Australian Government
Australian Transport Safety Bureau

Steering failure and contact with navigational beacon involving *CMA CGM Puccini*

Port of Melbourne, Victoria on 25 May 2023

ATSB Transport Safety Report
Marine Occurrence Investigation
MO-2023-002
Interim – 4 October 2023

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

Publishing information

Published by: Australian Transport Safety Bureau
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Addendum

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Interim report

This interim report details factual information established in the investigation's early evidence collection phase, and has been prepared to provide timely information to the industry and public. Interim reports contain no analysis or findings, which will be detailed in the investigation's final report. The information contained in this interim report is released in accordance with section 25 of the *Transport Safety Investigation Act 2003*.

The occurrence

Arrival Melbourne

At 0900[1] on 23 May 2023, a pilot boarded the 277.3 m, fully cellular container ship *CMA CGM Puccini* (Figure 1) for pilotage into the Port of Melbourne. Pre-pilotage checks included a test of machinery and equipment, including the steering gear. The ship was safely berthed at Swanson Dock at 1330 and cargo operations commenced soon thereafter.

Figure 1: *CMA CGM Puccini*

Source: Owen Foley

The following day, the ship was attended by an Australian Maritime Safety Authority (AMSA) surveyor to conduct, among others, a port State control (PSC) inspection. As part of the PSC inspection, emergency operation of the steering was conducted with the surveyor in attendance in the steering gear room. The ship's chief engineer, chief mate, electro-technical officer and the third engineer were there to carry out or oversee the test.

The test included changeover of steering control from the navigation bridge (bridge) to the steering gear room followed by demonstration of local operation of the steering gear. The third engineer configured the steering machinery for local operation including starting one steering gear pump and opening the by-pass valve on the other pump (stopped). Control of the rudder was then demonstrated by manual operation of the running pump solenoid valve. Both pump systems were

[1] All times referred to in this report are local time, Coordinated Universal Time (UTC) + 10 hours.

tested in local control, individually and in parallel. The steering tests were conducted to the satisfaction of the surveyor.

Steering failure

The ship's remaining stay at the berth was routine with nothing significant or unusual reported. At 0300 on 25 May, the second mate on watch on the bridge called the engine control room (ECR) and gave one hour's notice to ready the main engine for departure. The second mate then called the third mate and the deck cadet to assist with preparations for departure, including steering gear checks. The deck cadet was sent to the steering gear room to witness rudder movement and repeat its response to the third mate who operated the steering from the bridge steering console. At 0322, rudder operation to maximum angles (hard over on both sides) was checked using one, then the second pump, separately, and then both together. The steering gear was recorded to have been tested as required by regulations.

At 0346, the main engine was tested and the pilot boarded at 0350. The bow thruster was tested and, at 0354, the master-pilot exchange was conducted on the bridge. On the bridge for departure were the pilot, master, chief mate, deck cadet and an able seafarer at the helm. In the engine control room were the chief engineer, third engineer (the duty engineer) and the electro-technical officer.

Weather conditions for the departure were clear skies and good visibility with winds from the north-north-east at force 4.[2] The tide was flooding, with high water expected at 0545. Just after 0405, 2 tugs were made fast (one forward, one aft) and by 0418 all mooring lines had been let go. *CMA CGM Puccini* was then manoeuvred out of Swanson Dock, through a 60° starboard turn and into the Yarra River.[3] (Figure 2)

During the turn to leave Swanson Dock, the master and chief mate noticed that the rudder response appeared sluggish, as if only one steering pump was running (both pumps were operating). Neither raised their observations with each other, or the pilot, and there were no alarms to indicate a pump had stopped or other abnormal condition.

By 0436, the ship was moving along the channel in the river, both tugs had been dismissed and the main engine was increased to slow ahead. At 0442, the ship passed under the Westgate bridge, about 1 mile downriver of Swanson Dock. The ship's speed was 6.6 knots[4] with a rate of turn of 4° per minute to port. At 0443, the main engine was increased to half ahead[5] and more rudder ordered (port 10)[6] to increase the rate of turn. To maintain the turn rate, the pilot then gave helm orders (rudder) of port 5 (0443:34), followed by port 10 (0443:54).

Soon thereafter (0444:03), the pilot noticed that the rudder angle indicator was showing that the rudder was midships and repeated the earlier port 10 order. The able seafarer steering the ship by hand (helmsman) responded that the helm (steering wheel) was at port 10. This exchange drew the attention of the master and chief mate, who both verified that the helmsman had correctly followed the order. The helmsman informed them that the rudder was not responding to the wheel. By that time, the chief mate had moved to the steering console to investigate and observed that the rudder moved to port 5 and then slowly to starboard 5. The ship, with its speed increasing and rate of turn diminishing, tracked toward the western edge of the channel and beacon 32. At the time, the ship's speed was 7.7 knots, it was turning to port at 3° per minute and was 7 m to starboard of its planned track.[7]

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[2] 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. Force 4 indicates moderate winds, 11 to 16 knots.

[3] Speed limit in the Yarra River Channel upstream of the West Gate Bridge was 6 knots.

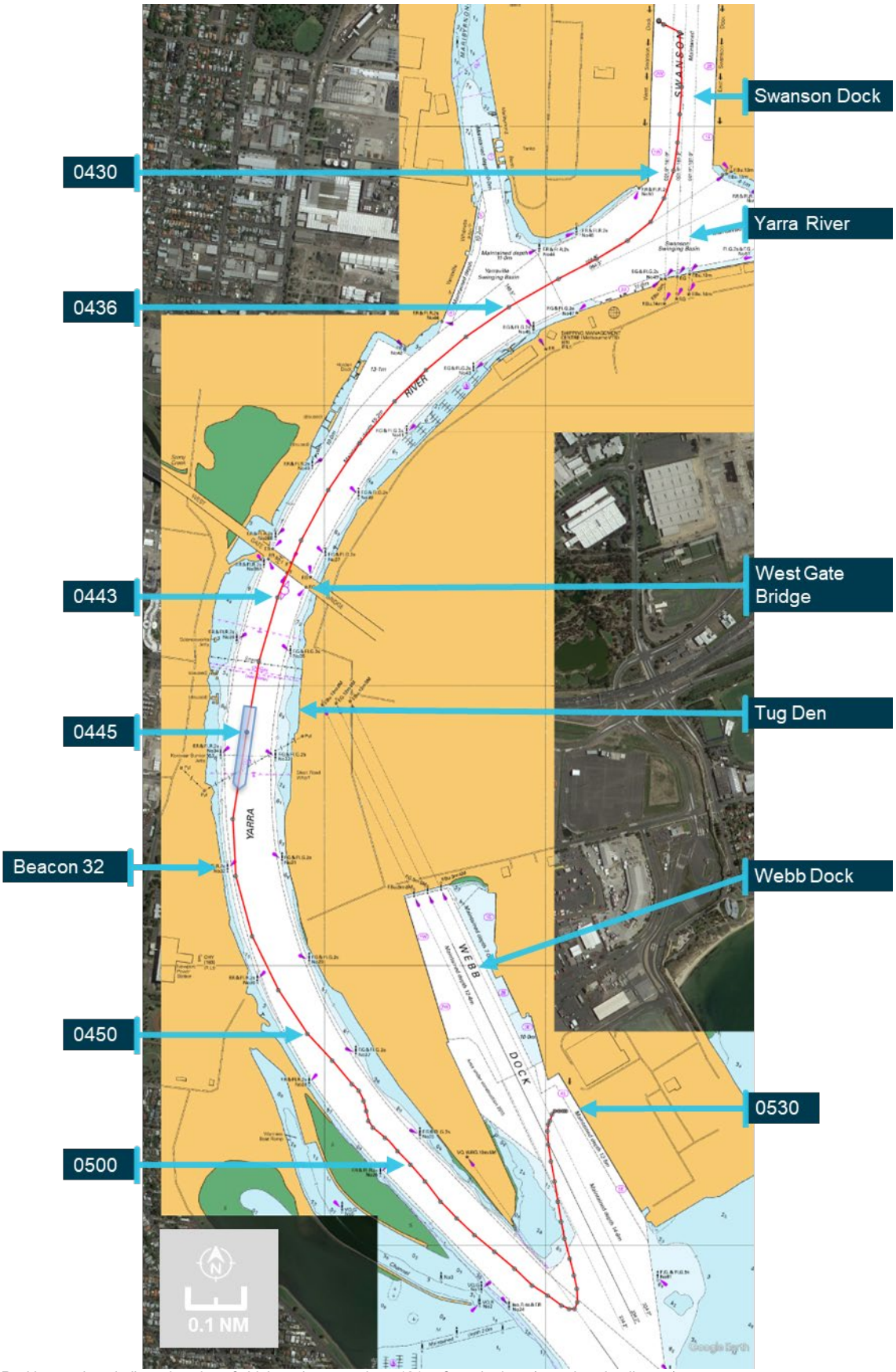
[4] One knot, or one nautical mile per hour, equals 1.852 kilometres per hour.

[5] Speed limit in the Yarra River Channel downstream of the West Gate Bridge was 8 knots.

[6] Rudder angle orders are direction and rudder angle in degrees. Port 10 equals an order for the rudder to be moved to 10° to port.

[7] Under the West Gate Bridge, the Yarra River Channel is 153 m wide (*CMA CGM Puccini* had a beam of 40.00 m).

Figure 2: *CMA CGM Puccini*'s track from Swanson Dock to Webb dock



Position markers indicate location of ship's main mast, about 181 m from the bow (atop the wheelhouse).
Source: Australian Hydrographic Office, Google Earth with annotations by ATSB

Further helm orders and helm (wheel) movement indicated that the rudder was not responding. The master remained at the manoeuvring console and, after confirming with the pilot, reduced the main engine to slow ahead, and then (0444:50) to dead slow ahead. The master confirmed that the bow thruster was operational and suggested further slowing the ship (to less than 5 knots) to make the thruster effective.

At about this time, the master called the ECR and asked for the steering gear to be attended immediately. In response, the chief engineer called the electro-technical officer, who had returned to the accommodation, and directed them to go to the steering gear room. The electro-technical officer collected a radio and, soon thereafter, was informed by the master (via radio) that emergency steering was required.

Meanwhile, the chief mate and the helmsman went about fault finding and checked steering control modes, including non-follow-up (NFU)[8]. Their attempts were unsuccessful and the rudder remained unresponsive to their control inputs. At 0445, the pilot contacted Melbourne vessel traffic service (VTS) and reported that the ship had lost steering and requested immediate tug assistance. Both tugs that had been dismissed earlier were directed to return to the ship.[9]

The pilot then instructed the helmsman, using NFU, to put the rudder hard to port if and when possible. At 0445:26, the main engine was stopped. *CMA CGM Puccini*'s speed was 8 knots and it was turning to port at 1° per minute. The ship was now 26 m to starboard of track with its bow about 32 m from the 10 m depth contour (the edge of the navigable channel).

Shortly thereafter, the rudder was observed to move to 35° to port (wheel was hard to port). The main engine was restarted, and the bow thruster set full to port. At 0445:30, the ship's rate of turn to port suddenly increased as its bow closed with the side of the channel. By 0445:44, the ship's speed had reduced marginally (to 7.9 knots) and its swing to port had increased to 13° per minute, with the bow now less than 20 m from channel's edge. The pilot ordered the rudder midships and immediately after to starboard 20 to reduce the increasing swing to port with the aim of avoiding the ship's stern closing and contacting the western bank or shoals (Figure 3).

At 0446:12, the ship was 58 m to starboard of the planned track with significant headway (7.7 knots) and turning rapidly to port (20° per minute) with the bow only about 12 m from the 10 m depth contour and shoal water. Hard starboard rudder and bow thruster full starboard were ordered and the rudder observed to move to about 20° to starboard. However, as *CMA CGM Puccini* was swinging to port, its stern was swinging in the opposite direction (to starboard) and contacted beacon 32. The impact resulted in damage to the beacon, which canted over about 20° from the vertical. The ship's side was scratched due to scraping against the beacon.

Following the contact, the helmsman advised that the wheel was hard starboard (as ordered) but the rudder angle was only 5° to starboard. At 0447, the ship's speed had decreased to 7.2 knots and its swing to port had reduced (now 13° per minute). The ship was 67 m to starboard of track as the curve of its stern passed across the 10 m depth contour.

Meanwhile, both tug masters had been in contact with the pilot and the closer of the 2, *SL Daintree*, was instructed to make fast on the port shoulder. *Svitzer Marysville* was instructed to make fast aft through the centre lead. The ship's speed was reducing (6.9 knots at 0447:26) and its turn rate was unchanged with the bow thruster kept full starboard to arrest the swing.

The master confirmed that steering control had not been restored. The ship's bow was now in the middle of the channel and the stern clear of the channel's edge. The engine was ordered dead slow astern at 0448:56, followed soon after by slow astern. The master ordered the rudder to be put midships and a series of astern engine movements reduced the ship's speed to 4.5 knots.

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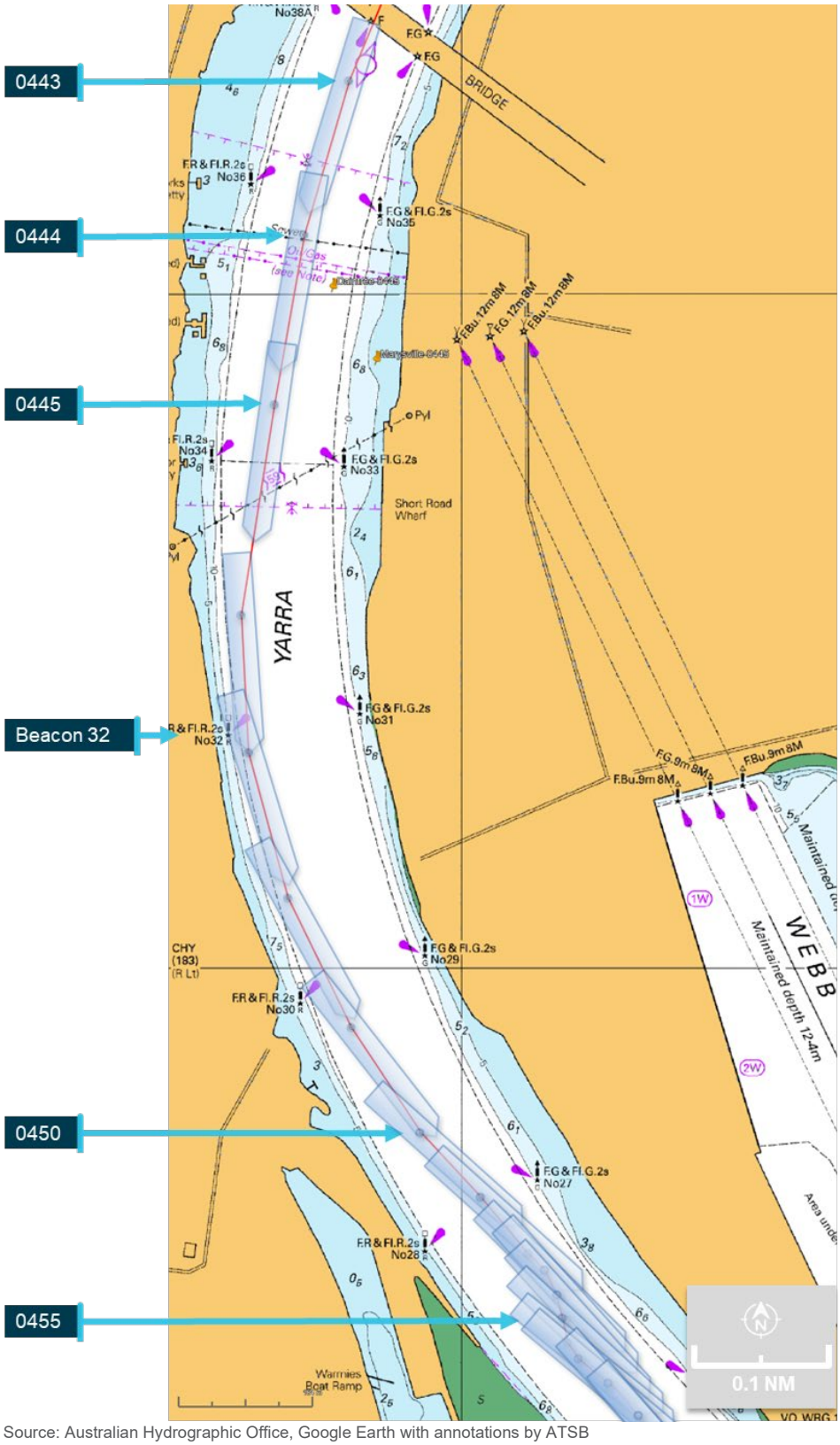
[8] In non-follow-up (NFU) steering mode, movement of the rudder to port or starboard is controlled using a lever. The lever is released when the rudder reaches the required angle.

[9] Both tugs were nearby (less than a cable (0.10 NM) away), *Svitzer Daintree* following just astern of the ship and *Svitzer Marysville* was off to port in the tug den, having arrived shortly before.

Figure 3: *CMA CGM Puccini*'s track showing contact with Beacon 32



Source: Australian Hydrographic Office, Google Earth with annotations by ATSB

At about 0451, the bow thruster was stopped and tug orders given to arrest *CMA CGM Puccini*'s headway. The ship had started swinging to starboard and at 0451 cleared the eastern side of the channel with its bow about 15 m from the channel edge. Headway had reduced to 2 knots and the ship continued to move away from the eastern bank, now turning to starboard at 3° per minute.

At 0454, with the ship temporarily stabilised along the centre of the channel, the pilot discussed moving the ship to Webb Dock (about 5 cables downriver) with the ship's bridge team and the tug masters. Once they had agreed on the proposed plan, the pilot advised VTS about the recovery plan.

Meanwhile, efforts to engage emergency steering locally from the steering gear room were ongoing with the electro-technical officer and the third engineer there. At 0456, they notified the bridge that the steering gear was being reconfigured for emergency steering.

By this time, the ship's speed had decreased to about 1 knot and the 25-knot wind from the north-north-east was turning the ship to port. The pilot ordered dead slow ahead and, with the tugs assisting, began moving the ship towards Webb Dock. Shortly after, emergency steering was engaged and rudder orders given via the dedicated emergency telephone in the steering gear room.

At 0541, *CMA CGM Puccini* was made fast alongside Webb Dock East berth 4 without further incident. At completion of movements, the electro-technical officer and third engineer reconfigured the steering from emergency to normal.

Inspections

Later that day various parties attended *CMA CGM Puccini* to inspect the ship's steering gear. This included personnel from AMSA, the ship's manager's (CMA CGM), classification society (Bureau Veritas (BV)) and 2 independent service engineering companies to fault-find and test the steering gear. The ship was detained (by AMSA) as reasonably assumed as 'being unseaworthy due to failure of steering and possible damage to the hull.'

An underwater hull examination by divers the following day found no hull damage. Additionally, the ship's engineers inspected and tested the steering gear and systems and changed the hydraulic oil filters. Nothing abnormal was found.

Despite multiple, extensive inspections and tests by the ship's engineers and the service engineers, the erratic behaviour of the steering gear could not be replicated and no fault was identified.

Later on 26 May, AMSA received confirmation from BV that the steering gear had been tested, no defect found and nor had there been any hull damage. Subsequently, AMSA released the ship from detention.

At 2028 that day, the ship was issued its port clearance and preparations were made to depart Melbourne the next morning.

Departure Melbourne

At 0630 on 27 May, one hour's notice was given to the engine room for departure and, at 0640, the steering gear was tested in bridge control without issue. At 0700, the pilot (the same pilot as during the incident) boarded. The master-pilot exchange was completed, and, among other things, a steering failure risk assessment prepared for this pilotage was discussed. Additional precautions prescribed by the Melbourne harbour master were in place and included in the risk assessment. These included having the electro-technical officer and an able seafarer standing by in the steering gear room for the pilotage.

CMA CGM Puccini's unberthing and departure into Port Phillip Bay were completed without incident. Once sufficient sea room was available, the ship was taken out of the channel into open water in the bay, its speed increased to 16 knots and the steering tested with various rudder movements. The steering gear operated normally.

At 1150, the ship re-entered the channel to depart Melbourne. The pilotage continued without incident, the pilot disembarked at 1357 and the ship set course for Port Botany, New South Wales.

Melbourne to Brisbane

On 28 May, in preparation for arrival to Port Botany, and to meet Port Authority of New South Wales' arrival requirements, *CMA CGM Puccini*'s crew tested the steering gear. The chief mate, duty mate, deck cadet, bosun and off duty able seafarers were in the steering gear room with the master and duty able seafarer on the bridge.

These tests included changing over to emergency steering (local control). The chief mate reconfigured the steering machinery as previously shown by the third engineer. When an attempt to steer the ship was made, the steering began to behave erratically and did not respond exactly to the helm orders. At this time, the newly-joined second engineer arrived to observe the tests. The engineer noticed that the system's hydraulics was incorrectly configured and asked the chief mate to close the by-pass valve of the (non-running) pump. Once the valve was closed, there were no further erratic rudder responses.

At 1912 that day, a pilot boarded. The pre-arrival declaration from the master to the Port Authority confirmed that the steering had been tested but made no mention of the Melbourne incident. The pilot had been made aware (informally) of the incident in Melbourne, though not of its nature, extent or resolution. Hence, during the master-pilot exchange, the pilot queried the master about the incident but received no additional information. The master, however, did inform the pilot that the steering gear room was attended by the electro-technical officer and an able seafarer for the duration of the pilotage. With 2 tugs in attendance (the usual for such pilotages), the pilot safely conducted the ship into Port Botany. After it was berthed, the pilot submitted a report about the steering matter to the harbour master.

Subsequently, on 30 May, the ship departed Port Botany for Brisbane. The steering had been tested at 0450, with nothing abnormal observed, and at 0545 the (same) pilot boarded. As a result of the pilot's earlier incident report, an additional tug was assigned for departure. The electro-technical officer and an able seafarer stood by in the steering gear room during the pilotage, which was completed without incident, and at 0645, the pilot disembarked.

At 0630 on 1 June, the ship's steering gear was tested before entering Brisbane and functioned normally. The electro-technical officer and an able seafarer again stood by in the steering gear room during the pilotage and the ship berthed without incident at 1318.

On 2 June, ATSB investigators attended the ship (see the section titled *Further investigation*) and as part of the investigation, inspected the steering gear and conducted tests and simulations. No defects with the steering gear systems were found.

CMA CGM Puccini departed Brisbane on 4 June without incident.

Context

CMA CGM Puccini

CMA CGM Puccini was built by Samsung Heavy Industries (Korea) in 2004. At the time of the incident, it was owned by CMA CGM, France, managed and operated by CMA CGM International Shipping, Singapore, and classed with Bureau Veritas (BV). The ship's trading in recent years has regularly included Australian ports of call.

The ship's length overall is 277.30 m long and a beam of 40.0m. It has a gross tonnage[10] of 65,730 and deadweight[11] of 73,234 DWT at a draught of 14.526 m. It can carry 5,782 TEU including 3,168 on deck and 500 refrigerated containers. On arrival into Melbourne the ship was carrying 4,337 TEU (2,860 containers) and on departure 3,552 TEU (2,354 containers).

The ship was fitted with a Hyundai MAN B&W 10K98 MC-C main engine that delivered 57,075 kW through a fixed-pitch, four-bladed, 8.70 m diameter, right-handed propeller. The ship's manoeuvring speeds (in loaded condition) were 6.2 knots at dead slow ahead, 8.3 knots at slow ahead and 12 knots at half ahead.

CMA CGM Puccini was fitted with a semi-balanced, spade type rudder with an effective area of 52.18 m² and standard maximum working angles of 35° to port and starboard (see the section titled *Steering gear* for further details). The ship was also fitted with a 2,000 kW bow thruster. The speed at which the bow thruster became ineffective was 5 knots.

Crew

CMA CGM Puccini had a multinational crew of 23 Romanian, Sri Lankan and Malaysian nationals. All were appropriately qualified and endorsed for the positions held.

The deck department consisted of the master, 4 deck officers (chief mate, second mate and 2 third mates) and a deck cadet. The chief mate did not keep a navigation watch. The deck crew consisted of the bosun, 3 able seafarers and an ordinary seafarer.

The engineering department consisted of the chief engineer, 3 engineers (second, third and fourth engineers), an electro-technical officer, a reefer engineer (for refrigerated containers) and a refrigeration assistant plus a fitter and 2 oilers.

The master was sailing with a Romanian master's (>3,000 GT) qualification issued in 2023. They had joined the ship for this posting in February 2023

The chief mate was sailing with a Romanian chief mate's (>3,000 GT) qualification issued in 2018. Prior to joining *CMA CGM Puccini* as chief mate in 2021, and since 2016, they had sailed as second mate in the CMA CGM fleet of container ships. This was their fourth contract as chief mate on *CMA CGM Puccini* and they had joined in February 2023.

The chief engineer was an experienced seafarer with many years in the position. At the time of the incident, they were sailing with a Romanian chief engineer (>3,000 kW) qualification issued in 2017. Recent experience, since 2017, had all been on CMA CGM container ships. This was their first time on *CMA CGM Puccini* after their previous 4-month posting as chief engineer of the sistership *CMA CGM Chopin* and they had engineer joined *CMA CGM Puccini* in April 2023.

The second engineer was sailing with a Romanian chief engineer (>3,000 kW) qualification issued in 2016. They had sailed on 4 ships since 2021, all as second engineer, after spending time

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[10] Gross tonnage (GT) is a measurement of the enclosed internal volume of a ship and its superstructure with certain spaces exempted.

[11] Deadweight tonnage (DWT) is a measure of how much weight a ship can carry including cargo, fuel, ballast, fresh water, crew, passengers, and provisions.

ashore in a CMA CGM shore management role. Recent experience was all on CMA CGM container ships. The second engineer joined in Melbourne, 2 days before the incident.

The third engineer was sailing with Sri Lankan engineering qualifications issued in 2017. Since 2017, the third engineer had sailed on 7 ships, all as third engineer. They joined the CMA CGM container ship fleet in 2018. This was the third engineer's first posting to *CMA CGM Puccini* with a previous posting (9 months) as third engineer in its sistership *CMA CGM Bellini*. The third engineer joined *CMA CGM Puccini* in March 2023.

The electro-technical officer had Romanian qualifications as an electrical officer obtained in 2016. This was their tenth ship (all container ships) since 2016. The electro-technical officer joined *CMA CGM Puccini* in February 2023 and had had a previous 5 month posting to the ship in 2022.

Steering gear

The normal method of steering a ship is from the bridge (that is, remotely). The generally accepted use of the term 'emergency steering' refers to the method of steering when remote steering from the bridge fails. In most ships, and in *CMA CGM Puccini*, emergency steering is local steering, from the steering gear room.

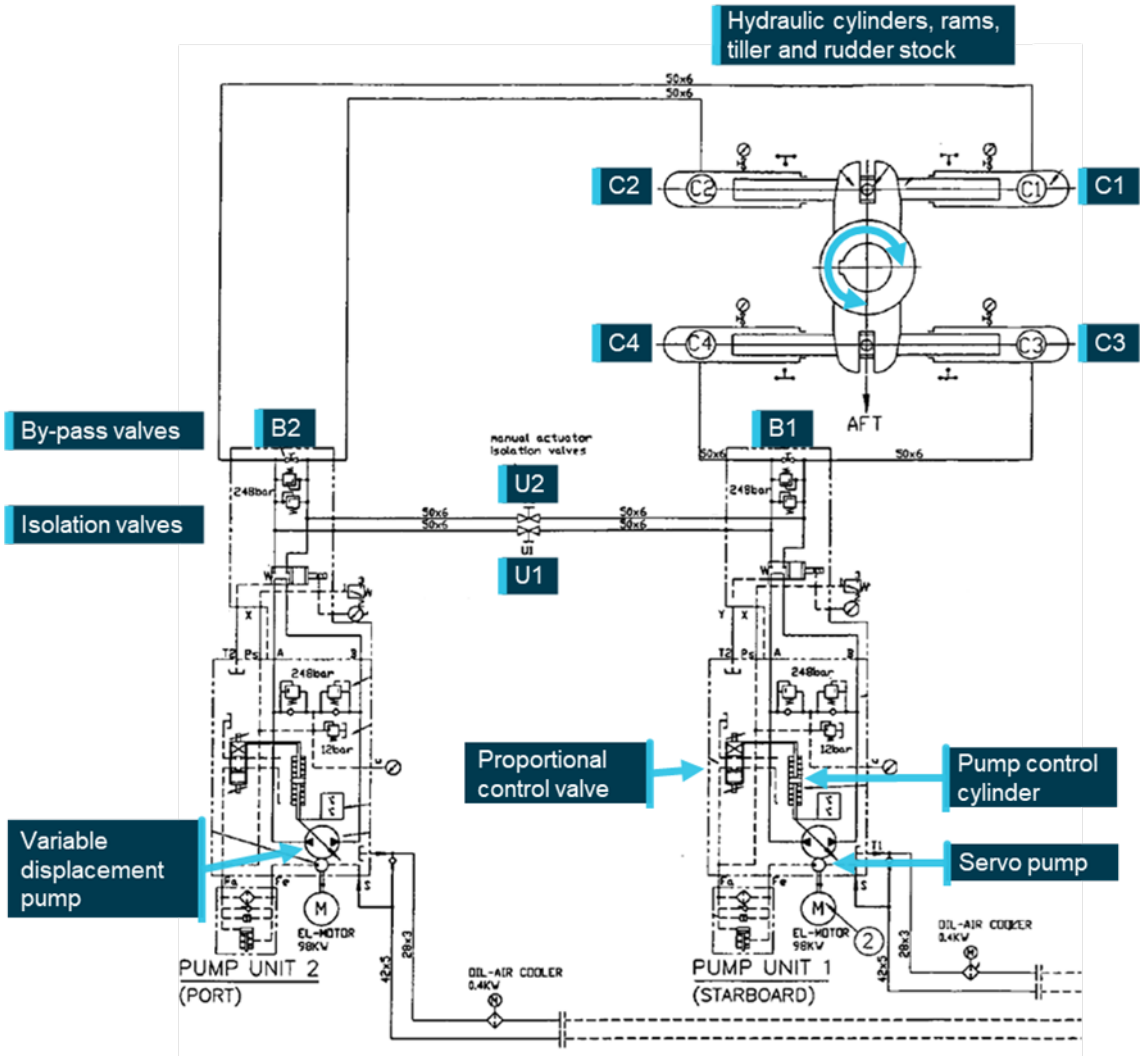
Description

CMA CGM Puccini was fitted with a Samsung-Hatlapa, Teleram type R4ST 700, 2-ram (300 mm diameter), 4-cylinder Rapson-slide electro-hydraulic steering gear with 2 identical power units. Rudder angle limits were set at 35° by electrical limit switches and 37° by mechanical stops.

The steering gear comprised 2 identical constant speed electric motors driving variable delivery piston pumps in a closed-loop hydraulic system (system relief valve setting was 250 kg/cm²). Each pump supplied bi-directional, infinitely-variable hydraulic oil flow to/from 2 cylinders connected to a ram. This ram was then attached through a Rapson-slide mechanism to the tiller arm, rudder stock and rudder. Pump flow rate and direction were controlled via a spring-loaded, self-centring pump control cylinder mounted as part of the pump housing, connected to the pump swashplate mechanism.

Each electric motor also drove a smaller, hydraulic auxiliary servo pump which provided 25 kg/cm² pressure control oil to the machinery. An electric solenoid operated hydraulic proportional control valve altered control oil flow to/from either side of the pump control cylinder to adjust the swashplate angle and oil flow rate and direction at the pump, as required. The rudder position was thereby changed by altering the rate and direction of oil flow to or from the cylinders connected to the tiller (Figure 4).

Figure 4: Steering gear hydraulic diagram



Source: CMA CGM, annotated by ATSB

Other ancillary components, such as oil expansion and storage tanks, oil filtration and cooling systems and electrical control, switching and monitoring completed the steering machinery.

Hydraulic pump unit 1 (starboard) was connected to cylinders C3 and C4 and pump unit 2 (port) to cylinders C1 and C2. Manually operated valves were fitted in the hydraulics systems to allow flexible operation of the system:

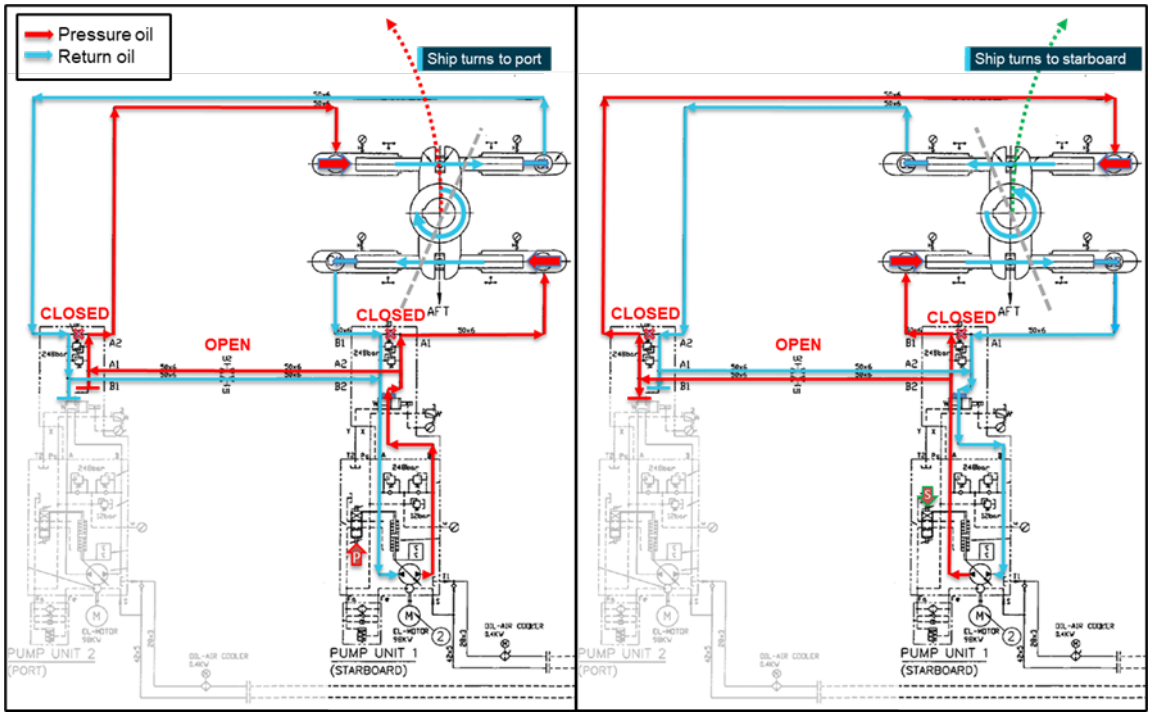
- isolation valves (designated U1 and U2) separated the 2 hydraulic circuits
- pump by-pass valves (B1 and B2) provided connection between individual pump suction and discharge lines to allow oil flow between cylinders, across a (non-running) pump.

Brass plaques with operating instructions, a block diagram of the system and the valve position status matrix were permanently mounted adjacent to the steering machinery. Copies of *CMA CGM Puccini*'s steering gear failure procedure were mounted and available at the steering gear.

Normal operation

During normal operation either one, or both, pumps were running, supplying all 4 cylinders. Isolation valves (U1 and U2) were open, pump by-pass valves (B1 and B2) were closed (Figure 5).

Figure 5: Single pump, 4-cylinder, normal operation of steering, to port and starboard

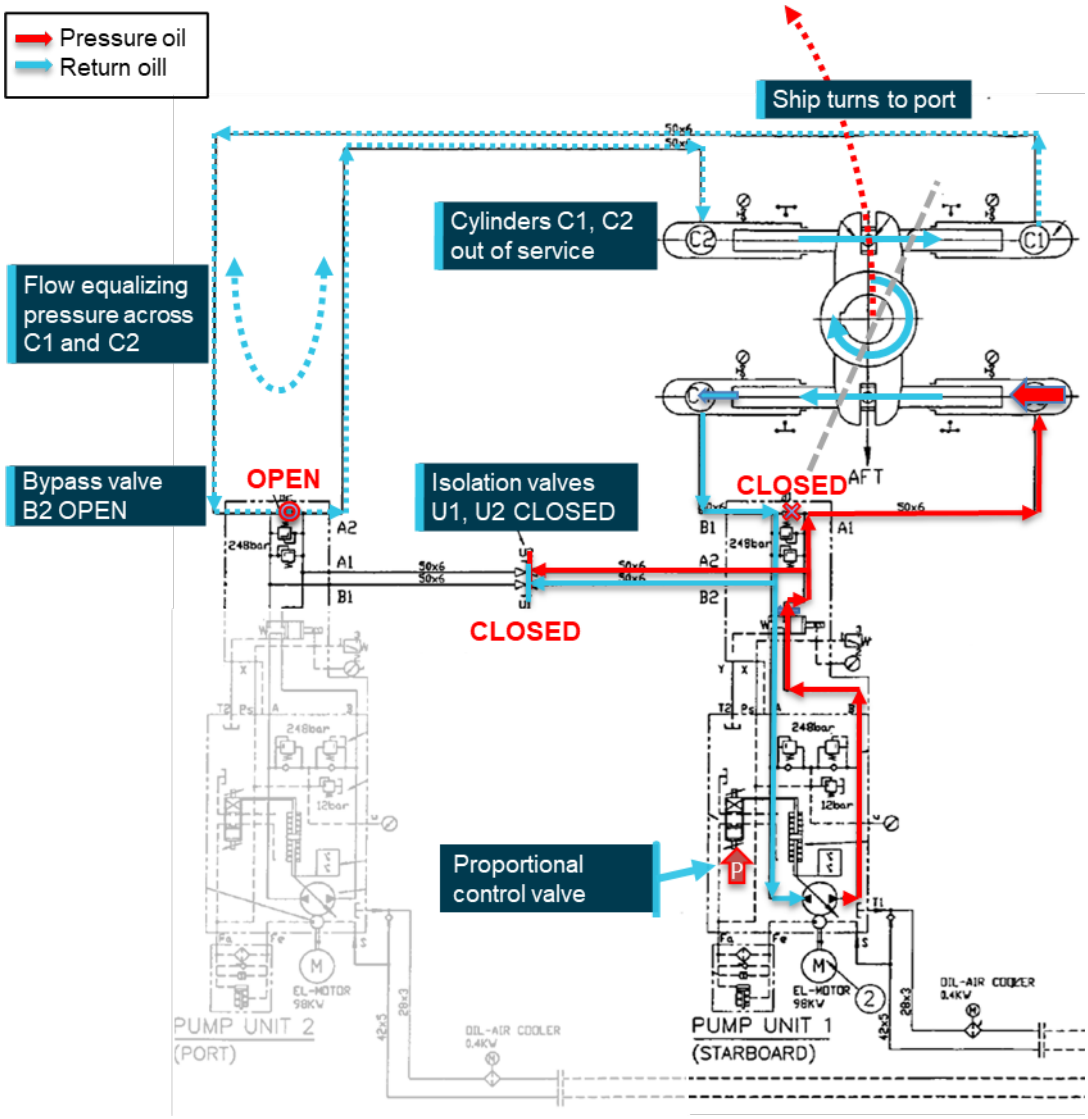


Single pump (#1) operation shown; diagram is similar for pump 2. Isolation valves (U1, U2) open, pump by-pass valves (B1, B2) closed. Signal is received into the proportional valve altering the flow rate and direction of oil at the pump. System response will be improved (faster) with second pump operating in parallel.
Source: CMA CGM, annotated by ATSB

Operation with one hydraulic circuit isolated

It was possible to separate the 2 hydraulic circuits and operate on one circuit (and pump) alone. In this case, the isolation valves were to be closed and the by-pass valve on the non-running pump was to be opened (Figure 6). This mode of operation was referred to in the shipboard procedures in relation to operation of the steering gear with an oil leak in one of the circuits.

Figure 6: Port rudder using pump 1 with hydraulic system 2 (pump 2, cylinders C1 and C2) isolated



Hydraulic system 2 out of service, isolation valves (U1, U2) closed, pump 2 isolated, pump 2 by-pass valve (B2) open to allow oil flow between cylinders C1 and C2 and prevent hydraulic locking.
Source: CMA CGM, annotated by ATSB

Remote operation

The manufacturer (Samsung-Hatlapa) provided machinery and equipment to scope and, as a minimum, supplied an electro-hydraulic steering gear which could be operated locally, from the steering gear room. Capability was provided for interfacing with a variety of possible remote operating systems available from the manufacturer or other third-party equipment provider.

CMA CGM Puccini was fitted with a Sperry Marine, Navipilot 4000 heading control system for remote steering control from the steering console on the bridge. In remote operation, rudder position (steering) signals were sent from the console to the pump proportional control valve. The signal operated the valve and adjusted the rudder position. Rudder position was monitored by sensors connected to the tiller boss (attached to the rudder stock).

Three modes of remote operation were available:

- Auto: The user input the desired heading, rate of turn or turn radius into the Navipilot control and display unit at the steering console. The software then adjusted the rudder angle to

achieve the set value. Signals were sent to the solenoids of the proportional control valve to move the rudder in the desired direction. Feedback of rudder position from one of the independent rudder angle sensors was compared to the desired value. The control system compared the desired and actual values and adjusted the rudder angle until the difference between them (the error) reduced to zero.

- Follow-up (FU): Follow-up steering mode is closed-loop, hand steering from the bridge steering console. The desired rudder angle is set by the operator adjusting the position of the ship's wheel. This set value is compared to the actual rudder position taken from the rudder angle sensor and the error used to generate a control signal to the appropriate solenoid of the proportional valve. The signal remains and the rudder moved until the error is reduced to zero and the rudder position is the same as that set at the steering wheel.
- Non-follow-up (NFU): This is open-loop, manual steering from the steering console. The operator uses a lever to manually send signals to the proportional valve to turn the rudder in the direction desired. When the lever is returned to the neutral position the signal stops, as does the rudder movement. The control loop is closed by the operator visually comparing the rudder position displayed on the rudder angle indicator with that desired and using the lever to move the rudder accordingly. On board *CMA CGM Puccini*, NFU control was available from the steering console, the manoeuvring panel, and both bridge wings.

Local control

Local control of the steering was from the steering gear room. To change from remote to local control, the rudder position feedback signal to the steering console had to be isolated. This was achieved by selecting NFU on the steering console on the bridge.

Once the feedback signal was isolated, the steering could be controlled by manually operating the proportional control valve on the running hydraulic pump. Rudder position was displayed on a graduated scale by a pointer connected to the rudder. The operator manipulated the appropriate solenoid valve of the proportional valve until the desired rudder angle was achieved.

It was normal to use one pump for local control, but the system did not require the second pump to be stopped to operate. In that case, the second variable delivery pump remained in the neutral position, with no throughput, and did not affect operation of the system.

Shipboard procedures

As part of safety management, the CMA CGM Group fleet operated an integrated management system (IMS) for operations across its fleet and related shore operations. The IMS included more than 500 procedures (cards) for common fleetwide tasks kept in various 'manuals'. Ship-specific cards were managed on board an individual ship with approval from shore management. The system on board *CMA CGM Puccini* included about 70, ship-specific cards of which the ones key to steering are summarised below.

- This bridge 'departure checklist' (Bridge manual card Bridge-051) was to be completed before departure and its completion recorded in the bridge logbook. The checklist included verifying the steering gear, including means of communication to the steering gear room, were operational. This required testing each pump and system operated individually and then together. The test required all pumps and rudder angle indicators to be checked while moving the rudder to hard over on both sides, as required by regulations.
- The navigation 'preparation for arrival checklist' (Bridge manual card Bridge-070A) required both steering systems operating with manual (follow-up) steering engaged. Its completion was to be recorded in the bridge logbook with any items in the checklist not completed to be listed.
- The 'steering gear failure checklist' (Emergency manual card Emcy-030) detailed the checks to be followed in the event of steering failure. Immediate, actions included engaging manual

steering and starting the second steering motor. Where necessary, further actions included mustering the crew and transferring to local steering control.

- The ship-specific 'steering gear and auto pilot control' (Bridge-550 card) procedure related to using the bridge steering column controls fitted in *CMA CGM Puccini* and made passing references to operating the steering machinery. The procedure referred to FU as hand steering, and, when referring to NFU, stated 'This position must be selected for steering from Steering gear room (Em'cy steering)'
- The ship-specific 'steering gear failure' procedure outlined, with illustrations, the actions to take in 2 different scenarios:
  1. Control from the steering gear room

     This section detailed the changeover from remote steering to local control. NFU was to be selected on the steering console and the preferred steering motor selected. An explanation, with photographs, illustrated how to access and manipulate the solenoids for the steering pump proportional control valve to operate the steering. Requirements to verify communications using the sound-powered telephone and checking that the local gyrocompass repeater was reading the same as that on the bridge were also included.
  2. Steering gear failure with oil leakage

     This section outlined the actions in the event of an oil leakage and the steering gear was to be operated using only one steering system and 2 cylinders. Users were advised to follow the maker's instructions posted in the steering gear room. The procedure then stepped through the reconfiguration (manipulating the by-pass and isolating valves as described in the *Steering gear* section above) of the machinery to steer the ship. Rudder movement was via manual manipulation of the proportional control valve solenoids as in local control.

  Copies of the 'steering gear failure' card were posted adjacent to the bridge steering console and in the steering gear room.
- Three-monthly steering drills were required by SOLAS[12] Chapter V, Regulation 26 Steering gear: Testing and drills. This regulation required drills to include testing steering control from the steering gear compartment and verifying the communications procedure with the bridge. The 'Emcy-006 drill report form' was to be completed with details of the drill conducted (the most recent such drill before this incident was recorded in May 2023).

Further investigation

Initial reports advised that, despite multiple inspections, the erratic behaviour of the ship's steering on 25 May remained unexplained over the following days and the ship departed Melbourne with no problem identified. On this basis, the ATSB commenced an investigation and, to date, has:

- attended the ship in Brisbane (June), and again upon its return to Melbourne (July)
- gathered evidence from the ship including conducting interviews, obtaining documents and recorded data, including from the ships' voyage data recorder, and extensive testing of steering gear systems
- interviewed and obtained evidence from the incident pilot and pilotage organisation
- obtained evidence from other organisations and agencies including AMSA, Ports Victoria and the Port Authority of New South Wales.

[12] SOLAS is the International Convention for the Safety of Life at Sea, 1974, as amended.

The investigation is continuing and will include:

- verification of data and evidence to confirm incident conditions, events and sequence
- analysis of the ship's steering arrangement, machinery and operation
- analysis of crew actions
- an assessment of shipboard and CMA CGM fleetwide procedures and steering gear guidance, operation, information sharing and testing/drills.

Should a critical safety issue be identified during the course of the investigation, the ATSB will immediately notify relevant parties so appropriate and timely safety action can be taken.

A final report will be released at the conclusion of the investigation.

General details

Occurrence details

Date and time:	25 May 2023 – 0446 Eastern Standard Time	
Occurrence class:	Serious incident	
Occurrence categories:	Contact, Machinery failure	
Location:	Beacon 32, Yarra River, Melbourne, Victoria	
	Latitude: 37º 50.327' S	Longitude: 144º 53.781' E

Ship details

Name:	*CMA CGM Puccini*
IMO number:	9280627
Call sign:	9HA3374
Flag:	Malta
Classification society:	Bureau Veritas (BV)
Departure:	Melbourne
Destination:	Port Botany
Ship type:	Fully cellular container
Builder:	Samsung Heavy Industries
Year built:	2004
Owner(s):	CMA CGM (France)
Manager:	CMA CGM International (Singapore)
Gross tonnage:	65,730
Deadweight (summer):	73,234.6 t
Summer draught:	14.526 m
Length overall:	277.30 m
Moulded breadth:	40.00 m
Moulded depth:	24.326 m
Main engine(s):	Hyundai MAN B&W 10K98 MC-C Mk 6
Total power:	57,075 kW
Speed:	24.5 knots
Injuries:	Nil
Damage:	Nil

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- 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, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

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

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining 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. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

An explanation of terminology used in ATSB investigation reports is available on the ATSB website. This includes terms such as occurrence, contributing factor, other factor that increased risk, and safety issue.