placed themselves in significant danger by running the damaged main engine to save the ship on two occasions when it was at risk of grounding on both Cutter Rock and the Hogan group of islands.
- *Maersk Tacoma*'s crew were unnecessarily imperilled by the failure to notify Australian authorities of the vessel's situation for some eight hours after the main engine was found to be effectively unserviceable.
- The delay in notifying the Australian authorities of the breakdown and the potential risk to the environment, together with the time taken to organise a tow indicates significant deficiencies in the ship manager's emergency planning.

The report recommends that:

Ship owners and operators include procedures in their vessel's safety management systems which stipulate that local rescue coordination centres must be notified promptly if the ship becomes disabled.

2 SOURCES OF INFORMATION

The master and crew of *Maersk Tacoma*

Australian Maritime Safety Authority

Rescue Coordination Centre Australia

MAN B&W Diesel Australia

Acknowledgments

The Inspector gratefully acknowledges the assistance of the Forensic Services division of the Australian Federal Police.

The Inspector also acknowledges the information and assistance provided by Peacock & Smith Pty Ltd of Melbourne.

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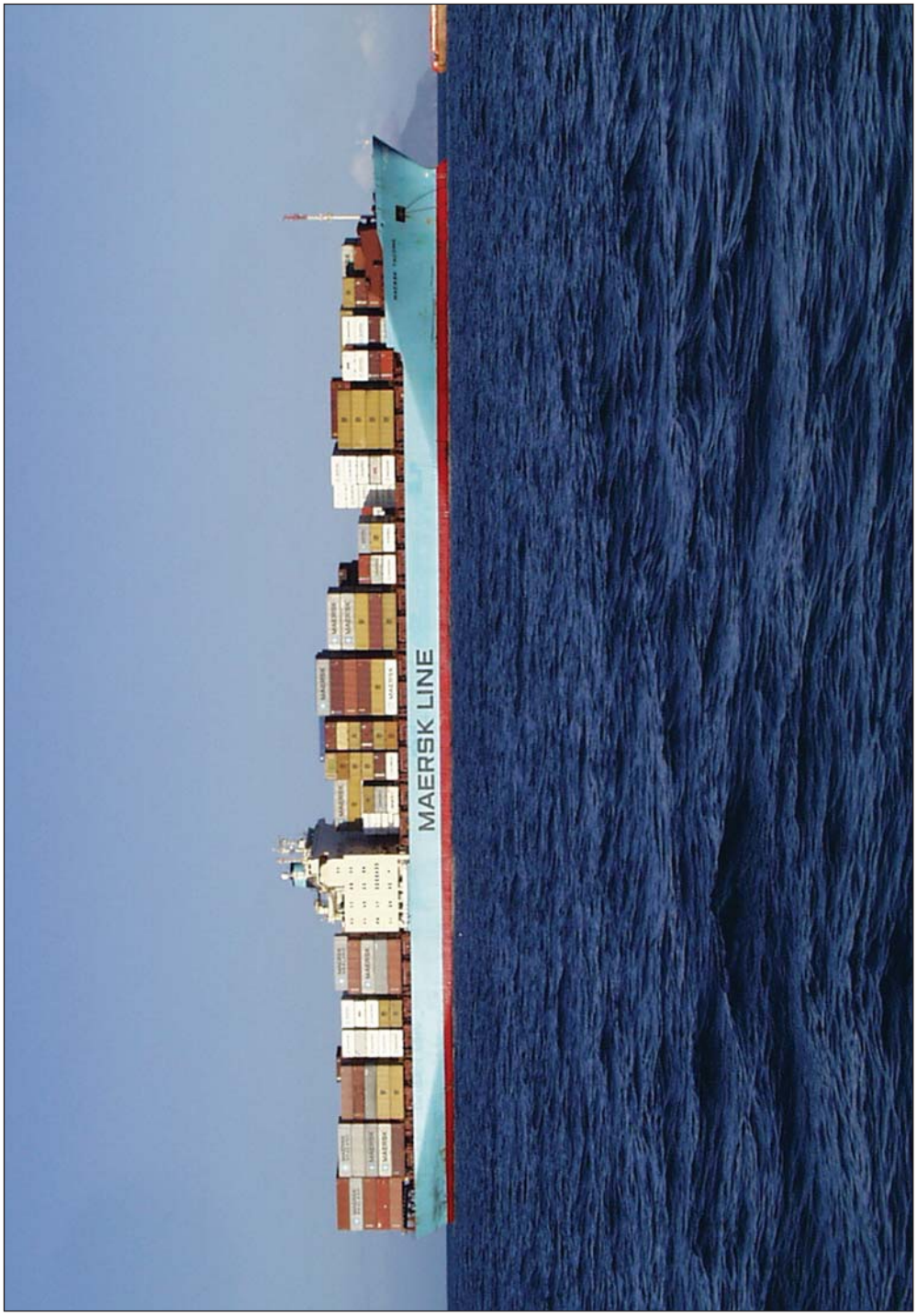
FIGURE 1: ***Maersk Tacoma*** **at anchor off Sealers Cove**



3 NARRATIVE

Maersk Tacoma

Maersk Tacoma is a Hong Kong flagged, cellular container ship of 44 153 deadweight tonnes at its summer draught of 13.022 m (figure 1). At the time of the incident, the vessel was owned by Tonnevold Tacoma K.S. Company and had been managed by Denholm Ship Management in Hong Kong since November 2000. It is classed ✠100A1 Container Ship, with ✠LMC[1] and UMS[2] notations, with Lloyd's Register.

Maersk Tacoma was built in 1982 by the Odense Staalskibsvaerft ship yard in Lindo, Denmark. The vessel has an overall length of 241.13 m, a moulded breadth of 32.20 m and a moulded depth of 19.80 m. The main engine drives a single fixed-pitch propeller which gives the ship a service speed of 24.1 knots. The ship is also equipped with both bow and stern thrusters to assist in berthing operations.

The vessel has the capacity to carry 3 292 TEUs (twenty foot container equivalent units) in thirteen holds, nine holds forward of the accommodation superstructure and four aft. The accommodation superstructure is located near midships.

At the time of the incident, *Maersk Tacoma* was trading on a six week, fixed schedule liner service between Sydney, Melbourne and Brisbane in Australia, Yokohama, Nagoya and Osaka in Japan, Pusan in South Korea, Hong Kong and Kaohsiung in Taiwan.

Maersk Tacoma had a crew of 28 comprised of a master and three mates, two deck cadets, chief and four engineers, an electrician, an engineer cadet, boatswain and six deck ratings, six engine room ratings and two catering staff. All of the crew were either Indian or Bangladeshi except one deck cadet and the engineer cadet who were Chinese nationals.

The mates on *Maersk Tacoma* maintained a watchkeeping routine of four hours on, eight hours off. Although the vessel had a UMS rating, the engineers had been keeping watches in the engine room for some time prior to the incident apparently due to a high number of alarms and as a result of some of the automated control equipment being unserviceable.

The master of *Maersk Tacoma* held a foreign-going masters certificate of competency issued in India and had seventeen years experience at sea, the last six of which were in command. He had had four years experience on container vessels and had joined the ship for the first time on 20 July 2001, nineteen days prior to the incident. *Maersk Tacoma*'s chief engineer had been at sea for 22 years and held a class one (motorship) certificate of competency issued in India. He had been sailing as chief engineer for six years and had joined the ship for the first time on 7 July 2001, four weeks before the incident. The chief engineer had not sailed on a ship fitted with a B&W GFCA series main engine prior to joining *Maersk Tacoma*.

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1 Notation assigned when machinery is constructed and installed under Lloyd's Special Survey in accordance with Lloyd's rules.

2 Notation denotes ship may be operated with the machinery spaces unattended.

The main engine

Maersk Tacoma is powered by an in-line twelve cylinder B&W 12L90 GFCA two-stroke diesel main engine of 34 800 kW maximum continuous rating at 97 rpm. The engine has a bore of 900 mm and a stroke of 2 180 mm. The engine is of 'crosshead' type and is single acting and direct reversing. The main engine was built by Burmiester and Wain at their factory in Denmark in 1982. The main engine auxiliary systems, including the lubricating oil (L.O.) system, are of standard design and were fitted by the shipyard at the time the vessel was built.

As a crosshead engine, each of *Maersk Tacoma*'s main engine pistons are connected to individual sliding crosshead assemblies via fixed piston rods. The motion of each piston is then transmitted from its crosshead assembly to the crankshaft via a connecting rod. Each piston rod slides through a stuffing box which seals the scavenge space around the bottom of the cylinder liner from the crankcase. Pressurised and cooled scavenge air is provided by four exhaust gas driven turbochargers with integral charge air coolers.

Scavenging (clearing) of cylinder exhaust gas is achieved when each piston nears the bottom of its power stroke and it uncovers the scavenge ports located towards the bottom of the cylinder liner. When the scavenge ports are uncovered, pressurised and cooled scavenge air flows from the scavenge space into each cylinder and travels upward to exit the combustion chamber via a camshaft driven exhaust valve fitted to the cylinder cover. The exhaust valve opens just before the piston uncovers the scavenge ports and closes just after the piston moves back upward to re-cover the scavenge ports. As the piston continues to travel upward towards top-dead-centre (TDC) the air in the cylinder is compressed. Fuel injection takes place just before the piston reaches TDC, with ignition taking place at, or just after, the piston passes TDC. The power stroke then occurs until the exhaust valve opens just before the piston uncovers the scavenge ports again.

Lubricating oil system

The main components of *Maersk Tacoma*'s main engine L.O. system are; the main engine sump tank, three centrifugal pumps, a three-way thermostatic valve, two coolers and an automatic filter. Oil is drawn from the sump tank by the pumps, which are piped in parallel, and is discharged into the coolers which are plate type heat exchangers (also piped in parallel) via the thermostatic valve. The thermostatic valve controls the temperature of the oil by allowing a portion of the oil flow to by-pass the coolers to maintain the engine inlet temperature at approximately 50° C. From the coolers, the oil flows through the automatic filter and then to the main engine where it is divided into piston cooling and main bearing L.O. The normal oil inlet pressure measured after the automatic filter is 1.8–2.0 bar with the low pressure alarm set at 1.3 bar and the main engine shutdown set at 0.8 bar.

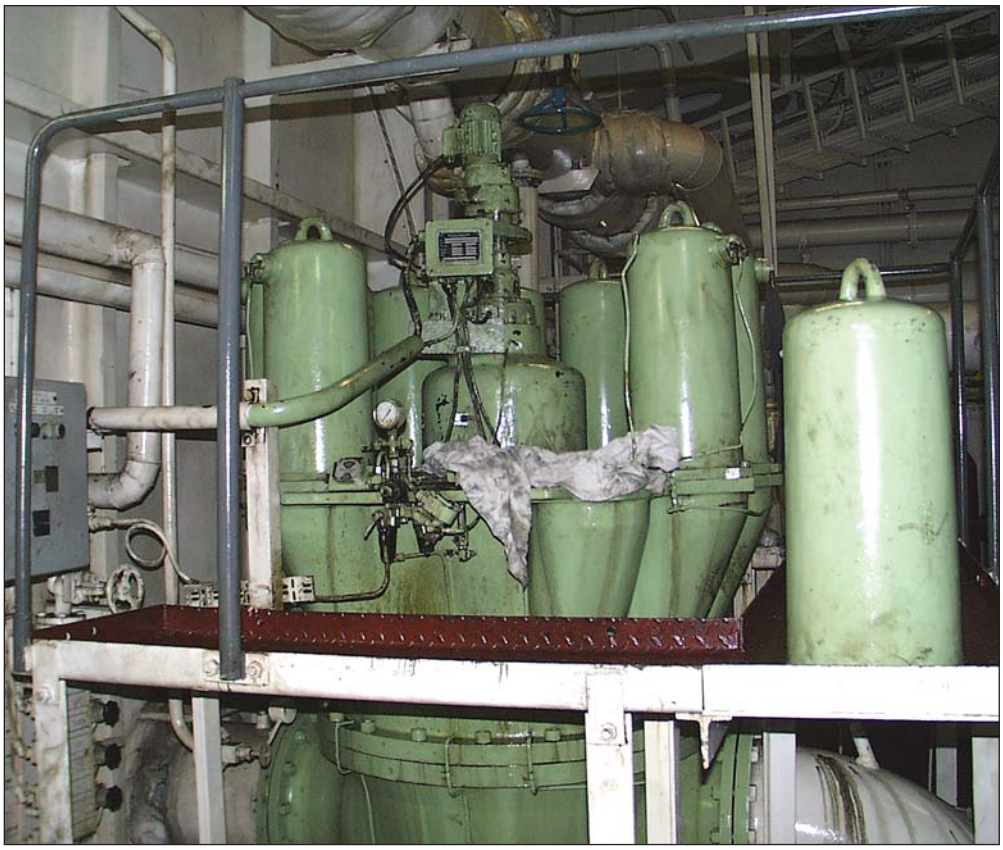
The piston cooling oil flows to each crosshead via a telescoping pipe inside the main engine crankcase. At the crosshead, the piston cooling oil flow is divided to supply lubrication to the crosshead bearings, piston cooling and bottom end bearing lubrication via an oil bore in the connecting rod. The main bearing L.O. flows to each main bearing via an oil pipe attached to the bearing cap.

The automatic filter fitted to *Maersk Tacoma*'s L.O. system is a Boll and Kirch model 6.34 (figure 2). The filter consists of ten chambers each fitted with multiple 'candle'

filter elements. In normal operation, the full flow of the main engine lube supply flows through the candle filters in nine chambers and the tenth chamber is on 'stand-by'. A differential pressure switch senses the pressure drop across the whole filter and initiates a cleaning cycle when the candle filters in operation accumulate sufficient debris. If the pressure drop across the filter becomes too large the flow of L.O. to the main engine is reduced and the oil pressure after the filter is lowered.

When a cleaning cycle is initiated, a motor-driven rotary valve is rotated until the stand-by chamber is brought on-line and the oil supply and return on one of the other nine chambers which has been in operation is shut off. A compressed air pulse is then directed into the off-line chamber in the opposite direction to normal oil flow which 'back-flushes' any accumulated debris from the candle filters. The debris is then carried by the oil in the chamber out through a 'sludge' valve in the base of the automatic filter. The cleaning cycle is completed when the empty filter chamber is refilled with oil. The 'clean' filter chamber then becomes the new 'stand-by' chamber. 'Dirty' oil which has passed through the sludge valve is recycled in a drain filter fitted with disposable filter cartridges. The filtered oil then flows back to the main engine sump tank.

FIGURE 2: Lube oil Boll and Kirch automatic filter



For some period before the incident, *Maersk Tacoma*'s Boll and Kirch filter had not been automatically flushing due to a problem with a differential pressure switch. The engineers had been in the practice of by manually initiating a cleaning cycle each four hour watch or when they noticed that the differential pressure on the filter was increasing.

In June, the engineers had found that the nut holding the automatic filter's sludge valve on its spindle had sheared. A spare had been ordered but had not arrived on

board prior to the incident. This meant that the each time a cleaning cycle was initiated, the 'dirty' oil discharged from the chamber being cleaned was passing through the relatively small holes in the sludge valve plate surrounding the spindle hole.

The incident

At 1430 on 5 August 2001, *Maersk Tacoma* arrived at the pilot boarding ground off Point Nepean at the entrance to Port Phillip Bay. After taking a pilot, the ship proceeded to Melbourne, arriving at Swanson Dock at 1748.

During the arrival stand-by it was found that the bridge control system for the main engine had failed. The subsequent berthing operation at Swanson Dock was completed by an engineer manoeuvring the main engine locally at the engine-side control stand.

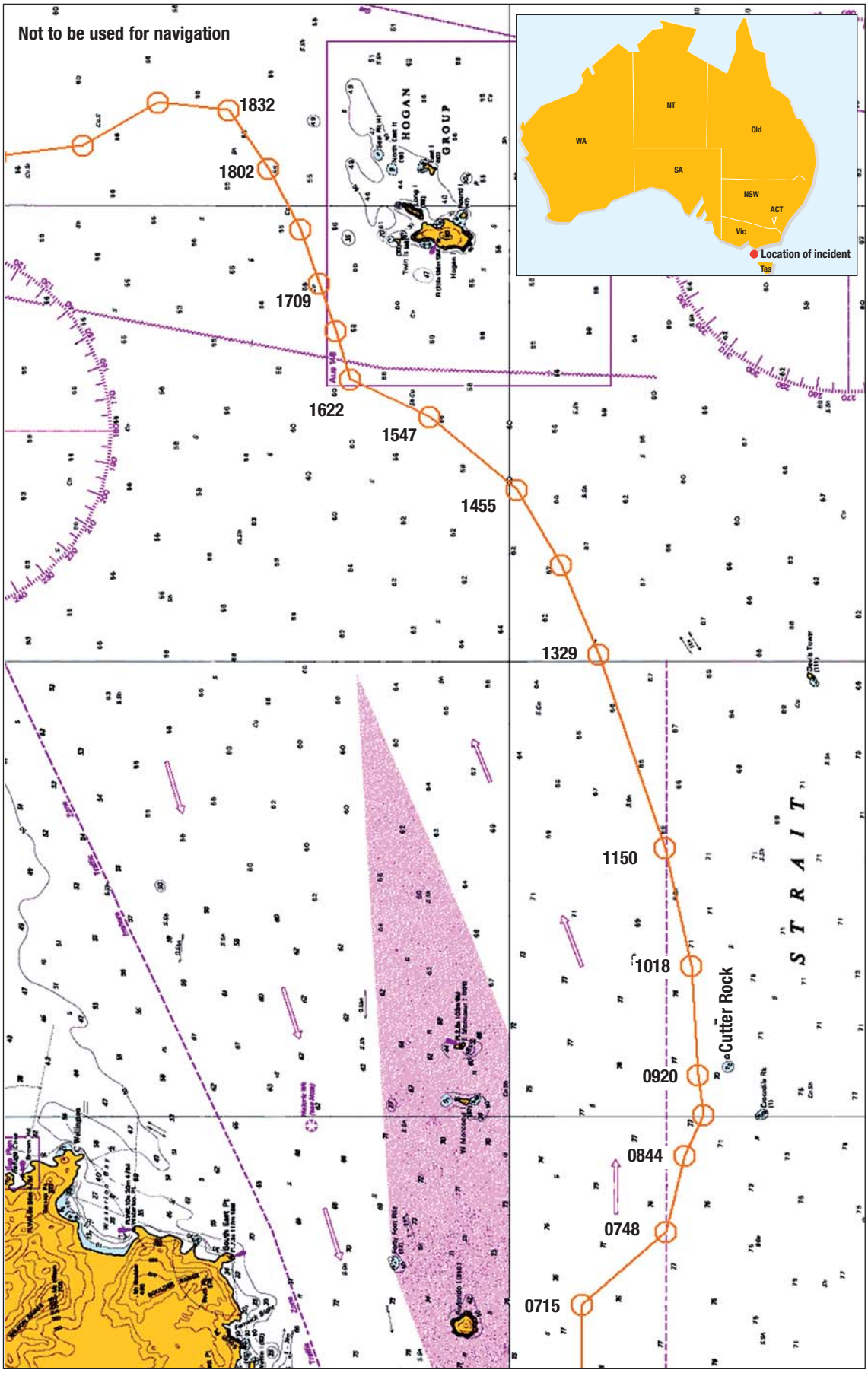
While *Maersk Tacoma* was in Melbourne, the engineers investigated the main engine control problem and found a faulty circuit board. The circuit board was repaired in Melbourne and returned to the ship prior to departure. The engineers also changed the candle filters in the main engine L.O. automatic filter with the ship's clean spare set. In addition, they purified approximately 9000 litres of oil from the stuffing box drain tank. This oil was then added to the main engine sump. The L.O. purifier was opened for cleaning after the stuffing box oil had been purified and no undue build up of sludge or debris was noted.

Maersk Tacoma departed Melbourne at 1100 on 7 August en route to Brisbane. The repair to the automated engine control system could not be tested while the ship was alongside in Melbourne so the master made the decision to use the *engine-side* controls during the departure stand-by. The ship was loaded with containers and had a mean departure draught of 11.10 m. In addition to the cargo, it was carrying 2640 tonnes of heavy fuel, 423 tonnes of diesel and 132 cubic metres of L.O. By 1524, the ship had cleared Port Phillip Bay and after disembarking the pilot, the main engine automatic control system was brought into operation. After five minutes the engine control system failed again to leave the engineers manually manoeuvring the main engine using the engine-side controls.

At 1608 when the ship was 6.5 nautical miles south-west of Cape Schanck, the duty engineer responded to a main engine low L.O. pressure alarm by stopping the main engine. He called the chief engineer who arrived in the engine room a short time later. After checking the L.O. system, the chief engineer found that the automatic filter in the L.O. system was showing a high differential pressure which he cleared by manually initiating several cleaning cycles. At 1716, after the L.O. pressure had returned to normal, the main engine was restarted and worked up to full sea speed.

At 2016, the duty engineer rang the chief engineer to report that he had had another main engine L.O. low pressure alarm and that he had stopped the engine. When the chief engineer arrived in the engine room he checked the L.O. system again. The chief engineer decided to change the candle filters in the automatic L.O. filter with the spare set which had been cleaned after being removed from the filter in Melbourne. While changing the filters, the chief engineer did not note any unusual debris deposited on the filter candles. By 2107 the automatic filter was back on-line and the main engine was restarted.

FIGURE 3: Excerpt from *Maersk Tacoma*'s approximate track on 8 August 2001



At 2115 the main engine was stopped again after another low L.O. pressure alarm. The engineers opened the automatic filter and cleaned the filter candles again.

The main engine was restarted at 2155, and was run briefly until being stopped at 2200 again due to low L.O. pressure. The chief engineer opened the automatic L.O. filter again but this time also opened the drain filter attached to the automatic filter. He inspected both filters and found white metal particles deposited in the drain filter. He instructed the engineers to conduct a crankcase inspection of the main engine and it was found that number twelve unit bottom end bearing appeared to be damaged, with extruded white metal showing on the bearing journal either side of the connecting rod. Pieces of bearing material were also found in the bottom of the crankcase in number twelve crank chamber. All of the other main engine bearings appeared to be normal.

After completing the crankcase inspection, the chief engineer conferred with the master and the decision was made to proceed at reduced speed to a safe anchorage where the damage to the main engine could be more fully assessed. The fuel to number twelve cylinder was turned off and the main engine was restarted at 0114 on 8 August at dead slow ahead with only 11 cylinders firing.

At 0152, the main engine was stopped after another low L.O. pressure alarm. After back flushing and cleaning the filter candles in the automatic filter again the chief engineer found that he was having difficulty maintaining the lube pressure. He then informed the master that the main engine could not be used. The master then contacted Denholm Ship Management (Denholm) in Hong Kong to inform them of the situation.

Maersk Tacoma was approximately 13 miles west of Rodondo Island and, with the weather from the north-west at force five, started drifting south-east at 2.5 knots.

By 0320 the ship had drifted to a position 11 miles west-south-west of Rodondo Island, close to the eastbound lane of the Bass Strait traffic separation scheme. At 0330 the master had another discussion with an officer from Denholm in Hong Kong regarding towing arrangements. At this time the vessel was taken off hire.

By 0500 the weather had deteriorated to force seven from the north-west and the vessel's rate of drift had increased to 3.0 knots in an easterly direction. By 0600, *Maersk Tacoma* was 4.2 miles south-west of Rodondo Island. The master was becoming increasingly concerned about the weather and the direction and speed at which the ship was drifting. The nearest immediate dangers were Cutter Rock, with a charted depth of 7.4 m, and the drying Crocodile Rock to the east-south-east of *Maersk Tacoma*.

At around this time, the chief engineer and master conferred and the decision was made to restart the main engine and attempt to move the ship to a safe anchorage. Now he was aware of the condition of number twelve bottom end bearing, the chief engineer was concerned about the possibility of a crank case explosion when the main engine was running. He realised that one of the engineers would have to stay in the engine room to control the main engine from the manoeuvring stand at the side of the engine. He told the other engine room staff that they may leave the engine room while the engine was running.

At 0710 the main engine was started dead slow ahead and full port rudder was applied to turn the vessel onto the planned track (at this point the ship was drifting in a south easterly direction). At 0720 the bow thruster was also started in an attempt to turn the ship to port and after several minutes the ship started swinging, overshot the planned heading and then came around onto a heading of approximately 015°(T). However at 0736 another low L.O. pressure alarm occurred which meant the main engine had to be stopped. The ship was now 4.6 miles south of Rodondo Island and drifting east-south-east at 2.8 knots.

In the time that main engine had run from 0710 to 0736, *Maersk Tacoma* had tracked 2.4 miles to the south-south-east and was now in a position 5.2 miles west-north-west of Cutter Rock.

After the engine had stopped at 0736 the engineers cleaned the L.O. filter candles again. The chief engineer noted that there was more bearing metal debris in the back-flush filter than the previous time the filter had been cleaned.

At 0755, the master called Denholm again to update them on the situation.

By 0800 the weather had deteriorated further and was now force eight from the west-north-west. *Maersk Tacoma* was drifting on a course of 110°(T) at 2.8 knots and rolling up to 10°.

The master had another conversation with Denholm at 0805 and attempted to call the coastal radio station at Port Welshpool on VHF channel 16 and 60 but received no response.

At 0845, with Cutter Rock at a range of 2.3 miles and bearing 130°(T) the master spoke to the charterers (Maersk Australia) in Sydney and informed them of the situation and asked about towage and salvage. At this point the master was very concerned that the ship would ground on Cutter Rock within the next hour.

By 0900 the distance to Cutter Rock had closed to 1.8 miles on a bearing of approximately 135°(T). The ship was drifting beam-on to the sea. The master asked the chief engineer if he could have the main engine again for what ever time was possible so the ship could be manoeuvred away from the danger posed by Cutter Rock. At 0910 the main engine was started dead slow ahead and full starboard rudder was applied to turn the ship onto an easterly heading. The master found that the ship was not responding to the helm and so he used both the bow and stern thrusters to assist in turning the ship. He spoke to the engine room who confirmed that they could not increase the main engine speed above dead slow. At 0928 the main engine was stopped again after another low L.O. pressure alarm. All attempts to turn the ship during the manoeuvre had failed but the ship had tracked far enough north to clear Cutter Rock by 0.8 miles.

At 0928 Denholm Hong Kong spoke to the master who updated them on the current situation. The wind had shifted to become almost westerly at force seven to eight with *Maersk Tacoma* drifting east-north-east at three knots. The master called Denholm again at 0939 to appraise them of the situation.

At 0946 Maersk Australia contacted the Rescue Coordination Centre (RCC) in Canberra to report *Maersk Tacoma*'s breakdown and at this point the RCC started to monitor the situation. The RCC made contact with various authorities including the Melbourne Water Police, the Marine Board of Victoria, the Tasmania Police and

the Australian Maritime Safety Authority's Manager for Environment Protection Response.

At 0950 the master received another call from Denholm Hong Kong which was followed by a call from the RCC at 1005 and a call from the charterers at 1008.

The master was still concerned about the vessel's rate of drift and so he made the decision to slow the drift by lowering an anchor. At 1026, the starboard anchor was lowered until eight shackles of anchor cable (approx 220 m) were in the water with a charted water depth of 71 m. After the anchor was lowered, the ship continued to drift but at a slightly slower rate of 2.5 knots.

At 1038 the main engine was started dead slow astern and was stopped again at 1043 after another low L.O. pressure alarm. The engineers opened the automatic L.O. filter and again cleaned the filter candles.

At 1105 the charterers called the master who updated them on the situation. Shortly after at 1125, the master called Denholm in Hong Kong and updated them also. During this time AusSAR had made contact with Denholm, which indicated that it would coordinate the salvage operation from its emergency centre in Glasgow, Scotland.

At 1145 the master broadcast an urgency alert message (Pan call) on VHF channel 70 and 16, stating the ship's position and situation.

At this time the RCC contacted Swire Pacific Offshore at Barry Beach (located north-east of Wilsons Promontory) and were told that the offshore support and towing vessel *Pacific Conqueror* was available to assist *Maersk Tacoma* and would depart the port after its cargo had been discharged.

By 1150 it became apparent to the master that *Maersk Tacoma*'s direction of drift had changed since the anchor had been lowered. The ship was now drifting east-north-east towards the Hogan group of islands, some 16 miles away. The master was now concerned about the possibility that the ship would ground on one of the Hogan islands or the shallow patch to the south of the group.

At 1156 the crew of *Maersk Tacoma* attempted to raise the anchor using the ship's windlass. However, the weight on the dragging anchor and cable was too much for the windlass and they were unable to recover the anchor.

Maersk Tacoma was contacted by Swire Pacific Offshore at 1225. They indicated that *Pacific Conqueror* had departed from Barry Beach and would take approximately four hours to arrive at the ship's position.

The master was concerned that *Maersk Tacoma* would ground on one of the Hogan islands before *Pacific Conqueror* arrived to take the ship under tow. The RCC were also concerned and had checked the availability of helicopters in the area, should it become necessary to evacuate the ship's crew.

At 1310 the crew made another attempt to recover the anchor without success.

By 1345 it was clear to the master that *Maersk Tacoma* would ground on Hogan Island in approximately four hours if it continued to drift at its current speed and direction. It appeared increasingly unlikely that *Pacific Conqueror* could reach *Maersk Tacoma* and connect a tow in time to save the ship.

At 1440, when *Maersk Tacoma* was 6.6 miles from Hogan Island, the RCC called the vessel. They solicited information from the master regarding the number of people on board, the ship's survival craft and the quantities of fuel and L.O. on board. They asked the master if he had considered abandoning the ship if necessary and indicated that two helicopters would be dispatched to stand-by the ship to assist in rescuing the crew if necessary. The master called Denholm to relate the details of the conversation with the RCC and the current situation of the vessel.

At 1450 Denholm called the master back and afterwards the master asked the chief engineer if it was possible to have the main engine. The decision was made to run the main engine and attempt to save the ship despite the certain knowledge that the engine would be damaged further.

The main engine was started dead slow ahead at 1505. At this time, the southern tip of Hogan Island was 6 miles away on a bearing of 085°(T) and *Maersk Tacoma* was drifting east-north-east. After the engine was started the master ordered full port rudder. The ship turned to port and came onto a heading of approximately 215°(T). After failing to make significant headway for 25 minutes with the main engine running ahead, the master decided to try the engine astern. The main engine was stopped and then re-started dead slow astern. The ship turned with the wind on the starboard quarter and began to make sternway at approximately three knots in a north-easterly direction.

At 1618 the main engine was stopped with *Maersk Tacoma* 4.3 miles north-west of Hogan Island and clear of immediate danger.

At 1625 one of the rescue helicopters which had arrived at Hogan island called the vessel and the master explained that they would clear the island and were out of danger for the time being. The wind was still force eight from the west-south-west and *Maersk Tacoma* was lying almost beam on to the heavy sea and swell and rolling heavily up to 10°. The master called Denholm at this time and asked permission to sign the salvage contract (Lloyd's Open Form) on behalf of the owners. Permission was granted and the master contacted *Pacific Conqueror* to convey the approval.

Pacific Conqueror was sighted on the starboard beam by the crew of *Maersk Tacoma* at 1646. Radio contact was established between the vessels and the master of *Pacific Conqueror* indicated that he would be coming around the stern of the ship, moving toward the bow to try hooking the ship's anchor cable with a 'J' hook rigged on the tug's towing wire. By 1706 *Pacific Conqueror* was alongside *Maersk Tacoma* and was attempting to hook the ship's anchor cable.

At around this time the RCC released the two rescue helicopters to return to their home bases before last light.

At 1735 the master received a call from Denholm which informed him that the Victorian Channels Authority had advised that he may be able to anchor the ship on the eastern side of Wilson's Promontory off Sealers Cove.

By 1822 *Pacific Conqueror* had hooked the ship's anchor cable after several failed attempts due to the very poor sea conditions. The masters of the two vessels discussed the towing arrangements. *Maersk Tacoma*'s master expressed concern that there may be damage to the ship's hull if it was towed using the anchor cable led directly from the hawse pipe. The decision was made to shorten the ship's anchor

cable to four shackles on deck and then secure the cable through the forward centre lead and onto the adjacent mooring bits. The tow would then be effected using four shackles of the ship's anchor cable and approximately 600 m of *Pacific Conqueror*'s towing wire.

During this time, *Maersk Tacoma*'s master had several discussions with Denholm, the ship's charterers, and the RCC regarding the ship's situation. There was some uncertainty as to where the vessel was to seek refuge. Eventually the master had some discussions with the master of *Pacific Conqueror* and it was tentatively decided to head northward and seek shelter from the weather in the lee of Wilsons Promontory.

At 2125, after *Maersk Tacoma*'s master had indicated to *Pacific Conqueror* the charterers and ship's willingness to be towed, the tow commenced. After starting the tow, it became apparent that the ship's propeller shaft would need to be secured as the trailing propeller was turning the main engine. Advice was sought from Denholm and the propeller shaft was eventually secured.

By 2305 *Maersk Tacoma* was 11.6 miles north-north-east of Hogan Island being towed at a speed of 2.5 knots in a north-north-westerly direction in very heavy seas and swell. The weather was still force seven from the west-north-west.

The tow proceeded uneventfully throughout the next six hours or so with *Maersk Tacoma* making headway to the north-west at approximately 2.5 knots. The master was updating Denholm's Glasgow office on the vessel's progress approximately every two hours.

By 0455 on 9 August, *Maersk Tacoma* was 6.5 miles north-east of Cliffy Island. The weather had improved and was now force 5 from the west-north-west with rough seas on a moderate swell. At this point *Pacific Conqueror* informed the master that they had still not received any definite instructions regarding where the vessel was to be towed so the decision was made to hold position until such time as the destination was confirmed.

At approximately 0900, after several conversations with master of *Pacific Conqueror*, Denholm's offices in Glasgow and Hong Kong, the charterers and the Victorian Channel Authority, the decision was made to proceed to an anchorage off Sealers Cove.

At 0955 the tow resumed on a course of 262°(T) at 3.7 knots to pass south of the Seal Island group and then onto the anchorage.

By 1300 on 9 August, *Maersk Tacoma* had arrived at the anchorage. The wind had come around to the north-north-west at force five and the sea was rough on a moderate swell. The port anchor was prepared and then lowered. The ship was safely anchored 2.4 miles off Horn Point by 1412. *Pacific Conqueror* continued to stand-by the ship and during this time recovered the ship's starboard anchor and connected the anchor cable directly to its tow wire.

Maersk Tacoma remained at the anchorage off Sealers Cover until 12 August when the weather had moderated sufficiently to allow the ship to be towed to Melbourne. On 14 August, the ship arrived back at Swanson Dock where it remained until 17 October 2001 while damage to the main engine was repaired.

4 COMMENT AND ANALYSIS

Evidence

An investigator from the Australian Transport Safety Bureau (ATSB) attended *Maersk Tacoma* at anchor off Sealers Cove on the eastern side of Wilson's Promontory on 10 August and at Swanson Dock on 15 August 2001. Various documentary evidence was obtained from the ship including copies of the ship's navigation charts, log books, movement book, passage plan, course recorder trace, engine room logs maintenance records and procedures. The master and chief engineer were interviewed and provided accounts of the incident.

While in Melbourne the main engine was repaired under the supervision of engineers from MAN B&W Australia and Denmark.

On 21 August 2001, it was announced that *Maersk Tacoma*'s owners had declared general average[3]. The result of this declaration was a civil action on the part of the vessel's owners to recover salvage costs from the many owners of the cargo aboard the ship at the time of the incident. Over the succeeding months, the ATSB made repeated requests to the owners and their legal representatives for the technical report written by the service engineer from B&W Denmark. The report was finally provided to the ATSB some 34 months after the incident.

The incident

The failure of number twelve bottom end bearing in *Maersk Tacoma*'s main engine led to the ship being effectively disabled and adrift in severe weather conditions in Bass Strait on 8 August 2001. During the time adrift, in excess of nineteen hours from 0152 until 2125, the vessel drifted more than 45 miles and came very close to grounding on both Cutter Rock and the Hogan group of islands. If *Maersk Tacoma* had grounded, it is likely that the ship and its cargo would have been totally lost and any rescue operation for the crew would have been difficult in the prevailing conditions. There would also have been severe environmental consequences including a significant oil spill resulting from the ship's 2640 tonnes of heavy fuel oil bunkers.

The cause of the failure of the bottom end bearing cannot be ascertained with certainty. However the pre-existing condition of the bearing and the reduction in L.O. flow to the bearing due to problems with the automatic filter in the system were probably instrumental in the failure.

On two occasions when the ship was closing on both Cutter Rock and the Hogan group of islands, the circumstances dictated that the engineers put themselves at risk by running the damaged main engine to save the ship. The engineers realised that the condition of number twelve bottom end bearing was poor and deteriorating each time the engine was run. There was a significant risk that the damaged

3 General average: The principle of equity in which all parties in a sea adventure (ship, cargo, and freight) proportionately share losses resulting from a voluntary and successful sacrifice of part of the ship or cargo to save the whole adventure from an impending peril, or extraordinary expenses necessarily incurred for the joint benefit of ship and cargo. In the case of a salvage claim, the vessel's owner and all cargo owners share in the payment of the costs the vessel incurred to save the cargo and the journey.

bearing would overheat and cause a crankcase explosion. The failure of the main engine remote control system meant that an engineer had to manoeuvre the engine from the control stand on the side of the engine. This placed the engineer in real danger if a crankcase explosion had occurred.

The master made contact with *Maersk Tacoma*'s management company at 0152 to report that the main engine was unserviceable and to request assistance in the form of a tow. The company then put in place their emergency plan which involved managing the emergency from their office in Scotland. Australian authorities were not told of the emergency until 0946, after the ship had narrowly avoided grounding on Cutter Rock, and almost eight hours after the master made contact with the management company.

The weather continued to deteriorate over the course of the day and despite the master's decision to lower the anchor, the vessel continued to drift in an easterly direction. By the time the ship was closing on the Hogan group at around 1530, Australian authorities had organised contingency arrangements to evacuate the crew. In the event, the damaged main engine was run again to avoid grounding and the tow was eventually arranged and effected more than nineteen hours after the master had first requested assistance from his management company.

Main engine damage

Maersk Tacoma's main engine underwent extensive repairs while the vessel was in Melbourne for nine weeks after the incident. In addition to the damaged number twelve bottom end bearing, the B&W repair report states that the main engine's L.O. system was found to be contaminated with steel particles. All other bearings assemblies in the engine including the thrust, crosshead and main bearings were opened and checked with most showing minor damage from the metal particles in the oil.

All the other bottom end bearings (one to eleven) were opened and inspected and were found to have longitudinal parallel fatigue cracks in the bearing material. Number eleven bottom end bearing being noted in particular with some of its white metal bearing material found to be missing and loose. The report states with respect to the fatigue cracks:

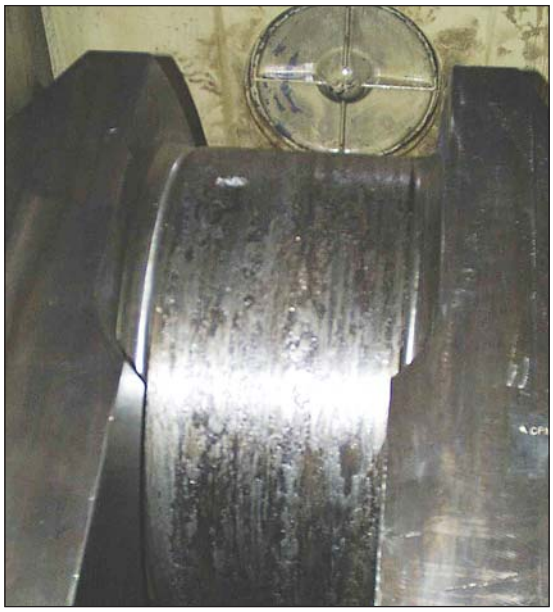
> It is very unusual to see cracks, at this extend (sic), develop in bearings, it appear to be fatigue cracks which may have developed for the following reasons or combination:
>
> 1. Insufficient lub. oil supply
> 2. Contamination of the lub. oil supply and/or high content of water in the lub. oil
> 3. Increased surface roughness
> 4. High load on the bearings for a long period possible with in combination with either of the above mentioned reasons.

With regard to number twelve bottom end bearing failure, the report from B&W states:

> It is not possible to establish the reason for the break down of the crankpin bearing no.12, following scenarios can be set up.
>
> 1. A foreign object has enter (sic) the lub. oil system and damaged the bearing and journal.
> 2. The bearing has deteriorate (sic) as seen on crankpin bearing no.11, 10, 6 and 3.

While the cause of the bearing failure is not conclusive, the report does suggest several mechanisms based on the condition of number twelve bearing surface and the type of breakdown it exhibited (figures 4 & 5).

FIGURES 4 & 5: Number twelve bottom end bearing journal and bearing



Number twelve bearing failure

The chief engineer stated that the engineers had stopped the main engine each time they had received a low L.O. pressure alarm in the afternoon and evening of 7 August and the during the following day, 8 August. After the stoppages at 1608, 2016, 2115 and 2200 on 7 August, the engineers found that the L.O. pressure was low due to a high differential pressure across the automatic filter. The L.O. pressure alarm setting was 1.3 bar, which is between 0.5 and 0.7 bar lower than the normal system operating pressure of 1.8-2.0 bar. In most circumstances a L.O. pressure low enough to trip the alarm would not result in damage to the engine. However the lower than normal flow of oil almost certainly contributed to the eventual failure of number twelve bearing probably in combination with a pre-existing fatigue crack or the poor condition of the white metal bearing surface.

The intervals of running time between the main engine stoppages due to low L.O. pressure rapidly decreased between 1608 and 2200. The probability is that the bearing had started to fail some time before 2016 and its condition continued to deteriorate each time the engine was subsequently run. The failing bearing had led

to increasing amounts of debris in the L.O. system which in turn had led to an increasing rate of fouling in the automatic filter. The differential pressure across the automatic filter was building up at an increasing rate after 2016 which in turn decreased the times between low L.O. pressure alarms.

The chief engineer finally realised that there was a bearing problem when he opened the automatic filter's drain filter at 2200 and found white metal debris. This discovery led to the crank case inspection and the discovery of number twelve bottom end bearing's condition.

Lubrication system

There was a number of issues with the main engine's L.O. system which may have led to the initial high differential pressures across the automatic filter and the consequent decreased L.O. supply flow to the main engine. These included the failure of the filter's automated flushing system, the filter's sludge valve being detached from its spindle and the addition of the purified stuffing box L.O. to the main engine sump in Melbourne.

Stuffing box lube oil: The engineers had purified approximately 9 000 litres of L.O. from the stuffing box drain tank while the ship was in Melbourne. After being purified, this oil had been added to the main engine sump via some in line filters in accordance with normal ship board practice. The stuffing box drain tank is a receptacle for oil which has been scraped off the main engine piston rods as they slide through their respective stuffing boxes. When the piston rod is moving inside the scavenge space above the stuffing box, it will almost invariably pick up some particulate matter which will be carried into the space by the scavenge air or result from piston blow-by. These particles adhere to the film of oil on the piston rod and are scraped off by the scraper rings in the stuffing box to be carried away with the surplus L.O. to the stuffing box L.O. drain tank.

The chief engineer on board at the time of the incident had noted that the purifier did not have any excessive build up of sludge after the stuffing box oil had been purified. However the previous chief engineer had indicated in his hand-over notes that the stuffing box L.O. during the month of June had been particularly dirty and so had not been returned to the main engine sump. It is likely that the purified stuffing box oil which had been added to the main engine sump in Melbourne still had a higher level of particulate contamination than the rest of the oil in the sump tank. This higher level of contamination would have led to the candle filters in the L.O. automatic filter accumulating more debris than normal while the engine was running and thus the need for the filter to be 'flushed' with greater than usual frequency.

For some period before the incident, the engineers had been initiating manual flushing cycles on the automatic filter. The differential pressure switch which monitors the pressure drop across the filter and normally initiates a flushing cycle was faulty. Whether or not the engineers on watch were carefully monitoring the pressure drop across the filter, and flushing the filter often enough after the ship had left Melbourne, is a matter for some conjecture.

Automatic lube oil filter: The differential pressure switch on the automatic filter has two functions. It senses the pressure drop across the filter to initiate the flushing

cycles but also activates an alarm if the pressure drop increases to a level 25 per cent above the flushing trigger level. This alarm is a safeguard which protects the main engine's L.O. supply and will normally operate before the main engine's low L.O. pressure alarm to indicate a problem with the automatic filter. This important safety feature was not operating at the time of the incident and would have helped the engineers ensure that the main engine L.O. pressure did not reach a level low enough to trigger the low pressure alarm.

The chief engineer indicated that the nut securing the sludge valve plate to its spindle in the automatic filter had sheared some time in June (before he had joined the ship). A spare part had been ordered but had not arrived by the time of the incident. As a result, the engineers had been operating the filter with the sludge valve detached from its spindle for a significant period of time.

When the automatic filter is operated in this fashion, with the sludge valve fixed to its seat during a flushing cycle, the 'dirty' oil from the chamber being cleaned must pass through the relatively small holes around the centre of the sludge valve plate. This means that there is a significant back pressure working against the cleaning air pulse which dislodges the debris from the filter candles. This back pressure reduces the 'cleaning' effect of the air pulse particularly if a number of cycles are initiated in quick succession. After a protracted period of operation in this fashion, particularly when oil with a high level of contamination is being filtered, all of the filter candles in the automatic filter will quickly build up a residue of un-dislodged debris. This was evident at the time of the incident by the high pressure drops the engineers had experienced across the automatic filter and their need to remove the candles for manual cleaning to restore the main engine L.O. pressure.

It is likely that in combination, the addition of the purified stuffing box oil to the main engine sump, the failure of the automatic filter's differential pressure switch and sludge valve all contributed to the failure of number twelve bottom end bearing.

Bearing maintenance

Maersk Tacoma's main engine bottom end bearings are normally only opened and inspected during class surveys every five years. Number twelve bottom end bearing had not been surveyed in the previous twelve months, although the bearing clearance on the journal had been checked in December 2000 and found to be within normal tolerance.

The B&W service report notes that all of the other bottom end bearings exhibited unusual longitudinal fatigue cracks in the white metal bearing material. As part of their investigation, the engine manufacturer conducted several tests on bearings throughout the engine to determine the type of bearing material (white metal) and whether or not it conformed to their standard. Their analyses revealed that the bearing material was type HMO2 with the report stating:

> HMO2 is white metal specified by us for main-, crank pin bearings and crosshead guide shoe up to and including this engine type.
>
> For this engine type and newer we now specify HMO7 which basically has a higher melting point and can take more load.

In this regard the B&W report is somewhat confusing. It apparently indicates that the manufacturer's bearing specification has changed since the time *Maersk Tacoma*'s main engine was built to one with a higher melting point which can take more load.

Subsequent engineering actions

Maersk Tacoma's engineers were faced with difficult decisions on 8 August. Their actions after finding the damaged bottom end bearing were sensible and prudent. They minimised the load on the damaged bearing by stopping the fuel to number twelve cylinder (so the cylinder was not firing and subjecting the bearing to combustion loads) and by running the main engine at low speed.

If the circumstances had permitted, the next step which the engineers had considered, was to 'hang' number twelve piston and remove the connecting rod. This would have allowed the engine to be run without risk of further damage to the bottom end bearing and journal and also have eliminated the risk of a crankcase explosion. In the circumstances they did not have sufficient time to carry out this operation and the work would have been difficult and dangerous with the ship rolling. In any case, had they started this work the engine could not have been run to save the ship as it approached both Cutter Rock and Hogan Island.

When the vessel was safely anchored in Sealers Cove on 9 August, the engineers removed number twelve connecting rod with a view to putting the main engine back in service. However the discovery of metal particles throughout the rest of the main engine's L.O. system meant the decision was made to tow the ship to Melbourne in order to minimise the risk of further damage. In the circumstances, and considering the damage subsequently found in Melbourne, this decision was prudent.

Emergency plans

The Denholm Ship Management procedures on board *Maersk Tacoma* stipulated that in the event of an emergency the master was to contact the operations room at the Maritime Rescue Coordination Centre of the United Kingdom Coastguard (MRCC UK). There was a standing arrangement that the MRCC UK would then notify Denholm's emergency team who would manage the emergency from Denholm's office in Scotland. In the event, the master made contact initially with the company office in Hong Kong at 0152 and it was not until some time later the office in Scotland took over the management of the salvage operation. The tow was then arranged through United Salvage's London office.

Given the speed and reliability of modern communication systems, emergency management arrangements such as Denholm's are common. However in this instance, their effectiveness with respect to ensuring the safety of the crew, as distinct from organising the salvage of the vessel, is questionable. The Australian RCC should have been notified of the ship's situation much earlier given that the vessel was in Australian waters with the ready resources and experience of the RCC close at hand.

The Australian RCC was eventually contacted by the ship's charterer (Maersk Australia) almost eight hours after the master had contacted Denholm's Hong Kong

office at 0152. At the time, the ship had just narrowly avoided grounding on Cutter Rock. Up till this time, Australian authorities had no knowledge of the ship's predicament and no arrangements or contingency plans for evacuating the crew had been made. If they had had to abandon the ship at this time the crew would have been in real peril in the prevailing weather conditions. When it became apparent to the master that the ship was in significant danger there was a clear duty to inform local authorities so appropriate plans could be made.

Later in the day when *Maersk Tacoma* was approaching the Hogan group of islands, Australian authorities had arranged two helicopters to stand-by to evacuate the crew if necessary. This gave the master at least some reassurance that the crew may have been able to be evacuated safely if the ship went aground.

Pacific Conqueror rendezvoused with *Maersk Tacoma* at around 1700 on 8 August after four hours steaming. This occurred more than fifteen hours after the master's first request for assistance. Once again, it is a matter for some conjecture why it took so long to arrange a suitable towing vessel given the ship's relative proximity to the offshore support base at Barry Beach. There were two occasions in the intervening hours when the ship could have been lost.

In their submission, the solicitors for *Maersk Tacoma*'s owners stated:

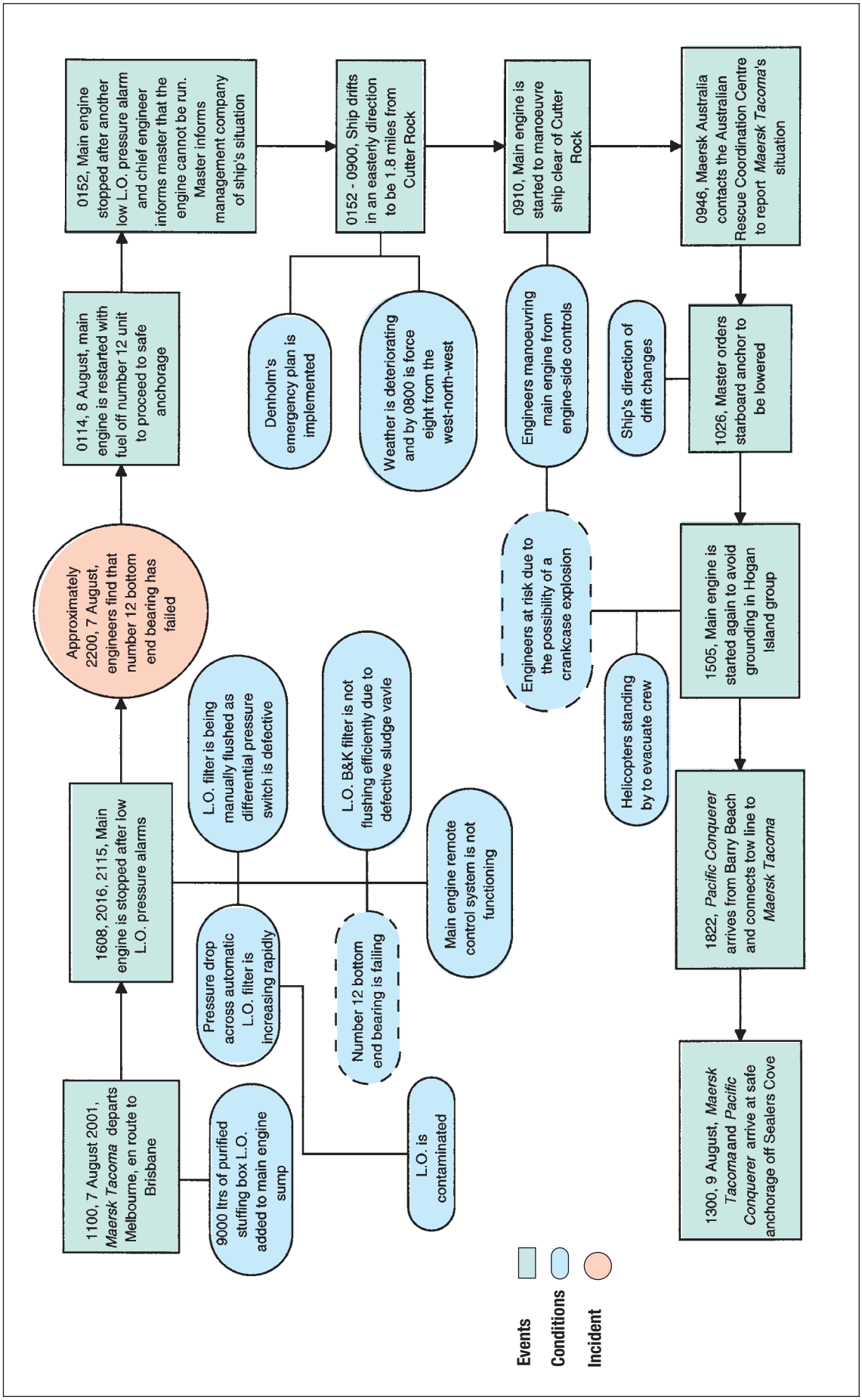
> We do not consider it appropriate to dwell, in any communications with the ATSB, on the timing of events according to our clients' evidence, or the activity that was taking place in the time-gap of which the ATSB complain. We will restrict ourselves to the observation that it really has not been demonstrated that if (as the ATSB imply, rather than state) the RCC should have been alerted earlier, this would necessarily have made any difference to the vessel's predicament or the rapidity of the salvage response. If "PACIFIC CONQUERER" was involved in cargo operations, it does not follow that she would have been free earlier to have assisted "MAERSK TACOMA".

Use of the anchor

The master's decision to lower an anchor at 1026 on 8 August was probably prudent in the circumstances given the ship's rate and direction of drift. At the time, the ship was drifting in the direction of Devils Tower approximately 10 miles to the east-south-east with the possibility that it would ground in approximately four hours.

When it was lowered, the anchor did slow the rate of drift but changed the ship's drift to a more northerly direction. This meant that the ship was drifting toward the danger posed by the Hogan group of islands. The change in drift direction could not reasonably be foreseen by the master when he made the decision to use the anchor. His experience would have suggested, however, that it would be very difficult to recover the anchor without running the main engine using only the windlass once it had been lowered. And, in fact when it became apparent that the ship was drifting towards the Hogan islands the crew's attempts to weigh the anchor were unsuccessful.

FIGURE 6: *Maersk Tacoma*: Events and causal factors chart



5 CONCLUSIONS

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

The following factors are considered to have contributed to the equipment failure and subsequent salvage of the Hong Kong flag container vessel *Maersk Tacoma* in Bass Strait on 8 August 2001:

1. The ship's main engine was disabled when number twelve bottom end bearing failed.

2. It is likely that the bottom end bearing failure was the result of its pre-existing condition in combination with reduced L.O. flow.

3. The reduction in L.O. flow to the main engine was as a result of the addition of 9000 litres of purified stuffing box oil to the main engine sump prior to the incident, and the pre-existing failure of the main engine automatic L.O. filter's differential pressure switch and sludge valve.

4. *Maersk Tacoma*'s engineers placed themselves in significant danger by running the damaged main engine to save the ship on two occasions when it was at risk of grounding on both Cutter Rock and the Hogan group of islands.

5. *Maersk Tacoma*'s crew were unnecessarily imperilled by the failure to notify Australian authorities of the vessel's situation for some eight hours after the main engine was found to be effectively unserviceable.

6. The delay in notifying the Australian authorities of the breakdown and the potential risk to the environment, together with the time taken to organise a tow indicates significant deficiencies in the ship manager's emergency planning.

It is also considered that the master's decision to lower the anchor was justified in the circumstances.

6 SUBMISSIONS

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

The final draft of the investigation report was sent to the Australian Maritime Safety Authority, *Maersk Tacoma*'s owners, Anglo Eastern Ship Management (formerly Denholm Ship Management), MAN B&W Diesel Australia, the master and chief engineer. The chief engineer's ship management company later returned his copy of the draft report stating that he no longer worked for the company and that they had no forwarding address.

Submissions were received from MAN B&W Diesel Australia and *Maersk Tacoma*'s owners through their solicitors. The owner's solicitors made the point in their submission that the owners comments were limited due to the fact that a confidential commercial arbitration, arising from the incident, was currently proceeding in London. The draft report was amended where appropriate to reflect the content of the submissions received.

7 RECOMMENDATIONS

It is recommended that:

MR20050018

Ship owners and operators include procedures in their vessel's safety management systems which stipulate that local rescue coordination centres must be notified promptly if the ship becomes disabled.

8 *MAERSK TACOMA*

Name	*Maersk Tacoma* (formerly *Luna Maersk*-96, *Newport Bay*-92, *Luna Maersk*-91)
IMO No.	7909425
Flag	Hong Kong
Classification Society	Lloyds Register
Vessel type	Container ship
Owner	Tonnevold Tacoma K.S.
Year of build	1982
Builder	Odense Shipyard, Lindo, Denmark
Gross tonnage	37 238
Summer deadweight	44153 tonnes
Length overall	241.13 m
Breadth, moulded	32.20 m
Depth	19.80 m
Draught (summer)	13.022 m
Engine	B&W 12L90GFCA, 2-stroke, single acting
Engine power	34 800 kW
Service speed	24.1 knots
Crew	28 (Indian, Bangladeshi and Chinese)

Independent investigation into the into the equipment failure aboard the Hong Kong flag container vessel *Maersk Tacoma* in Bass Strait on 8 August 2001

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