



Office of Transport Safety Investigations

FERRY SAFETY INVESTIGATION

COLLISION AND GROUNDING OF THE *LADY NORTHCOTT*

SYDNEY HARBOUR

11 and 13 December 2012



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ACRONYMS AND ABBREVIATIONS

CCTV	Closed Circuit Television
DIP	Directly Involved Party
FLIR	Forward Looking Infrared
GPH	General Purpose Hand
HCF	Harbour City Ferries
MCR	Machinery Control Room
OTSI	Office of Transport Safety Investigations
RMS	Roads and Maritime Services
SF	Sydney Ferries Corporation
SMS	Safety Management System
VDR	Voyage Data Recorder

EXECUTIVE SUMMARY

On 11 December 2012, the Harbour City Ferries' ferry *Lady Northcott* experienced a suspected control failure resulting in the ferry coming into collision with the timber backboard at the southern end of No.2 Wharf West at Circular Quay. The ferry had just disembarked passengers and was being moved along the wharf to be shut down for the night. No faults were detected during an inspection by Harbour City Ferries' engineers or during trials the following day, so the ferry was returned to passenger service on 13 December 2012.

On 13 December 2012, the *Lady Northcott* overshot the Taronga Zoo Wharf and went aground with passengers onboard. The Master indicated that the ferry experienced a control failure. The ferry was refloated and secured to the wharf where the passengers were disembarked. The ferry was then towed to the Harbour City Ferries' shipyard at Balmain and placed out of service pending investigation of the causes of both control failures. It sustained a bent propeller from the grounding. One crew member suffered a minor rope burn to the hand but no passengers were injured.

The cause of the loss of control could not be definitively established. However, it is most probable that intermittent electrical relay faults caused incorrect responses from the propulsion system. In the case of the second incident, there is also the possibility that leaks in the air supply to the pneumatically activated clutches resulted in the lowering of pressure to the extent that the clutches were rendered inoperable.

As Harbour City Ferries has replaced all identified suspect components in the *Lady Northcott's* drive system and established an appropriate maintenance regime for electrical relays and pneumatic clutch assembly components, no further recommendations for safety action are considered necessary.

PART 1 FACTUAL INFORMATION

Introduction

- 1.1 On 11 December 2012, the Harbour City Ferries' (HCF) *Lady Northcott* experienced a suspected control failure resulting in the ferry coming into collision with the timber backboard (arrestor) situated at the southern end of No.2 Wharf West at Circular Quay (No.2 Wharf). The ferry had just disembarked passengers and was being moved along the wharf for overnight berthing.
- 1.2 The ferry was inspected by HCF engineers on 12 December 2012 and trials undertaken. No faults were detected so the ferry was returned to passenger service on 13 December 2012.
- 1.3 On 13 December 2012, the *Lady Northcott* overshot the Taronga Zoo Wharf and went aground with passengers onboard. The Master indicated that, while travelling 'ahead', the ferry experienced a control failure in that the ferry's speed did not abate despite his selecting the 'astern' command.
- 1.4 The ferry was refloated and secured to the wharf where the passengers were disembarked. The ferry was then towed to the HCF shipyard at Balmain and placed out of service pending investigation and determination of the cause of the control failure. One crew member suffered a minor injury but no passengers were injured. The ferry sustained a bent propeller from the grounding.

Vessel and crew information

- 1.5 *Lady Northcott* is a monohull "Lady" Class double-ended ferry. It is of steel construction, is 42.5 metres long, has a loaded displacement of 383 tonnes and is powered by two 305 kW diesel powered engines. It was in current NSW 1D survey¹, Identifying Number 15177. The bridges at both ends of the *Lady Northcott* were equipped with radar, automatic identification system (AIS) Class A, forward looking infrared (FLIR) cameras, very high frequency radio (VHF) and an HCF internal radio network. At the time, the vessel was

¹ Survey Class 1D identifies the vessel as a passenger carrying vessel permitted to operate in sheltered waters (partially smooth water operations).

being operated by Harbour City Ferries on behalf of the NSW Government.²
(See *Photograph 1* and for more details refer to *Appendix 1*)



Photograph 1: *Lady Northcott*

- 1.6 At the time of both incidents the ferry had a crew of four consisting of the Master, Engineer and two General Purpose Hands (GPH), and carried a supernumerary GPH who was undergoing HCF training. The same Engineer was onboard when both incidents occurred. Both Masters held current Master IV Certificates of Competency as well as local knowledge certificates issued under Section 7 of the *Marine Pilotage Licensing Act 1971* to operate vessels over 30 metres within the Port of Sydney. The Masters had 19 and 10 years experience respectively, operating within Sydney Harbour, and were both experienced in the control of the *Lady Northcott*.
- 1.7 The Engineer onboard was a relief Engineer. After completing 13 weeks training and induction on the *Lady Northcott*, he was assessed as competent on 22 November 2012. He held a current Marine Engine Driver Grade 2 Certificate of Competency which he attained in 2011.
- 1.8 All GPHs onboard during both incidents held current Certificates of Competency issued by Roads and Maritime Services (RMS).

² Harbour City Ferries took over the contract for Sydney Ferries' services on 28 July 2012.

- 1.9 All crew members underwent drug and alcohol testing with all returning negative results.

Incident 1: 11 December 2012

- 1.10 The first incident occurred on the western side of No.2 Wharf at Circular Quay after completion of the day's service (see *Figure 1*). The wharves at Circular Quay are referred to as 'dead end' wharves as ferries berth in the forward direction then have to reverse out or, in the case of double-ended ferries, be operated from the alternate wheelhouse.

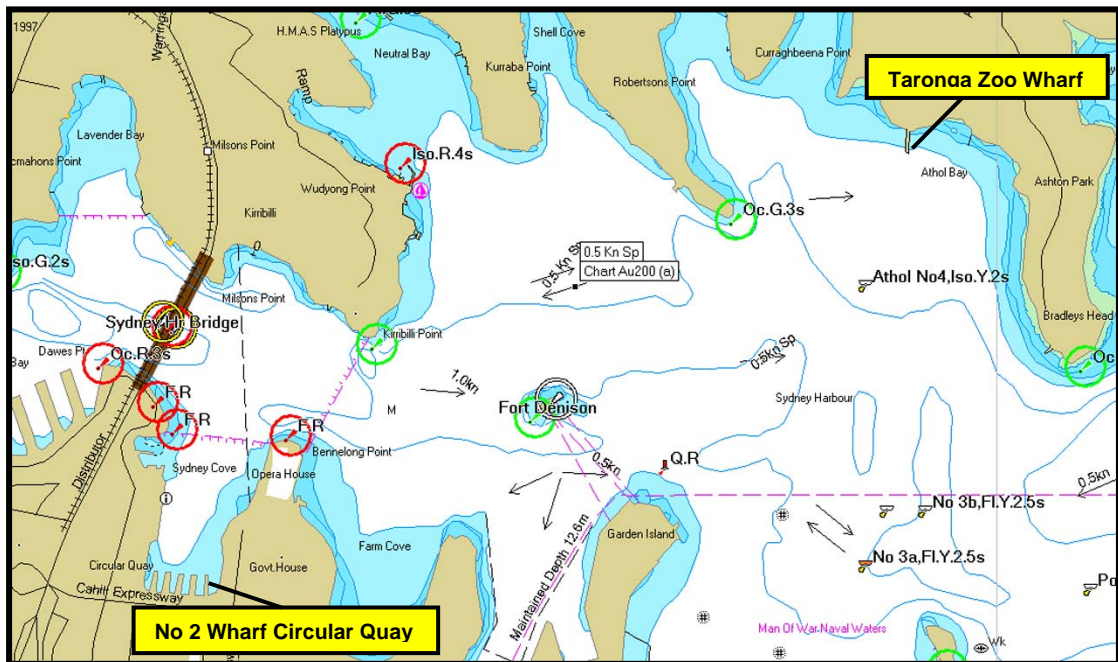


Figure 1: Chart extract showing where the incidents occurred

- 1.11 Circular Quay acts as the main hub for ferry services which operate to all parts of Sydney Harbour and into the two rivers which feed into the Harbour. The Circular Quay wharves are owned by the RMS. There are five finger wharves at Circular Quay (numbered 2 to 6 from east to west) where ferries routinely berth to embark and disembark passengers.
- 1.12 There are large timber backboard structures attached to timber piles positioned approximately six metres from the land end of all the wharves. They are intended to act as barriers separating vessels from the concrete promenade on shore in the event of a ferry overshooting the wharf.

- 1.13 Number 2 Wharf at Circular Quay consists of a large floating pontoon 35 metres in length attached to a 40 metre fixed section over the water and connected to the shore. Both sides of the wharf are available for ferry services, being identified as No.2 East and No.2 West.
- 1.14 The *Lady Northcott* was navigated from Mosman to Circular Quay by the Master from the No.2 wheelhouse. At about 1920³ on approach to the wharf, the Master reduced speed by engaging '*slow astern*' to slow the ferry. A GPH was then able to secure an aft spring mooring line⁴ to the wharf. The Master then declutched and selected '*slow ahead*' to move the ferry ahead on the spring line. Instead of going ahead, the ferry went astern. He again declutched, then again selected '*slow ahead*'.⁵ This time the clutch engaged and the ferry responded to the command. The Master brought the ferry alongside the wharf where it was secured and passengers disembarked.
- 1.15 As the ferry had completed services for the day and was to be berthed overnight at the southern end of the wharf, lines were removed and the Master selected '*slow ahead*' to move the ferry forward about 30 metres. He then selected '*astern*' to stop the ferry. However, instead of '*astern*' being engaged on the No.2 propeller, the ferry responded by rapidly moving ahead on the No.1 propeller. This caused it to collide with the timber backboard at a speed of 2.2 knots (see *Photograph 2*). The ferry suffered only minor paint damage as it was the bow anchor and fairlead⁶ that came into contact with the backboard. However, the backboard was displaced backwards about one metre and its top timbers were slightly damaged.

³ All times in this report are Eastern Daylight-saving Time, UTC+11 hours.

⁴ A spring mooring line is a line set to arrest a vessel's movement parallel to its berth.

⁵ A ship's telegraph is a signalling device for communicating propulsion orders and acknowledgements between a ship's bridge and the engine room.

⁶ A fairlead is a smooth non-chafing channel through which mooring ropes and wires are passed.



Photograph 2: Circular Quay timber backboard

Incident 2: 13 December 2012

- 1.16 The second incident occurred on 13 December 2012 when approaching the eastern side of Taronga Zoo Wharf. This wharf is a 'dead end' wharf similar to those at Circular Quay. It consists of a large floating pontoon 24 metres in length attached to a bridge which in turn is attached to a fixed structure on piles over the water and the shore. The timber backboards, or deflectors, are in place on both sides 32 metres from the southern end of the wharf. They are angled at 17 degrees to the wharf so as to deflect a vessel away from the fixed structure of the wharf should it over-shoot the berthing position (see *Photograph 3*).
- 1.17 The *Lady Northcott* was navigated from Circular Quay to Taronga Zoo Wharf by the Master from the No.1 wheelhouse. At about 1455, the ferry approached the south-eastern side of the wharf at a speed of 6.6 knots reducing to 6 knots when the bow was near the end of the wharf. The Master declutched and selected '*slow astern*' to slow the forward momentum, but the No.1 propeller did not engage and the ferry continued in a forward direction. He then selected '*full astern*' but, again, the ferry continued forward.



Photograph 3: Taronga Zoo Wharf

- 1.18 As the ferry travelled along the wharf, a GPH managed to lasso a wharf bollard.⁷ However, he was unable to make fast the mooring line and the line was pulled from his hands causing minor rope burns.
- 1.19 The ferry collided with the timber deflector at a speed of 4.5 knots. It was deflected away from the wharf and went aground on the shore at a speed of 3.6 knots. After contact with the shore, the ferry slid backwards slowly towards the wharf where the crew secured it.
- 1.20 Forty-one passengers were disembarked while the watertight integrity of the ferry was examined by the Engineer. The Master reported the incident by radio to HCF and requested the services of a tug to tow the ferry to the Balmain Shipyard.
- 1.21 There was no damage caused to the deflector or wharf. However, an inspection of the hull, rudder and propeller by divers identified damage to the blades of the propeller on the No.1 shaft where it had impacted on the rocks.

⁷ A post for securing (tying) mooring lines or ropes on a jetty or wharf.

Environmental conditions

- 1.22 Conditions on the Harbour were calm and visibility was good at the time of both incidents. As both wharves involved were floating pontoon structures the tidal flow had little influence on the incidents.
- 1.23 The ebb tide at Taronga Zoo on 13 December 2012 produced a low of 0.11 metres at 1522. This had the effect of minimising the distance for the *Lady Northcott* to travel between the end of the wharf and the rocks on the shoreline.

Previous control related incidents

- 1.24 The *Lady Northcott* had been involved in four previous incidents since 2008, three of which were attributed to loss of control.
- 1.25 On 23 November 2008, the *Lady Northcott* on approach to No.2 wharf at Circular Quay failed to go astern when the No.2 clutch failed to engage. This resulted in the ferry colliding with the stern of the Sydney Ferries Corporation (SF) ferry, *Friendship*, which was moored at the southern end of the wharf. This collision resulted in extensive damage to the *Friendship* and damage to the *Lady Northcott's* bow. The cause was identified as a faulty relay, R32, in the clutch control unit.
- 1.26 On 21 April 2009, after departing Taronga Zoo Wharf, the *Lady Northcott* lost power to both engines and drifted south of Mosman Bay. The ferry was anchored and 250 passengers were transferred to another ferry, the SF *Supply*, and conveyed to Circular Quay. Analysis of data recordings showed that both engines had shut down in response to an electrical signal to move the fuel racks to zero on both engines, which corresponds to the main engine emergency stop being activated. The wheelhouse telegraph was in the '*full ahead*' position at the time. The location and type of the engine emergency stop buttons in both wheelhouses was changed as a result.
- 1.27 While undergoing a NSW Maritime Survey on 1 March 2010, the No.1 clutch of the *Lady Northcott* became inoperable. The control wheelhouse ends were reversed and it was found that the No.2 clutch was also inoperable. At the time, the ferry was in the deepest part of the Harbour and the anchor could

not be deployed, so the prevailing wind and tide caused the ferry to drift towards the rocks at Balls Head. The SF *Charlotte* secured to the *Lady Northcott* holding it from the shore until a tug arrived. The clutch failures were attributed to parting of the hydraulic oil supply line to No.1 clutch causing it to fail, and the interlocking between the clutches, described in paragraph 1.31, preventing No.2 clutch from engaging.

Lady Northcott's manoeuvring system

- 1.28 Being a double-ended ferry, the *Lady Northcott* has two bridges, one at either end of the vessel, and designated No.1 Wheelhouse and No.2 Wheelhouse. Both bridges are identical in layout. The main helming position is amidships on the bridge. Port and starboard wing positions afford the Master clear vision of the wharves when berthing. The wing bridge controls are slaves of the main position and are mechanically linked to the central bridge control telegraph. A single lever telegraph allows the Master to select ahead or astern propulsion by engaging the appropriate clutch. Engine speed is also controlled using this lever.
- 1.29 Signals are sent electronically from the telegraph to the engine room through a series of 12 relay switches. These switches control the engine speed and select the engagement/disengagement of the clutches which activate pneumatic rams to engage the shaft at either end. The setting of the bridge telegraph is also displayed on the engine room control console.
- 1.30 In normal operation, each of the *Lady Northcott's* two engines is connected to a single 2:1 reduction gearbox driving the main propeller shaft, effectively coupling the engines together (see *Photograph 4* and *Figure 2*). However, for emergency operation, the engines may be used independently to provide propulsion, albeit at greatly reduced speed.
- 1.31 The main propeller shaft is connected at each end to a propeller through a clutch. The propellers are unidirectional, i.e., they turn only one way, and the clutches are interlocked so that only one propeller may be in operation at any one time. Meanwhile, the propeller shaft at the opposite end is 'freewheeling' due to the movement of the ferry through the water. While freewheeling, this

shaft is turning in the opposite direction to that when it is engaged by the clutch. There is no brake locking the shaft when it is not used in propulsion.

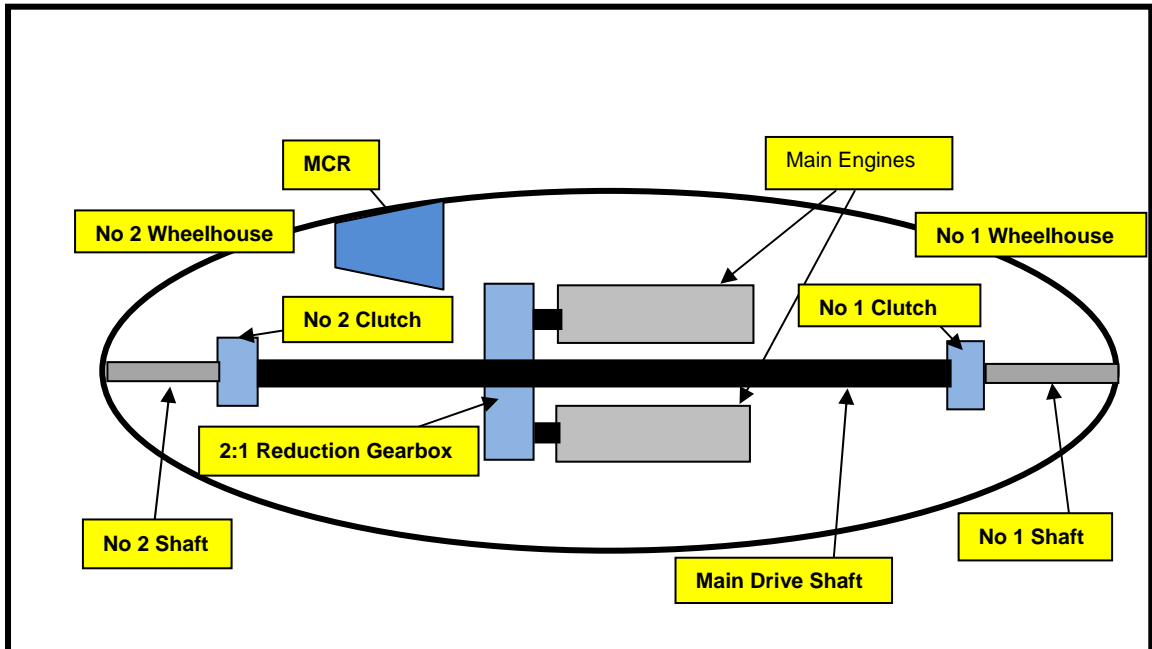
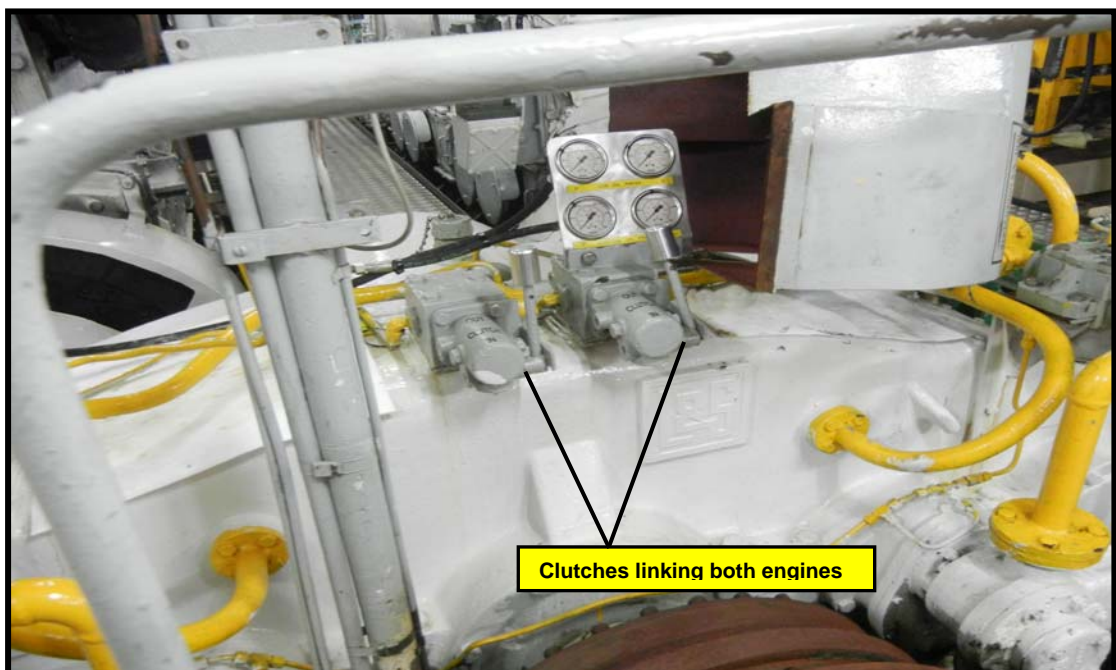


Figure 2: Propulsion diagram



Photograph 4: *Lady Northcott's* main engine coupling

- 1.32 To go ahead operating from the No.1 Wheelhouse requires the No.2 propeller shaft at the opposite end of the vessel to be engaged. To go astern, the No.2 propeller shaft is disengaged and the No.1 propeller shaft is engaged. The reverse applies when operating from the No.2 Wheelhouse. Moving from 'ahead' to 'astern', or vice versa, involves reducing the main engine speed to idle, disengaging one clutch and engaging the other clutch. If the speed of the freewheeling shaft is not reduced sufficiently, and the clutch engaged, the shaft could break or be damaged.
- 1.33 Varying propeller thrust (ahead or astern with respect to the direction of travel), corresponding with 'stop', 'dead slow', 'slow', 'half' or 'full' speed orders, is achieved by varying the engine speed (see *Photograph 5*).



Photograph 5: *Lady Northcott's* telegraph control lever

- 1.34 The vessel is steered using only the rudder at the opposite end to the wheelhouse which is in use. The rudders are located astern of each propeller on the centreline of the vessel. A hydraulic solenoid valve, operated by a key switch in each wheelhouse, is used to lock the non-operational rudder in the centreline position.

Engine control modes

- 1.35 **Wheelhouse control** is the normal control mode where engine speed and propulsion direction are controlled directly by the Master using the telegraphs in the wheelhouses. When using wheelhouse control, changing propulsion direction (i.e., ahead to astern or astern to ahead) normally involves a time delay of around seven seconds while the control system reduces the engine speed to idle, disengages one clutch and engages the other clutch.
- 1.36 **Emergency control** is intended for use in the event of a failure of the wheelhouse control system. Emergency control is achieved by passing control from the wheelhouse in use to the machinery control room (MCR). There, the engineer manually 'drives' the main engine using the clutch and the main engine speed controls in response to the telegraph or voice commands given by the Master via a PA system (see *Photograph 6*).



Photograph 6: Lady Northcott's MCR controls

- 1.37 The emergency control procedure requires the engineer to acknowledge the master's order by using the 'stand by' response on the MCR telegraph before he executes the command. Both the telegraphs in the MCR and in the wheelhouse are fitted with buzzers which continue to sound until the telegraph position is matched on both telegraphs.

- 1.38 The emergency control process takes longer to achieve the desired engine movement than the automated wheelhouse control system. In addition, while the engineer is manoeuvring from the MCR in the engine room, he has no visibility of the direction of travel and must rely totally on the directions conveyed from the Master via the telegraph or PA system.
- 1.39 It is an operational requirement for the engineer to be standing-by in the MCR, ready to take over propulsion control during critical vessel operations such as berthing at 'dead end' wharves.
- 1.40 Changing over the engine controls from the wheelhouse to the MCR or vice versa involves a number of steps. The wheelhouse console is fitted with 'Bridge Control' and 'Main Control Room' request buttons with indicator lights and a buzzer, as well as a 'stand by' button. The control selector switch is located on the MCR manoeuvring console together with 'W/house' control and 'MCR' control indicator lights and a buzzer.
- 1.41 If the Master decides to change over control to the engine room while the vessel is underway, he actuates the 'stand by' button to ensure that the engineer is in the MCR. The Master cannot proceed any further until the engineer acknowledges 'stand by'. (If the engineer does not acknowledge 'stand by', the Master must immediately stop the ferry until the engineer is in position.) The Master must then bring the wheelhouse telegraph to 'stop' and press the 'MCR' control request button. This causes the 'MCR' control indicator lights in the wheelhouse and MCR to flash and buzzers to sound. The engineer then changes over the control selector switch to take control in the engine room. The buzzers then stop and the 'MCR' control indicator lights remain lit. After switching to 'MCR' control, the engineer is required to maintain this station until control is passed back to the bridge after 'Bridge Control' is telegraphed.
- 1.42 If the Master decides to resume wheelhouse control from the MCR, he presses the 'W/house' control request button which causes the 'W/house' control indicator lights in the wheelhouse and MCR to flash and buzzers to sound. The engineer should then move the engine room telegraph to 'stop', reduce the engine speeds to idle, disengage the clutches, and change the

control selector switch to the 'W/house' position. The 'W/house' control indicator lights then remain lit and the buzzers stop.

- 1.43 Depending on the position of the telegraph and engine controls, changing control from the wheelhouse to the MCR or from the MCR to the wheelhouse may take up to 9 seconds.

Digital emergency announcements

- 1.44 The *Lady Northcott* is equipped with a digital information broadcast system which is capable of playing pre-recorded announcements to passengers at the press of a button on the wheelhouse control panel. Two emergency recordings are described in the vessel operations manual. Message No.3 is described as the "alert for impending incident/danger" and contains the following message:

Attention passengers! We are currently experiencing some difficulties. It is important to remain seated or if standing, hold onto something secure. Please listen carefully for instructions from the crew.

Message No.4 is described as "incident has occurred" and contains the following message:

Attention passengers! An incident has occurred. Please remain calm and follow all instructions from the crew.

In neither of the two incidents were announcements by the Masters to warn or advise passengers or crew that an incident had occurred, or was about to.

PART 2 ANALYSIS

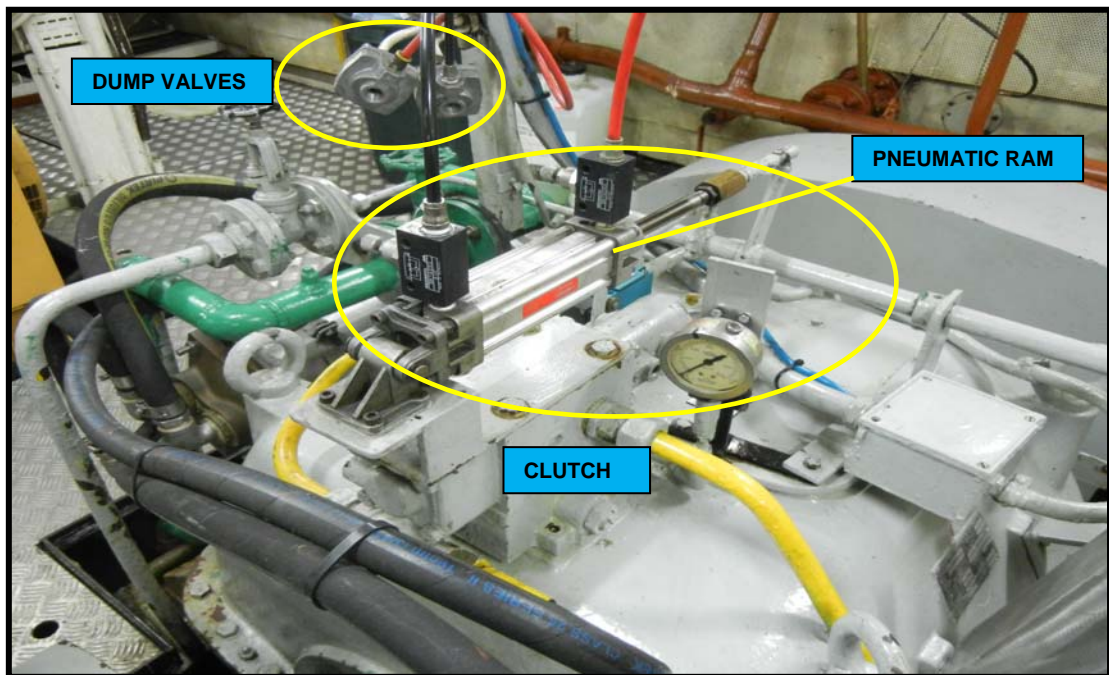
Introduction

- 2.1 The investigation involved detailed examination of the relevant onboard FLIR and communications recordings and data from the voyage data recorder (VDR), as well as CCTV recordings from both wharves. Vessel Safety Management Systems (SMS), logs, operating procedures and documentation were also examined along with the recent history of incidents involving the *Lady Northcott*. Both Masters and the Engineer were interviewed, and the training, induction and assessment of the Engineer reviewed.
- 2.2 **Limitations of the VDR.** The VDR records engine revolutions and shaft speed but not the wheelhouse in use or the position of the telegraph, and most importantly whether 'ahead' or 'astern' has been selected. Consequently, the shaft engagement cannot be directly correlated with the corresponding telegraph selection.

Inspections and trials

- 2.3 Investigators examined the *Lady Northcott* on 14, 18 and 20 December 2012 at the HCF Balmain Shipyard in company with HCF electrical and mechanical engineers, an insurance underwriters' representative and a RMS survey engineer. Trials with the vessel were conducted involving both Masters involved in the incidents. All control modes, including critical control failure, were trialled from both bridges to test the backup system and involved the Master and Engineer using both the wheelhouse controls and voice controls. This testing was not successful in replicating the control failures which occurred during the two incidents.
- 2.4 During the initial inspection of the *Lady Northcott* by OTSI investigators on 14 December 2012, a leak was found in the air supply to the pneumatically operated ram which engaged and disengaged the clutch on the No.2 propeller shaft. Additionally, one of the air exhaust valves was found not to be working, possibly due to the air leak reducing the pressure in the line. The ram did operate during testing although with a slight hesitation and with not as smooth an action as compared to the ram on the No.1 shaft. However, the clutch engaged and disengaged correctly. Minor air leaks were also detected in the

pneumatic supply lines from the stored compressed air to both operating pneumatic cylinders (see *Photograph 7*).



Photograph 7: *Lady Northcott*'s pneumatic clutch at the gearbox

- 2.5 During critical control failure testing of the emergency changeover of control from the wheelhouse to the engine room, confusion arose if the Master gave the voice command '*ahead*' or '*astern*' without also selecting the corresponding button on the wheelhouse indicator board. The confusion arose as the Engineer, from his position in the MCR, did not know from the command which way the ferry was travelling. In normal operation, the ends of the vessel are changing constantly as it arrives and departs numerous 'dead end' wharves. It is impossible to keep track of this below decks without a frame of reference. Therefore, voice only orders to the Engineer from the Master must include the shaft or clutch number so as to avoid this confusion.

Sequences of events

- 2.6 The following sequences of events were assembled from analysis of VDR, FLIR and CCTV recordings. They correspond well with the Masters' accounts of the incidents.

Incident 1: 11 December 2012

- 2.7 The *Lady Northcott* was withdrawn from service on 8 December 2012 for repairs to an unserviceable port engine head gasket. At about 1030 on 11 December 2012, prior to returning to service, the vessel commenced a series of trials to test the repairs. No faults in the control system were encountered.
- 2.8 At 19:20:20 the *Lady Northcott* approached No.2 Wharf to complete a passage from Mosman during which it was controlled from the No.2 Wheelhouse. The Master placed the Engineer on 'stand by' which was acknowledged. As the ferry was north of the wharf, the Master declutched the No.1 propeller shaft allowing the ferry to continue to the wharf under its forward momentum. An aft spring mooring line was then secured to arrest the vessel's movement and assist in swinging it alongside the wharf.
- 2.9 The Master then engaged the No.1 shaft to 'slow ahead' to bring the ferry ahead on the spring line, swinging the bow in parallel to the wharf. As evidenced from the CCTV and FLIR, the No.2 shaft engaged instead of the No.1 shaft. The VDR recorded the No.2 clutch engaged with the engine speed at 320 rpm. The ferry commenced to move astern, rapidly swinging the bow of the ferry away from the wharf (see *Photograph 8*). The Master declutched the No.2 clutch and put the Engineer on 'stand by' then asked him via the intercom what had happened. The Engineer did not know.



Photograph 8: *Lady Northcott* at No 2 Wharf going astern

- 2.10 At 19:21:52, using the telegraph, the Master selected '*slow ahead*' which correctly engaged the No.1 propeller shaft. This brought the ferry alongside where it was secured by two spring lines and both shafts were declutched. Two gangways were attached and eight passengers disembarked.
- 2.11 At 19:23:01, with the passengers disembarked, the spring lines were removed and the Master placed the telegraph in the '*slow ahead*' position. The No.1 shaft engaged and the ferry moved forward. According to the Master, when the bridge porthole was in line with the fixed structure on the wharf, he selected '*astern*' on the telegraph. This should have resulted in the No.2 clutch being engaged. However, the No.2 clutch did not engage, and the No.1 clutch remained engaged driving the ferry forward.
- 2.12 The CCTV recorded the ferry moving forward at an increasing speed until, at 19:23:34, it collided with the backboard where it 'hung' by the anchor and fairlead. The FLIR recorded the speed at the time of collision as 2.2 knots. The VDR recorded the No.1 clutch engaged and the engine speed increasing to 580 rpm.
- 2.13 The Master directed the GPHs to secure the ferry. He asked the Engineer to shut down everything and come to the bridge where they discussed the situation but could not come up with an explanation.
- 2.14 At 19:31:12, after the Engineer had returned to the engine room and restarted the engines, the Master took control at the bridge, directed the lines be removed and selected '*dead slow astern*'. The ferry responded and detached from the backboard. In the Master's words: '*When vessel was in contact with the backboard, the vessel did not respond when revolutions astern were increased. However, on shutting down and restarting the engine, the vessel responded appropriately to a dead slow astern command*'. It was then re-secured and shut down.

Incident 2: 13 December 2012

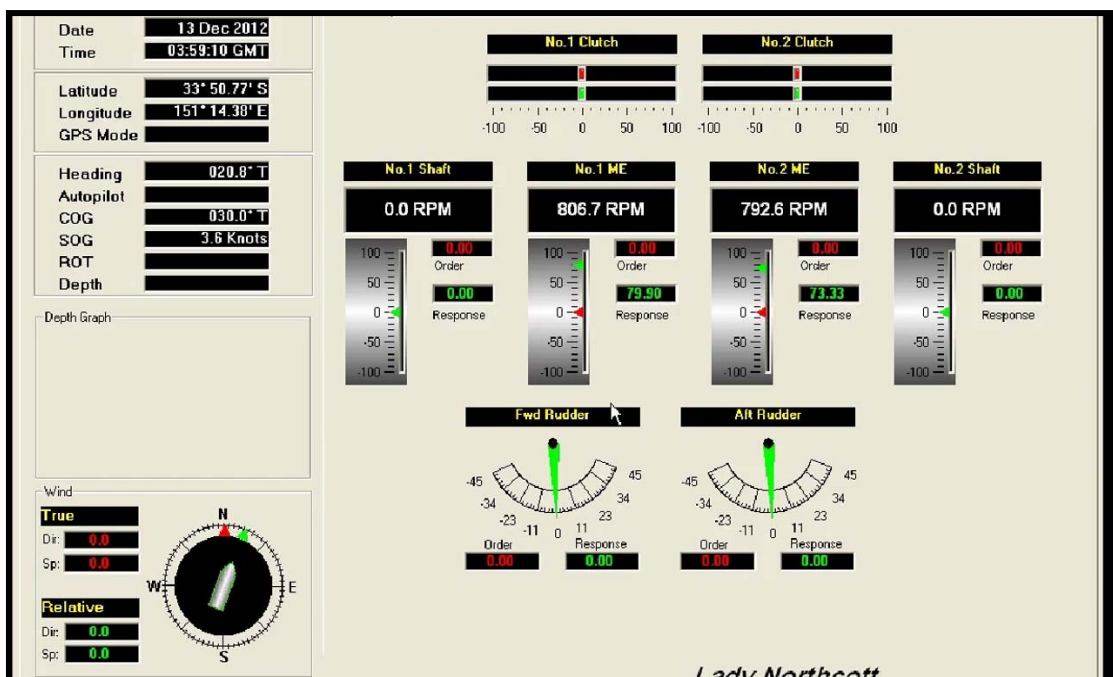
- 2.15 According to the log, the *Lady Northcott* commenced a return service to Manly from Circular Quay at 0900 followed by services to Manly at 1030, to Mosman at 1325 and to Taronga Zoo at 1415. No problems were reported on these services.

- 2.16 On the return passage from Taronga Zoo, the Master advised the Engineer that they would be trialling the backup systems in which control is transferred to the engine room from the wheelhouse. This was completed successfully and the *Lady Northcott* returned to Circular Quay without incident.
- 2.17 At 1445 the ferry departed Circular Quay to Taronga Zoo with passengers onboard. At about 1500, on approach to the eastern side of the Taronga Zoo wharf, the Master was operating from the No.1 Wheelhouse. In accordance with normal operating procedure on approaching a 'dead end' wharf, he gave the '*stand by*' order to the Engineer which was acknowledged.
- 2.18 At 14:58:11 the Master reduced engine speed then moved the telegraph to '*dead slow astern*' as the bow of the ferry came into line with the southern end of the wharf. At this time the ferry was travelling at 5.8 knots. As evidenced by the VDR, the No.1 shaft did not engage but the No.2 shaft had disengaged and remained disengaged; the ferry continued on under its forward momentum.
- 2.19 The sound of the telegraph being moved at 14:58:37 was captured on the FLIR. The ferry was reducing speed but continuing to go '*ahead*'. The Master tried to switch control to the MCR and requested '*full astern*'. However, the Engineer was not able to take control as the main engines were turning at full speed. The Engineer is not permitted to take control until the main engines are at idle, otherwise major machinery damage may ensue. The ferry continued forward until, at 14:58:50, it collided with the timber deflector. At the time it was travelling at a speed of 4.6 knots. In response to the Master's '*full astern*' command, the engine revolutions had increased to 800 rpm but neither clutch had engaged.
- 2.20 The Master utilised the deflector on the side of the wharf to slow the ferry further. When the port bow hit the board, the ferry was deflected away from the wharf and towards the shoreline as shown by the CCTV wharf recording (see *Photograph 9*).



Photograph 9: *Lady Northcott* colliding with timber arrester at Taronga Zoo Wharf

2.21 At 14:59:10 the FLIR showed the ferry's bow grounding at a speed of 3.6 knots. The VDR recorded the engine revolutions still near the maximum of 800 rpm and neither clutch engaged (see *Photograph 10*). After impact the ferry slid back from the rocks towards the wharf where it was secured, awaiting subsequent recovery to the Balmain Shipyard.



Photograph 10: *Lady Northcott*'s VDR capture at 14:59:10

Maintenance and servicing

- 2.22 Despite a thorough examination of maintenance records, it could not be determined how long the current relays, pneumatic rams and valves had been in use. Additionally, there was no documentation providing information on operational life or programmed replacement for relays. The best estimate of engineering staff was that all components had been in service for more than five years.
- 2.23 The cause of the *Lady Northcott* colliding with the *Friendship* on 13 November 2008 was attributed to the failure of relay R32, part of the clutch control unit that provides a signal to the air solenoid control box which activates the clutch. The investigation into the incident identified that there was no relay replacement regime specified in the ferry's technical maintenance plan. The technical report recommended programmed replacement of control system relays every 12 months. Examination of the maintenance records showed that this recommendation was not implemented by Sydney Ferries Corporation, the operator of the *Lady Northcott* at the time of the incident.

Possible causes

- 2.24 From analysis of the available evidence, the following provide the most plausible explanations of the cause/s of the two incidents:
- human errors by the Masters inadvertently selecting the wrong telegraph control;
 - intermittent faults in one of the actuating control relays;
 - a fault in the operation of the pneumatic clutch controls; and/or
 - the combination of a faulty relay and a fault in the operation of the pneumatic clutch controls.
- 2.25 Factors that could have induced human error on the part of the Masters and Engineer were examined, such as personal circumstances, work and rostering regimes, and sleep patterns. No evidence was identified to indicate that fatigue or distraction might have played a part in either incident. The experience of both Masters generally, and specifically with the operation of the *Lady Northcott*, was extensive. Additionally, the Master in command at

the time of the first incident was likely to have been in a state of heightened awareness due having recently experienced the control failure on approach to No.2 Wharf.

- 2.26 On examination, the training, induction and assessment of the Engineer prior to taking up his position was found to be comprehensive and no issues were identified that might have contributed to the incidents.
- 2.27 As can be seen from *Photograph 6*, the telegraph control is sturdy, requiring a deliberate manual movement over an appreciable distance to change commands between '*ahead*' and '*astern*'. A series of mistaken control selections (or accidental bumps) is an unlikely coincidence.
- 2.28 On initial approach to the wharf in the first incident, the vessel was reported to have gone '*astern*' in response to a '*slow ahead*' command. It then responded correctly to a subsequent '*slow ahead*' command. This was followed by its continuing to go '*ahead*', and at increasing speed, despite an '*astern*' command. This is evidence of faulty relays failing to actuate the clutches as designed.
- 2.29 In the case of the second incident, '*ahead*' propulsion was disengaged in response to an '*astern*' command but '*astern*' propulsion was not then engaged, so the vessel continued on effectively in neutral. There could be two reasons for this: either there was insufficient air pressure to activate the clutch or a relay was not functioning correctly. It is possible, but unlikely, that both situations occurred concurrently.

Other safety issues

- 2.30 The CCTV footage taken from the Taronga Zoo Wharf shows the GPH throwing lines to the wharf bollards without the protection of a railing, bulwark, or the like to prevent them from falling overboard (see *Photograph 11*). While the GPH followed standard operating procedures in accordance with the Vessel Operating Manual, this clearly constitutes a significant safety hazard. In the event of a heavy berthing where the ferry contacts the wharf or pile at speed causing the ferry to be deflected, GPHs and nearby passengers could lose their footing and fall between the ferry and the piles or wharf resulting in serious injury or death.



Photograph 11: GPH on open deck

Remedial action

Control relays

2.31 HCF tested all 12 relays associated with clutch activation but no intermittent faults were detected. Further, no faults had been encountered during the trials of the vessel after each incident. However, HCF replaced all 12 clutch actuating relays and initiated a relay numbering and tracking system. The maintenance regime has been amended to include renewal of all clutch engagement relays every 4000 hours which reflects an interval of approximately 12 to 18 months depending on vessel usage. This action effectively implements the recommendation from the investigation into the incident in 2008.

Pneumatic clutch cylinders

2.32 In response to the leaks detected in the pneumatic system, HCF replaced the clutch activating cylinders on both gear boxes, sections of the stored compressed air supply lines to the cylinders, the four air control valves (two intake, two exhaust), the pneumatic system water traps and all pneumatic tubing in the air supply system.

VDR recorded information

- 2.33 Additional monitoring points are being added to the VDR so that it will record the selection of '*ahead*' and '*astern*' and the identification of the wheelhouse in operation. This is part of a review of all onboard recording devices currently being undertaken with the aim of enhancing event recording capabilities.

Digital emergency announcements

- 2.34 The importance of announcements to keep passengers and crew informed in emergency situations will be re-enforced in the training environment by HCF's lead trainers.

GPH position when berthing

- 2.35 HCF has identified the need to assess the risks associated with the mooring procedures followed by GPHs when a ferry is berthing.

PART 3 FINDINGS

- 3.1 The cause of the loss of control of the *Lady Northcott* on 11 and 13 December 2012 could not be definitively established. However, it is most probable that intermittent electrical relay faults caused incorrect responses from the propulsion system.
- 3.2 In the case of the second incident, there is also the possibility that leaks in the air supply to the pneumatically activated clutches resulted in the lowering of pressure to the extent that the clutches were rendered inoperable.
- 3.3 No robust technical maintenance program existed that enabled identification of the age or replacement criteria for electrical relays and components of the pneumatic clutch assembly. This was despite a recommendation to establish an annual relay replacement program contained in an investigation report which attributed a control failure on the *Lady Northcott* in 2008 to a relay failure.

PART 4 RECOMMENDATIONS

As Harbour City Ferries has replaced all identified suspect components in the *Lady Northcott's* drive system and established an appropriate maintenance regime for electrical relays and pneumatic clutch assembly components, no further recommendations for safety action are considered necessary.

PART 5 APPENDICES

Appendix 1: Vessel Information – *Lady Northcott*

Name	<i>Lady Northcott</i>
Vessel Type	Lady Class double ended ferry
Registered owner	NSW Government
Manager / Operator	Harbour City Ferries
Construction	Steel
Builder	Tomago - Newcastle, NSW
Launched	1974
Length	42.5m
Breadth	12.4m
Draught	3.35m
Displacement	383 tonnes
Engine	2 X MIRRLEES BLACKSTONE ES6M 6 cylinder marine diesel engines 405 BHP continuous rating 900 HP
Power	2 x 305kW
Service speed	14 knots
Propeller	2 X Single Fixed pitch propellers (one at either end)
Crew	4 to 5
Passenger capacity	811
Equipment	AIS type A, FLIR, VHF Radio

Appendix 2: Sources and Submissions

Sources of Information

- Sydney Ferries Corporation
- Harbour City Ferries

References

- Chart AUS 200, Aus 202
- *Passenger Transport Act 1990 (NSW)*
- Sydney Ports Corporation – *Port Procedures Guide for Sydney Harbour and Port Botany*

Submissions

The Chief investigator forwarded a copy of the Draft Report to the Directly Involved Parties (DIPs) to provide them with the opportunity to contribute to the compilation of the Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and to submit recommendations for amendments to the Draft Report that they believed would enhance the accuracy, logic, integrity and resilience of the Investigation Report. The following DIPs were invited to make submissions on the Draft Report:

- Harbour City Ferries
- Transport for NSW
- Roads and Maritime Services

Roads and Maritime Services did not propose any changes to the report. Points raised by Harbour City Ferries and Transport for NSW were taken into account in finalising the Report.