FERRY SAFETY INVESTIGATION REPORT

OCEAN RIDER COLLISION WITH WHARF
SYDNEY COVE, NSW
28 MAY 2016
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EXECUTIVE SUMMARY

On 28 May 2016, the Manly Fast Ferry (MFF) vessel Ocean Rider collided with the north-west corner of Circular Quay (CQ) Wharf 6. The vessel, carrying 54 passengers, was berthing following a scheduled service from Manly to CQ. The master was approaching the wharf when the vessel’s starboard\(^1\) engine stalled when the master engaged astern\(^2\). The loss of thrust turned the vessel towards the wharf and the port\(^3\) bow of the vessel collided with a pier. As a result, four passengers were injured from falls and conveyed by ambulance to hospital. Ocean Rider sustained damage to the port bow.

The investigation determined that the loss of control was due to the shutdown of the starboard engine which resulted in the collision. The engine shutdown was most likely attributable to the configuration of the starboard engine and gearbox. The engine could not overcome the inertia force created by the starboard propeller when astern was engaged, hence the engine stalled.

Other contributing factors included the master’s level of familiarity operating Ocean Rider and inadequate risk controls that reduced engine resilience to stalling.

Full details of the Findings and Recommendations of this ferry safety investigation are contained in Parts 3 and 4 respectively.

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\(^1\) The starboard side is the right side when facing the front of the vessel.

\(^2\) Engaged astern, is the action of placing the gearing into reverse.

\(^3\) The port side is the left side when facing the front of the vessel.
PART 1  FACTUAL INFORMATION

Introduction

1.1 At approximately 1300 on Saturday 28 May 2016, the Manly Fast Ferry (MFF) *Ocean Rider* was completing a regular scheduled service from Manly to CQ carrying 54 passengers. The ferry was approaching the wharf at CQ when the master lost control of the starboard engine. As a result, the ferry veered to port and collided with a pile on the north-west corner of Wharf 6.

1.2 The impact resulted in several passengers suffering minor injuries from falls. The ambulance service conveyed four of the injured passengers to hospital.

Location

1.3 The incident occurred at Wharf 6 west, which is the most western wharf at CQ (see *Figure 1*). CQ is within Sydney Cove, located at the northern end of Sydney’s central business district, and is the main hub for waterborne passenger transport on Port Jackson.

![Figure 1: Incident location Sydney Cove](source: Google Maps annotation by OTSI)

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Times in this report are in 24-hour clock form in Australian Eastern Standard Time.
1.4 Sydney Cove is a high-volume traffic area and maritime users must comply with Schedule 6 of the *Marine Safety Regulation 2016 (NSW)*\(^5\).

**Environmental information**

1.5 The Bureau of Meteorology recorded the weather during the afternoon of 28 May 2016 as cloudy with a light westerly breeze. OTSI determined that the environmental conditions played no part in the incident.

**Vessel information**

1.6 *Ocean Rider* is an aluminium catamaran high-speed ferry and is 29 metres in length, with a beam of 8.1 metres. The vessel is powered by twin Caterpillar 3412 750 kilowatts V12 diesel engines. The engines provide drive to propellers through conventional gearboxes and shafts. *Ocean Rider* was built in Queensland and is surveyed to carry 297 passengers and three crew members. *Ocean Rider* has an operational speed of 28 knots\(^6\).

![Figure 2: Ocean Rider](source OTSI)

1.7 *Ocean Rider* is the only vessel of her class operated by the company. While sharing a similar layout with other vessels of her type in the fleet, *Ocean Rider* is equipped with an older style gearbox on the starboard side.

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\(^6\) A knot is a unit of speed equal to one nautical mile (1.852 km) per hour.
1.8 The newer vessels in the MFF fleet are fitted with ‘Quick Shift’ type gearboxes. This type of gearbox provides reduced torque loading through the driveline and smoother gear change.

1.9 Prior to the incident, MFF had acquired, and had planned to install, a quick shift type gearbox on the starboard driveline in Ocean Rider at the next major overhaul.

The crew

1.10 At the time of the incident, the vessel had a crew of three appropriately qualified persons. The master held a Master less than (<) 35 metre and Marine Engine Driver (MED) class 2 certificates. The mate\(^7\) held a Master < 24 metre and a MED 3 certificate. The deckhand was qualified as a General Purpose Hand (GPH).

1.11 The company had familiarised the crew to operate Ocean Rider. The master joined the company approximately two months earlier to the incident. Prior to the incident date, the master had completed approximately 160 hours on various classes of vessels in the company’s fleet. Of these 160 hours, approximately 20 hours had been on Ocean Rider (including a 6.75 hour training shift).

The incident

1.12 The vessel was returning from Manly on a regular passenger ferry service with 54 passengers on board. While the vessel may operate at speeds of 28 knots, the master had slowed its speed appreciably to comply with the 8 knot speed limit within Sydney Cove (see Figure 3). At 1300, the vessel approached Wharf 6 west and the master further reduced the speed to approximately 6 knots in readiness to berth Ocean Rider.

\(^7\) The mate is a qualified master who is capable of taking over the navigation of the vessel when the master is unable to do so.
1.13 As the vessel approached Wharf 6 west, the master engaged astern on the starboard engine while continuing to drive ahead on the port engine. At this stage, the starboard engine stalled. The port engine propelled the bow of the vessel towards starboard and away from the wharf.

1.14 The master engaged astern on the port engine to correct the vessel’s alignment and reduce its speed for final berthing. The master was unaware the starboard engine had stalled. With the port engine engaged astern, the bow of the vessel swung back to port and towards the wharf.

1.15 The master recognised the bow of the vessel had continued to go to port and realised there was a problem with the starboard engine. The master increased the astern thrust on both controllers in an attempt to avoid collision with the wharf.

1.16 The increased thrust from the port engine and the lack of thrust from the starboard engine resulted in the vessel yawing further to port and colliding with the north-west corner pile of Wharf 6.

1.17 Ocean Rider suffered damage to the port bow above the waterline. The damage corresponded in shape and diameter of the wharf pile (see Figures 4 and 5).
Figure 4: Damaged port bow

Figure 5: View from inside the port forward void
1.18 The master restarted the starboard engine and slowly berthed *Ocean Rider*. The crew secured the vessel to the wharf. The master reported the incident to the MFF while the crew attended to passengers injured in the incident. Wharf personnel called the ambulance service and then assisted the crew to safely disembark the passengers.

1.19 OTSI received notification of the incident at 1325.

1.20 The OTSI duty officer informed MFF that the vessel could return to the MFF base at the Sydney Fish Markets under caution. OTSI quarantined *Ocean Rider* pending their investigation.

1.21 An OTSI investigator arrived at *Ocean Rider* at 1425 to examine the vessel and interview the crew. Following this inspection, the Chief Investigator determined that OTSI would conduct an investigation into the incident.
PART 2 ANALYSIS

Introduction

2.1 The investigation focussed principally on the factors that contributed to Ocean Rider’s loss of control and the collision with the wharf.

Crew actions

2.2 The master reported that as the vessel was being manoeuvred on approach to Wharf 6 west at CQ, the starboard engine stalled when engaged in astern. The master reported that at the time the starboard engine stalled, the vessel was driving ahead on the port engine at approximately 6 knots.

2.3 The master did not immediately realise that the starboard engine had stalled. The master realised something was wrong when astern was engaged on the port engine and the bow swung quickly to port.

2.4 During the masters two months with MFF he had operated a variety of vessels with different handling characteristics. Most of this experience was in normal operation and the master may not have been previously exposed to this type of abnormal situation.

2.5 Although the master increased both throttles astern to slow the vessel, without the balancing thrust from the starboard engine, the port engine thrust turned the bow towards the wharf.

2.6 Ocean Rider’s engines are equipped with audible low oil pressure alarms to warn the master of a stalled engine. In this case, OTSI was unable to ascertain whether the alarm activated however, the master said he did not hear an audible alarm to indicate the starboard engine had stalled. The vessel has no data recorder to confirm alarm activation.

2.7 The GPH realised that the vessel was about to collide with the wharf and shouted a verbal warning to passengers.

2.8 The crew promptly attended to the injured passengers and secured the vessel after the incident.
Training and assessment

2.9 MFF allocates experienced masters to provide familiarisation to new or junior crew. The masters rely on their knowledge and experience to deliver the general vessel induction.

2.10 MFF provide the General Vessel Induction Checklist for guidance to masters during familiarisation sessions. This checklist contains elements which candidates must be aware of before being deemed competent to operate MFF vessels. Masters are at liberty to determine the detail of information provided to candidates and the threshold of proficiency.

2.11 The different knowledge and experiences of individual masters likely introduced variation to the training outcomes. This variation was likely reflected in operational practices applied by trainee masters and crew.

2.12 Masters allocated to deliver vessel induction provide feedback to MFF management. MFF management then determine the suitability for a candidate to be deemed competent based on the master’s advice.

2.13 The training did not address the risks associated with manoeuvring a vessel with a stalled engine and one engine engaged in ahead while the other is in astern.

Vessel handling

2.14 *Ocean Rider* is steered primarily by a pair of rudders located near the stern of each pontoon (hull). A rudder alters a vessel’s direction by deflecting water flow over its surface. The steering forces created are in proportion to the speed of the water flow over the rudder and the rudder’s angle.

2.15 When the water flow over the rudders is low (slow vessel speed), the steering effect is reduced, whereas high water flow (fast vessel speed) will provide a greater steering effect.

2.16 A slow vessel speed is desirable when a vessel is preparing to berth at a wharf. A slow vessel speed acts to minimise the potential consequences from contact with the wharf. However, the reduction of steering effectiveness poses
a separate set of challenges for a master to overcome. A master can alleviate these challenges by utilising engine thrust control (increasing water flow) to assist the positioning the vessel when berthing and increase the effectiveness of the rudders.

2.17 On this occasion, during the early stages of berthing *Ocean Rider*, the normal expected movement of the vessel had masked the stalled starboard engine.

2.18 In normal operation, opposing thrust from the port and starboard engines produces a uniform turn (yaw) (A see Figure 6). Thrust input from only one engine provides a slower turn (B see Figure 6).

![Figure 6: Similar reaction of vessel to engine input](source OTSI)

**Engine controls**

2.19 The main engines are controlled by three EC300 Power Commander controllers that are located at the main helms position, and the port and starboard wing controls. Each station has two control levers, one for each engine.

2.20 The master first selects and activates the desired control station using the ‘Station Select’ button. The master moves the levers on the controller through their range to produce variable input commands to the engines. The left side lever for the port engine and the right side for the starboard (see Figure 7).
2.21 The controller provides input for forward and astern thrust, and centres in a neutral position. Moving the controller lever away from the neutral position increases thrust and engine rpm for the selected direction. The EC300 controller enables the selection of opposing thrust commands on the port and starboard engines by moving the control levers in opposite directions.

2.22 The EC300 control system is equipped with a Directional Inhibit Timer (DIT). The DIT inhibits a sudden opposite gear change and protects the driveline from damage. This feature prevents a reversal of gear selection from engaging until the propeller speed has reduced to a predetermined level. The DIT provides the greatest benefit during a reversal of gear selection at high speed.

2.23 An additional benefit of the DIT, is a reduction of load on the engines thus reducing the likelihood of an engine stalling during changes of direction. The DIT was not functioning on Ocean Rider at the time of the incident. The DIT had been deactivated by the previous owners prior to Ocean Rider being acquired by MFF.
2.24 The EC300 controller has two 3mm LED indicator lights that illuminate when the system identifies a fault within the controller or control system. The light flashes in set sequences to indicate a fault code and to assist in troubleshooting a failure. The indicator light’s luminosity is challenging to see, especially in bright ambient conditions (see Figure 8).

2.25 The system does not have an audible alarm accompanying the warning indicator light. The lack of audible alarm, combined with the poor luminosity of the warning lights, hampered the master’s response to this control failure.

2.26 The master’s awareness and response time can be improved by the inclusion of an audible alarm to supplement the existing EC300 warning lights.

**Vessel examination**

2.27 OTSI inspected the vessel on 28 May 2016 at the MFF base located at the Sydney Fish Markets’ marina. The following was observed during this investigation:
The vessel’s port bow had damage consistent with an impact with a round wharf pile.

The collision ejected bottled drinks from an upright fridge inside the main cabin.

2.28 The vessel steering and engine control systems were tested and found to be functioning normally.

**Main engines and gearboxes**

2.29 The gearboxes and EC300 throttle controllers were manufactured by Twin Disc, Inc (Twin Disc).

2.30 The starboard engine had over 6800 service hours and nearing an overhaul intervention. MFF had replaced the port engine on 20 February 2016 and the port gearbox in 2014. The replacement engine had accrued approximately 850 service hours leading up to the incident.

2.31 The replacement port gearbox was a Quick Shift MGX6599 model. The older starboard gearbox was a MG-6557-00-SC model. Twin Disc manufactured both models however; the two gearboxes have different operating characteristics.

2.32 The newer Quick Shift model has a smoother clutch engagement and improved electronics. This engine-gearbox configuration made the engine more resilient to stalling.

2.33 The engines are fitted with low oil pressure alarms. These alarms will sound when the engine operating oil pressure reduces following an engine shutdown. This alarm was tested by MFF the day after the incident and found to be operational.

**Main engines trials**

2.34 On 30 May 2016, OTSI observed MFF testing *Ocean Rider* under a variety of scenarios to determine the engine stalling characteristics.

2.35 MFF manoeuvred the *Ocean Rider* utilising a range of vessel speed settings. The EC300 controllers were engaged from ahead to astern, both with and without a short delay with the lever in the neutral position.
2.36 The results from the trials were:

- both engines would eventually stall when engaged astern at higher speeds
- the starboard engine was prone to stalling at a lower vessel speed and lower engine load than the port engine
- applying a manual time delay with the EC300 lever in the neutral position before engaging an opposing gear change improved the resilience of both engines to stalling
- the starboard engine was slower to increase rpm than the port engine.

2.37 A summary of the trial results is in the following table.

<table>
<thead>
<tr>
<th>Vessel speed</th>
<th>Port gear lever action</th>
<th>Starboard gear lever action</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 8 knots</td>
<td>Neutral to Reverse</td>
<td>Neutral to Reverse</td>
<td>No stall</td>
</tr>
<tr>
<td>&gt; 8 knots</td>
<td>Neutral to Reverse</td>
<td>Neutral to Reverse</td>
<td>Stb stall</td>
</tr>
<tr>
<td>&gt; 9.5 knots</td>
<td>Neutral to Reverse</td>
<td>Neutral to Reverse</td>
<td>Both stall</td>
</tr>
<tr>
<td>4 knots</td>
<td>Forward</td>
<td>Neutral to Reverse</td>
<td>No stall</td>
</tr>
<tr>
<td>&gt; 6 knots</td>
<td>Forward</td>
<td>Neutral to Reverse</td>
<td>Stb stall</td>
</tr>
<tr>
<td>&gt; 6 knots</td>
<td>Forward</td>
<td>Neutral to Reverse (1000 rpm)</td>
<td>No stall</td>
</tr>
<tr>
<td>&lt; 9 knots</td>
<td>Neutral to Reverse</td>
<td>Forward</td>
<td>No stall</td>
</tr>
<tr>
<td>&gt; 9 knots</td>
<td>Neutral to Reverse</td>
<td>Forward</td>
<td>Pt stall</td>
</tr>
</tbody>
</table>

Source: OTSI (Stb denotes starboard. Pt denotes port)

Figure 9: Stalling characteristics of main engines

Previous similar incidents

2.38 Ocean Rider had a history of engine stalling while operating in the MFF fleet. A review of the vessel log for the 12 months prior to the collision revealed a number of engine stalling incidents. These include:

- 20.7.15, port engine stalled when engaged astern on approach to a wharf
• 28.5.15, starboard engine stalled when engaged astern on approach to a wharf
• 27.10.15, port engine stalled when engaged astern approaching Manly wharf
• 29.10.15, port engine stalled
• 11.11.15, starboard gear box control failure approaching wharf
• 16.12.15, starboard engine reported stalling three separate occasions while approaching wharves
• 23.12.15, starboard engine stalled
• 27.12.15, starboard gearbox not engaging
• 25.1.16, starboard engine stalled approaching Manly wharf
• 2.2.16, repeated starboard engine stalling
• 2.5.16, an engine stalled and had trouble restarting
• 5.5.16 both engines stall during near miss with Collaroy
• 13.5.16, during a training session which included crash stops noted that a delay of at least 10 seconds is necessary to avoid stalling
• 14.5.16, starboard engine stalled resulting in damage after collision with wharf
• 28.5.16, starboard engine stalled resulting in collision with wharf (subject of this report).

2.39 Vessel records highlight a known propensity for the engines to stall on Ocean Rider in certain conditions. MFF had not incorporated this information into the development and implementation of the emergency crash stop procedure.

2.40 This additional information would have assisted a master to minimise the likelihood of an engine stalling during berthing.

**Company action to address stalling prior to incident**

2.41 MFF management had reviewed a selection of engine stalling incidents. Based on that review, the management implemented an emergency crash stop procedure to address the engine stalling and incident reports raised by masters.

2.42 The procedure advised masters of the correct method to engage astern at speeds over 10 knots. The procedure became part of initial familiarisation
training for new ferry masters and a printed copy was placed near the controls in the ferry’s wheelhouse (see Figure 10).

![Emergency Crash Stop Procedure](image)

Source: OTSI

**Figure 100:** Crash stop procedure located on wheelhouse dashboard

2.43 The Emergency Crash Stop procedure focused on maintaining vessel control including actions to take when a sudden change in drive direction was required when operating at speeds greater than 10 knots.

2.44 The procedure assumed that the engines would only stall at a speed over 10 knots. Vessel records (supported by the 30 May engine trials) demonstrated that this assumption was limited. The vessel trials confirmed the engines can stall at speeds as low as approximately 6 knots (starboard engine) in certain configurations.

2.45 Without the consideration for slow speed stalling, the procedure is incomplete in mitigating the risk of control failure during berthing.

**Safety actions taken post incident**

2.46 Following the incident, MFF engaged an engine maintenance contractor to investigate the starboard engine stalling and Twin Disc to investigate the condition of both gearboxes.
2.47 The engine contractor conducted a mechanical and computer diagnostic test of the engines. This analysis revealed incorrect fuel calibration settings were programmed into the Electronic Control Unit (ECU). The ECU was reset to the factory specifications and the vessel was re-trialled.

2.48 The changes to the ECU improved the engine response at low rpm, however, did not address the lack of mid-range power in comparison to the port engine. The starboard engine continued to stall at lower loads than the port engine.

2.49 A further inspection by the engine contractor revealed faults with both turbo chargers on the starboard engine. One turbo charger was replaced and the second repaired. This significantly improved engine performance however, this did not improve its resilience to engine stalling.

2.50 Twin Disc inspected the gearboxes and EC300 controllers and confirmed that they were functioning correctly. Following the inspection, MFF instructed Twin Disc to reactivate the DIT on the gearbox control software.

2.51 The vessel was trialled with the DIT enabled. The results, while improving the reliability at higher speeds, offered little improvement at the lower manoeuvring speeds encountered when berthing. While the starboard engine was still prone to stalling, the port engine had improved substantially and MFF considered it highly unlikely to stall.

2.52 Following the completion of remedial maintenance, the vessel was returned to service. However, the starboard engine developed a vibration. MFF exchanged the starboard engine for a newly refurbished and tested engine.

2.53 The replacement engine offered improved reliability. However, trials demonstrated that the low speed stalling issue remained.

2.54 In conjunction with the changes to the vessel system, MFF implemented a program of practical berthing training for masters. The training focused on wharf approach speeds and overcoming the vessel’s handling limitations to minimise the chance of an engine stall. A senior master conducted the training to ensure consistency and to assess master competence.

2.55 MFF followed up the training with instructive correspondence to all masters. The correspondence highlighted the importance of approaching a wharf at an
appropriate speed. MFF instructed masters to keep in mind possible failure scenarios including engine stall, and to plan accordingly.

2.56 MFF has docked the *Ocean Rider* for a major refit. During this refit they have upgraded the starboard gearbox and carried out a general refurbishment of the vessel.
PART 3 FINDINGS

From the available evidence, the following findings are made with respect to the collision of the ferry *Ocean Rider* with Wharf 6 CQ that occurred on 28 May 2016.

**Contributory factors**

3.1 The starboard engine and gearbox configuration comprised of a high-hour engine with the older type gearbox. The configuration increased the likelihood of the starboard engine stalling. This made *Ocean Rider’s* handling characteristics unique compared to like vessels in the MFF fleet.

3.2 The master had only been with the company for two months and his operating hours were spread over a number of vessel types. The master may not have previously been confronted with a degraded situation of this type. This may have affected the master’s response to regaining control the vessel.

3.3 The master said he did not see or hear alarms indicating the engine shut down.

3.4 The audio alarm or the LED warning lights on the EC300 may not have attracted the attention of the master regarding the engine failure. This significantly reduced the time available to allow for an effective response to the control loss.

3.5 MFF’s general vessel induction is a generic checklist that is reliant on the knowledge and experience of the master allocated to familiarise junior or new crew. The variation in master’s knowledge and experience likely lead to inconsistencies in the training outcomes and was likely reflected in operational practices being applied by masters and crew involved in the familiarisation.

3.6 The checklist was not designed to assess competence, rather used as a guide to ensure that each item had been covered in the familiarisation session.

3.7 Evidence within vessel records highlighted a history of engine stalling at both low and high vessel speeds. In response, MFF implemented an emergency crash stop procedure. The procedure, while catering to speeds greater than 10 knots, failed to address engine stalling at low vessel speed (less than 10
knots). A robust risk assessment of the operation, incorporating an analysis of all engine stalling data, would have enhanced the development and implementation of the new procedure.
PART 4  RECOMMENDATIONS

4.1 Noting that remedial safety action has already been implemented, it is recommended that the following additional safety actions be undertaken by the specified responsible entity.

Manly Fast Ferries

4.2 MFF to harness the collective knowledge and skills of experienced operational staff to capture proven good practice in vessel operation. This information can be the basis of future training and familiarisation programmes. The collection of proven good practice should include operations in normal, abnormal, degraded and emergency situations. Following the collection of proven good practice, populate the company risk register with newly identified risks and controls associated with navigating dead–end wharves and amend relevant procedures.

4.4 Install an audible alarm and improve the effectiveness of existing visual warning lights on the EC300 controllers to indicate engine / control failure.

4.5 Document and incorporate the newly developed training / induction procedure into the company Safety Management System.

4.6 Minimise the number of vessel classes on which a new master is initially trained. This will improve the likelihood of the trainee to becoming proficient with the vessel equipment and handling before attempting to learn another vessel.
PART 5 APPENDICES

Appendix 1: Sources, Submissions and Acknowledgements

Sources of Information

- Manly Fast Ferries
- Roads and Maritime Services
- Bureau Of Meteorology, Australian Government
- Twin Disc Inc

References

- National Standards for Commercial Vessels