OTSI Office of Transport Safety Investigations

FERRY SAFETY INVESTIGATION REPORT

COLLISION INVOLVING SYDNEY FERRIES' *SIRIUS* WITH THE AQUARIUM WHARF, *OCEAN DREAMING* AND THE PYRMONT BRIDGE

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DARLING HARBOUR

22 MARCH 2007

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THE OFFICE OF TRANSPORT SAFETY INVESTIGATIONS

The Office of Transport Safety Investigations (OTSI) is an independent NSW agency whose purpose is to improve transport safety through the investigation of accidents and incidents in the rail, bus and ferry industries. OTSI investigations are independent of regulatory, operator or other external entities.

Established on 1 January 2004 by the Transport Administration Act 1988, and confirmed by amending legislation as an independent statutory office on 1 July 2005, OTSI is responsible for determining the causes and contributing factors of accidents and to make recommendations for the implementation of remedial safety action to prevent recurrence. Importantly, however, OTSI does not confine itself to the consideration of just those matters that caused or contributed to a particular accident; it also seeks to identify any transport safety matters which, if left unaddressed, might contribute to other accidents.

OTSI's investigations are conducted under powers conferred by the Rail Safety Act 2008 and the Passenger Transport Act 1990. OTSI investigators normally seek to obtain information cooperatively when conducting an accident investigation. However, where it is necessary to do so, OTSI investigators may exercise statutory powers to interview persons, enter premises and examine and retain physical and documentary evidence.

It is not within OTSI's jurisdiction, nor an object of its investigations, to apportion blame or determine liability. At all times, OTSI's investigation reports strive to reflect a "Just Culture" approach to the investigative process by balancing the presentation of potentially judgemental material in a manner that properly explains what happened, and why, in a fair and unbiased manner.

Once OTSI has completed an investigation, its report is provided to the NSW Minister for Transport for tabling in Parliament. The Minister is required to table the report in both Houses of the NSW Parliament within seven days of receiving it. Following tabling, the report is published on OTSI's website at www.otsi.nsw.gov.au.

OTSI cannot compel any party to implement its recommendations and its investigative responsibilities do not extend to overseeing the implementation of recommendations it makes in its investigation reports. However, OTSI takes a close interest in the extent to which its recommendations have been accepted and acted upon. In addition, a mechanism exists through which OTSI is provided with formal advice by the Independent Transport Safety and Reliability Regulator (ITSRR) in relation to the status of actions taken by those parties to whom its recommendations are directed.

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EXECUTIVE SUMMARY

At approximately 1:08pm on Thursday 22 March 2007, Sydney Ferries' vessel MV *Sirius* was on a regular service run from Circular Quay to Darling Harbour and was due to make a scheduled stop at the Sydney Aquarium Wharf. As the ferry approached the Wharf from the North, the Master moved the control levers at the port control station to astern in order to slow and then stop the ferry. However, the ferry continued forward at a speed of approximately five knots and collided with the Aquarium Wharf and a moored vessel *Ocean Dreaming*, before the Engineer shut down both engines at the direction of the Master. The vessel then drifted on to strike the underside of Pyrmont Bridge. The Master subsequently reported that the vessel did not respond to his command inputs from the port control station.

The *Sirius* sustained minor damage to its port bow and the roof of its wheelhouse. The damage to the Aquarium Wharf, *Ocean Dreaming* and the Pyrmont Bridge was superficial.

There were no reports of injuries arising from the collisions.

NSW Water Police and Maritime Authority officers attended the scene of the collisions and commenced their respective investigations. NSW Maritime Authority investigators witnessed the ferry's controls being operated in a variety of test sequences during the vessel's return movement to Balmain Shipyard. OTSI Investigators boarded *Sirius* after its arrival at the Shipyard and commenced a preliminary investigation.

The investigation determined that the loss of control was most probably a consequence of the Master attempting to control the vessel from the ferry's port station before he had completed the required procedures to effect the transfer of control from the centre station at which he had been operating.

The primary safety action from the investigation recommends that masters be required to regard the Aquarium Wharf at Darling Harbour as a "dead-end" wharf and

to employ the specified “dead-end” berthing procedures when berthing at this location.

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

PART 1 FACTUAL INFORMATION

Accident Synopsis

1.1 At approximately 1:08pm on Thursday 22 March 2007, Sydney Ferries' vessel MV *Sirius* was on a regular service run from Circular Quay to Darling Harbour and was due to make a scheduled stop at the Sydney Aquarium Wharf. As the ferry approached the Wharf from the North, the Master moved the control levers at the port control station to astern in order to slow and then stop the ferry. However, the ferry continued forward at a speed of approximately five knots and collided with the Aquarium Wharf and a moored vessel *Ocean Dreaming*, before the Engineer shut down both engines at the direction of the Master. The vessel drifted on to strike the underside of Pyrmont Bridge. The Master subsequently reported that the vessel did not respond to his command inputs from the port control station.

Accident Narrative

Before the Collision

1.2 *Sirius* commenced its regular passenger service from Circular Quay at 6:20am and subsequently berthed at and departed from eight wharves without incident.

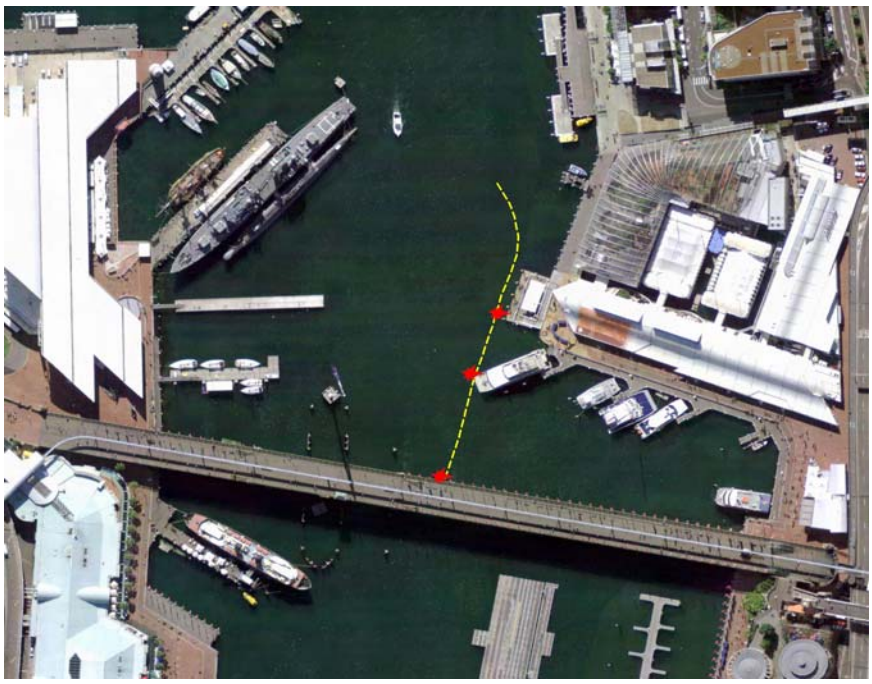
1.3 As *Sirius* was approaching the Aquarium Wharf, which was on the port side, the Master moved from the centre to the port control station in preparation for berthing. Having done so, he moved the control levers for both engines to the astern position to slow and then stop *Sirius* but the vessel did not respond.

The Collision

1.4 Upon realising that *Sirius* was not slowing, the Master attempted to steer to Starboard, away from the Aquarium Wharf, however the ferry's port side glanced the Southern pylon of the wharf and its bow then struck the starboard bow of the vessel *Ocean Dreaming* which was berthed on the Southern side of the wharf. As *Sirius* continued on, the Master directed the Engineer to shut down both main engines in a further attempt to arrest the ferry's momentum.

The main engines were shut down and *Sirius* drifted to a point where the roof of its wheelhouse came into contact with the underside of the Pyrmont Bridge.

1.5 The three incidents of collision occurred in quick succession and at low speed and as a consequence there were no injuries and the resulting damage was largely superficial. *Photograph 1* depicts the approximate points at which the collisions occurred.



Photograph 1: Approximated points of collision, Darling Harbour

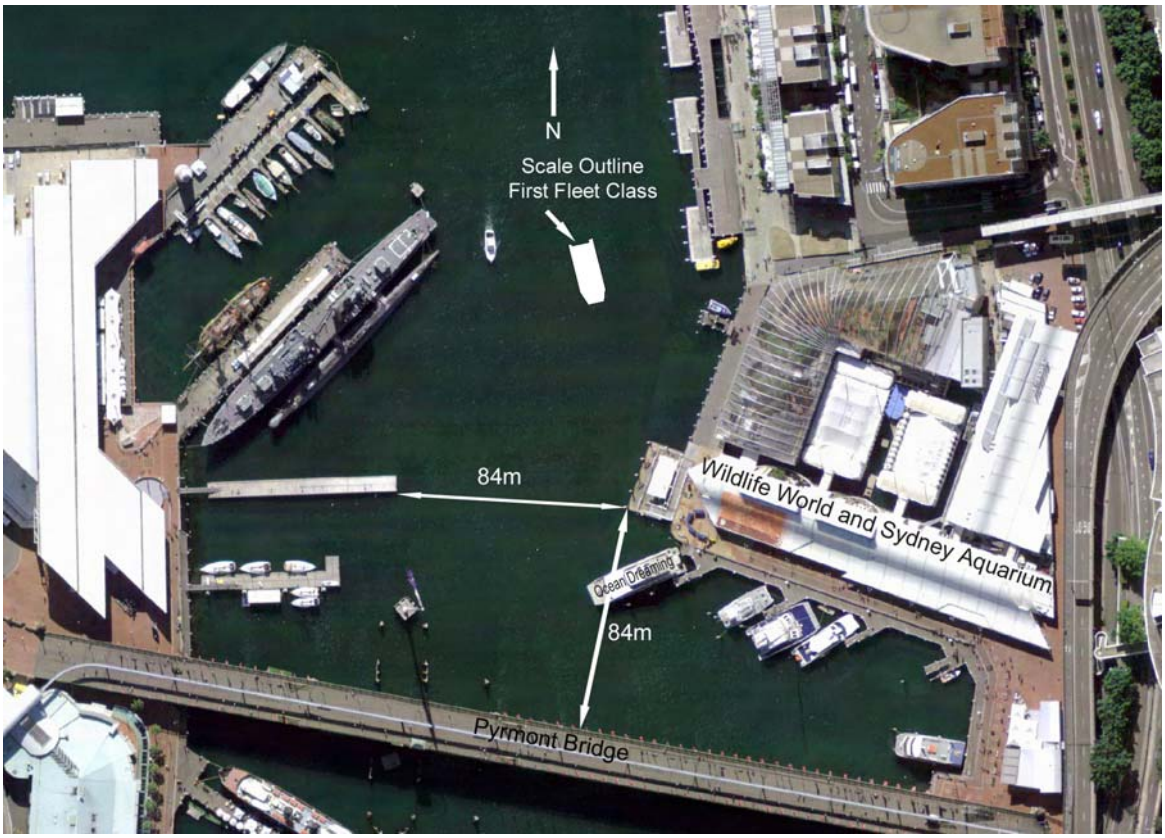
After the Collision

1.6 After the final of the three collisions, the Master re-started *Sirius* and manoeuvred it without further incident alongside the Aquarium Wharf. Thereafter he reported the incident, while the remainder of the crew moved amongst the passengers to determine whether any of them required assistance.

Location of the Collision

1.7 The Aquarium Wharf is situated approximately 84m North of Pyrmont Bridge. The wharf services vessels and passengers on the Eastern side of Darling Harbour's entertainment area and is located in the immediate vicinity of the Australia Zoo and the Sydney Aquarium. Significantly, the presence of a

pontoon opposite the wharf and the fact that there is limited clearance under Pyrmont Bridge restricts the manoeuvre of large vessels in this area. These major features and the extent to which they limit manoeuvre are depicted in *Photograph 2*.



Photograph 2: Overview of Accident Site

Vessel Information

1.8 *Sirius* was built in 1984 and is one of nine First Fleet class vessels operated by Sydney Ferries. First Fleet class vessels are twin-engine, propeller driven aluminium catamarans with a length of 25.4m and a beam of 10m. They have a displacement of 83 tonnes and are surveyed to carry up to 396 passengers. They operate at a service speed of approximately 12 knots (22km/h) and service Port Jackson, as far West as Meadowbank Wharf.

Crew Information

1.9 *Sirius* was crewed by a Master, Engineer, GPH and Cashier.

1.10 The Master commenced employment with Sydney Ferries in 1998 as a GPH. He obtained MED3 (Marine Engine Driver) and Master Class 4 qualifications in

2000 and 2003 respectively and was type-rated on the First Fleet Class in June 2005. At the time of the collisions, he held all of the requisite qualifications and endorsements. The Engineer joined Sydney Ferries in 1979 and was also appropriately qualified.

1.11 The Master was recorded as having no secondary employment and rostering records indicate that he had not been required to work on the two preceding days, but had worked three 12 hour day shifts prior to these days off, i.e., there was nothing to suggest that the Master could have been affected by any work-related form of fatigue. The crew had their allotted crib break at 8:30am and the Master was due to finish his shift at 2:25pm.

Medical and Toxicological Information

1.12 Drug and alcohol testing established that none of the crew of the *Sirius* was under the influence of illicit substances or alcohol.

Meteorological Information

1.13 The weather at the time was fine and the state of the current, tide and wind were such that they would not have impacted on vessel handling to any significant degree.

PART 2 ANALYSIS

Reason for the Loss of Control

2.1 Sydney Ferries' masters approach the Aquarium Wharf in a Southerly direction so as to bring the port side of their vessel alongside the wharf when berthing, and do so at approximately 5 knots. In order to come alongside on their starboard side, they would have to turn their vessel through 180° and while this can be achieved, it is a more complicated manoeuvre, with far greater consequences in the event of a control problem, because the channel is only some 84m wide in the immediate area.

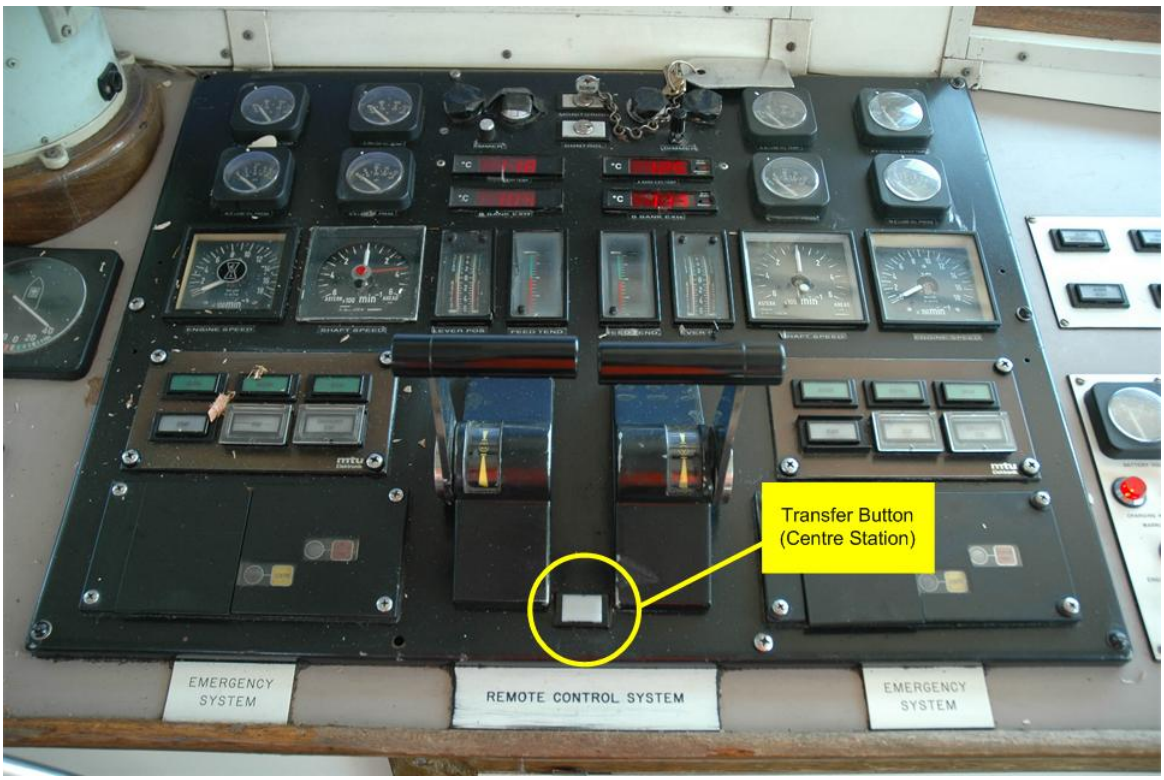
2.2 The Master stated that he experienced the loss of control after moving from the centre to the port control station in preparation for berthing at the Aquarium Wharf. Given that *Sirius* was able to be operated and to return to Balmain shipyard without incident following the collision, OTSI ruled out the possibility of a mechanical failure and focused on the other two possibilities: that there was some form of electrical malfunction within the ferry's control system, or that the Master erred in the process of transferring control from the centre to the port station.

Changing Control Stations

2.3 First Fleet vessels have port, centre and starboard control stations and the controls at each station relay a master's inputs to the engines, gearboxes and steering gear through electronic and hydraulic systems with microprocessors providing the interface between control positions and steering and propulsion systems. As a consequence, there is no direct mechanical link between the wheelhouse and the engines, gearboxes and rudders. The system controls are complemented with feedback in the form of gauges, alarms and indicators. A separate engine monitoring system, which does not affect the control of the vessel, is available at the engineer's console.

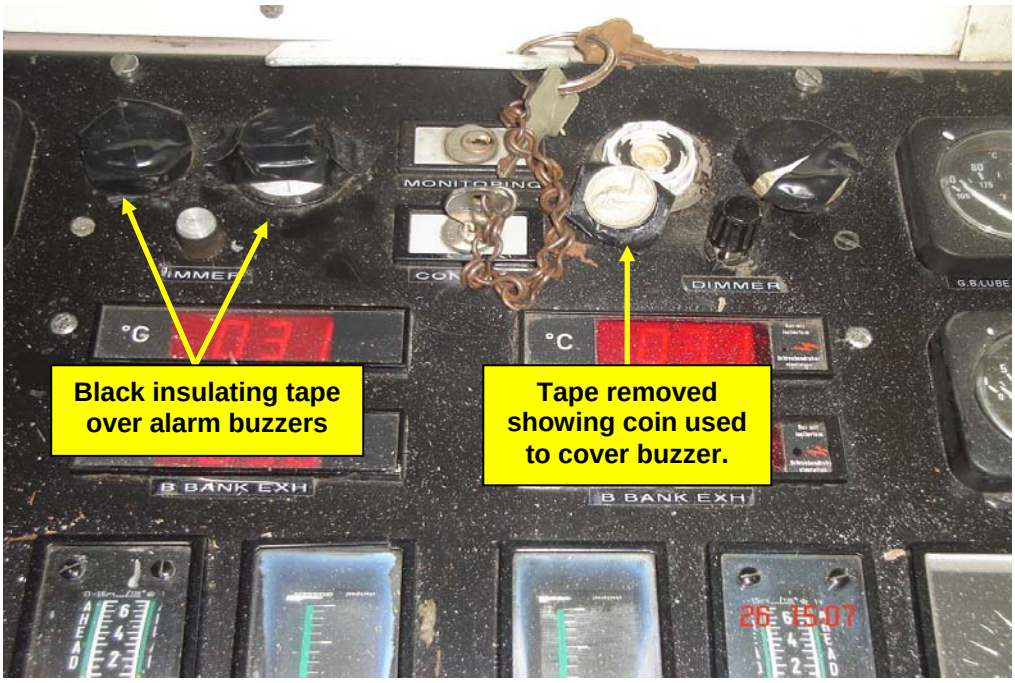
2.4 To switch control between stations, the master presses a button (*Photo 3*) to initiate transfer to another station and once in position at the new station, moves the controls until they are synchronised with the controls at the station

from which the transfer was initiated. Once the controls have been synchronised, the transfer process is complete.



Photograph 3: Transfer Button

2.5 When the request for transfer is initiated, an audible alarm is activated and this continues to sound until the transfer process is completed. When OTSI examined *Sirius*, it noted that the alarm's buzzer had been stuffed with paper and that coins had been taped over it with insulating tape, as can be seen in *Photograph 4*. Based on the appearance of the tape, this modification did not appear recent and it was clearly intended to dampen the intensity of the associated audio output which, at unmuffled full pitch, may have acted as a distraction to the crew. Subsequent to this incident, the audio alarm mechanisms have been rendered redundant through the installation of an automatic return to slow ahead after an incomplete change of stations.



Photograph 4: Control Station

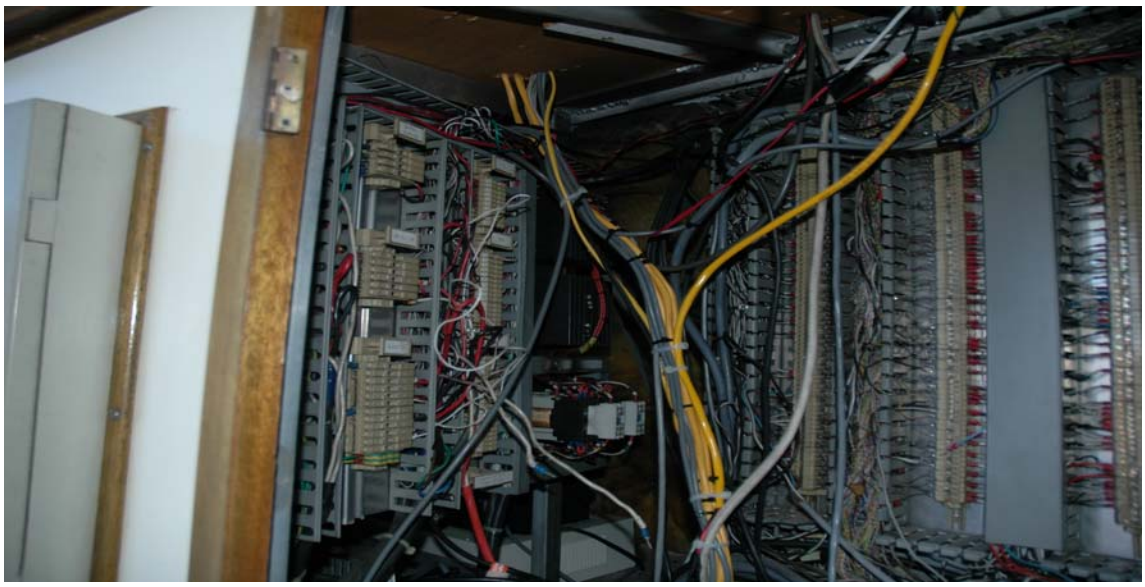
2.6 At the time the Master experienced the loss of control, a technician was repairing the CD player, which is part of the vessel's onboard audio system which includes the public address system. This work would not have impacted on the ferry's control system and, although he did not claim to have been distracted, the nearby presence of the Technician may have momentarily impacted on the Master's concentration at a critical stage in the process of transferring control from one station to another. Even if this was not the case, it raises questions as to the appropriateness of repair work being undertaken on the bridge while a vessel is in service.

Technical Issues

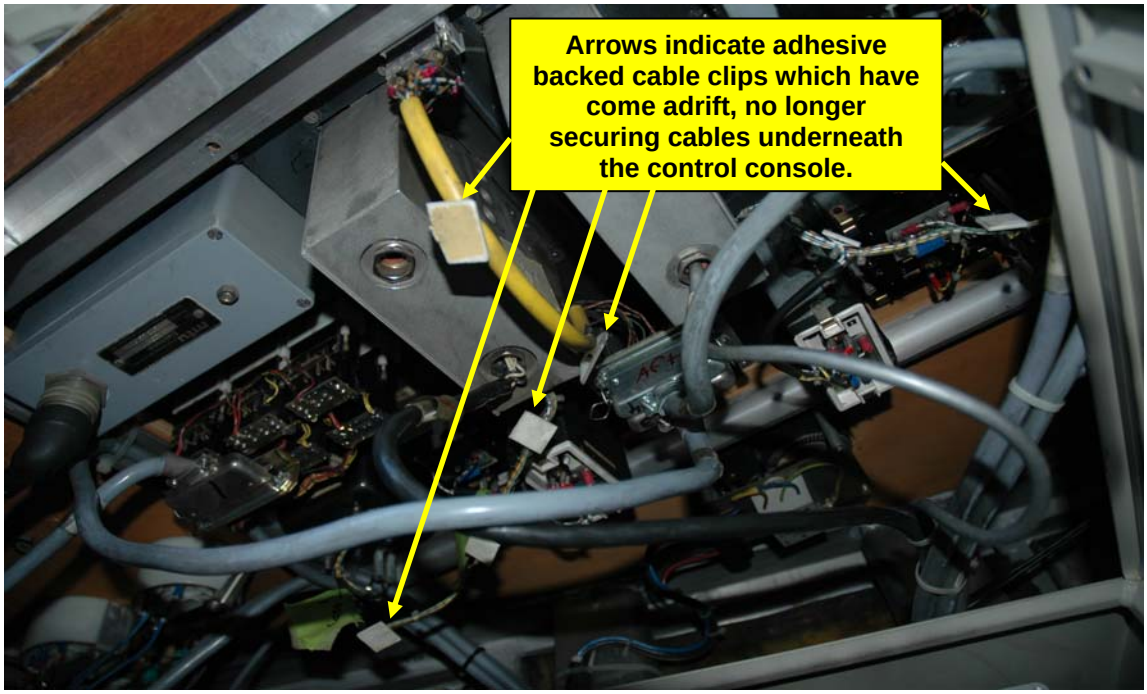
2.7 An examination of the locker spaces below the control console revealed that the general state of the vessel's wiring was sub-optimal. A variety of cables ran side-by-side, as can be seen in *Photograph 5,* carrying a variety of voltages and currents. The implications of running control system wiring among other potential sources of electromagnetic interference are that a false or interrupted signal which could affect the vessel's controls may be generated. In addition, much of the ferry's wiring is made of copper which is prone to metal fatigue if not properly secured. Unsupported lengths of cable also place stress on connectors and terminals and it was apparent that a

number of cable saddles, which are intended to reduce conductor fatigue and terminal stresses, had become detached from their mounting surfaces, as is shown in *Photograph 6.*

2.8 Despite the sub-optimal condition and routing of the control wiring, there were no recent instances of masters reporting a loss of control on *Sirius* and exhaustive testing of the system failed to replicate the circumstance described by the Master.



Photograph 5: Wiring underneath control console



Photograph 6: Poorly secured wiring

Adequacy of the Control System & Safety Defences

2.9 Notwithstanding OTSI's observations about the state of the ferry's wiring and the fact that more modern control systems have self diagnostic features and greater levels of redundancy, OTSI does not consider the control system onboard *Sirius* at the time of the accident to have been inherently flawed; indeed the First Fleet vessels are regarded within Sydney Ferries as being amongst the most reliable in its fleet. Nevertheless, Sydney Ferries has been progressively upgrading the vessels such that eight of the nine vessels in the class, including *Sirius*, now have new engines, gear boxes and control systems and have been fitted with voyage data recorders. Significantly, additional improvements which have replaced the audio alarm mechanisms include a timed return to slow ahead if control is not accepted after a transfer has been initiated.

2.10 The control system onboard *Sirius* at the time of the collisions was specifically designed to ensure that a master could not inadvertently transfer control from one station to another, and remains so. As previously indicated, it incorporated an alarm which commenced to sound when the transfer process was initiated and did not terminate until the process was completed. The fact that this alarm had been subject to unauthorised modification was readily apparent and would not have escaped the attention of other Masters and Engineers that were operating *Sirius* around the same time.

2.11 Masters move between control stations on a regular basis for the purpose of obtaining a clear view when berthing and there is no requirement for them to advise the engineer or any other crew member that they are transferring from one control station to another. However, masters are required to adopt certain vessel-specific practices when berthing at dead-end wharves. For First Fleet class, this includes having the Engineer at the ready to assist with the operation of backup controls if required. Aquarium Wharf is not defined as a dead-end wharf, however there is very limited room in which to manoeuvre in the event of a problem during berthing at this location. It is considered appropriate, therefore, that Sydney Ferries' masters should be required to approach Aquarium Wharf in the same manner as they would a dead-end wharf.

Adequacy of Response Actions

2.12 After the Master realised that he did not have control over the ferry, he had approximately 82m, or at five knots, 32 seconds in which to bring *Sirius* to a stop if he was to avoid colliding with some part of Pyrmont Bridge. His direction to the Engineer to stop both engines was both timely and appropriate and significantly reduced the consequences of the subsequent collision with the underneath of the bridge. OTSI noted that because the equipment that housed the PA system was being worked on at the time of the emergency, the Master was prevented from being able to broadcast a warning message to passengers, and this is another reason why OTSI considers that such work should not have been carried out while *Sirius* was in service.

2.13 Regardless of the possibility that his actions may have initiated the loss of control, the Master acted quickly and effectively in response to the situation, as did the rest of the crew.

2.14 As previously indicated, in the absence of injury and significant damage, an emergency response as such was not required, but NSW Maritime and Sydney Ferries did respond to the scene quickly.

2.15 Upon being made aware that the audio alarm on *Sirius* had been subjected to unauthorised modification, Sydney Ferries issued *Fleet Marine Circular 75* which instructed that masters should specifically check for and report such indications. While OTSI considers this to have been an appropriate action, the fact that it should have been necessary for Sydney Ferries to have issued such an instruction is disappointing given that its masters know that they are under a fundamental obligation to report any matter that impacts, or could impact on, a ferry's safety systems.

2.16 While the upgrade of First Fleet ferries was not in response to the Darling Harbour incident, it has significantly enhanced arrangements within the wheelhouse and revised wiring arrangements should reduce the possibility of electromagnetic interference to and within the control system. Replacement of the buzzer alarm with an automatic return to slow ahead after an incomplete change of stations provides an additional layer of defence.

Summary

2.17 The Master believes that the control system malfunctioned but extensive testing failed to identify any defects in the control system and could not replicate the failure. In the absence of evidence of electrical, mechanical or other technical defects causing the control system to malfunction, the loss of control is likely to have occurred when the Master relocated from the centre to the port station and inadvertently did not complete the procedure necessary to transfer control to the port station.

PART 3 FINDINGS

3.1 In relation to those matters prescribed by the Terms of Reference as the principal lines of inquiry, OTSI finds as follows:

a. Reason for the Loss of Control

i. OTSI could not definitively establish why the Master was unable to exercise control of the vessel after he moved to the port control station, but the two most likely causes were that there was either an electrical malfunction within the ferry's control system, or that the Master erred in the process of transferring control from the centre to the port station.

ii. The state of the control wiring onboard *Sirius,* particularly its routing, was sub-optimal. This raised the possibility that electromagnetic interference (EMI) could have contributed to a false control signal and a loss of control. However, exhaustive testing of the ferry's control electronics failed to replicate the fault condition described by the Master. Accordingly, OTSI considers that it is unlikely that the loss of control was a consequence of an electrical fault.

iii. It is more probable that the loss of control was a consequence of the Master attempting to control the vessel from the port station before he had completed the required procedures to effect the transfer of control from the centre station at which he had been operating.

iv. Although the Master did not claim to have been distracted, the nearby presence of a Technician who was working on the vessel's audio system may have momentarily impacted on his concentration at a critical stage in the process of transferring control from one station to another. Even if this was not the case, it raises questions as to the appropriateness of repair work being undertaken on the bridge while a vessel is in service.

b. Adequacy of the Vessel's Control System & Safety Defences

i. Sirius was built in 1984. While later control systems have become technologically more sophisticated, the ferry's control system is not inherently flawed. The control system onboard Sirius was engineered in a way that before the Master could transfer control from the centre to the port station, he first had to request a transfer, by pressing a button at the centre station, and then accept the transfer at the port station by synchronising its control levers with those at the centre station.

ii. In addition to the control system being designed in such a way that prevents the inadvertent transfer of control from one station to another, the system also incorporated an alarm that was activated when a request for transfer was initiated and terminated when the transfer was completed. This alarm was operational but had been interfered with to dampen its audio output; as a consequence, the alarm may not have been sufficiently loud for the Master to have heard it if he had not completed the control transfer process.

iii. *Sirius* was not fitted with a voyage data recorder at the time of the accident, but since has been. It was fitted with an engine monitoring system but this system did not record data which might have assisted OTSI to have confirmed or eliminated the possibility of false or intermittent signals being received by the control system, because the storage files on the floppy disk recording media were corrupted.

c. Adequacy of Response Actions

i. The Master reacted quickly to the loss of control by directing the Engineer to shut down the main engines to reduce the ferry's speed.

ii. In the absence of injury and major damage, an emergency response as such was not required, but representatives from NSW Maritime and Sydney Ferries responded to the scene

quickly and commenced to examine the vessel and to determine a recovery plan.

d. Other Operational and Safety Matters

Sydney Ferries' masters are required to adopt certain vessel-specific practices when berthing at dead-end wharves. Aquarium Wharf is not defined as a dead-end wharf but there is very limited room in which to manoeuvre in the event of a problem during berthing. OTSI considers that Sydney Ferries' masters should be required to approach this wharf in the same manner as they would a dead-end wharf.

PART 4 RECOMMENDATIONS

4.1 In order to prevent a recurrence of this type of accident, it is recommended that Sydney Ferries implements the following safety actions:

i. Require masters to regard the Aquarium Wharf at Darling Harbour as a ‘dead-end’ wharf and, accordingly, to employ the related berthing procedures at this location.

ii. Inspect all vessels on a regular basis to ensure that control and safety systems have not been subjected to any form of unauthorised modification.

iii. Work with crews to examine ways of replacing or modifying equipment that might act as a distraction, thereby reducing the prospect of safety systems being circumvented or subjected to unauthorised modification.

iv. Examine the appropriateness of allowing maintenance work to be performed from within the bridge or on any component that forms part of a vessel’s control or safety system while a vessel is in service.

PART 5 SOURCES AND SUBMISSIONS

Sources of Information

- NSW Maritime Authority
- Sydney Ferries Corporation

References

- *Passenger Transport Act 1990 (NSW)*

Submissions

The Chief investigator forwarded a copy of the Draft Report to the 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:

- NSW Maritime Authority
- Sydney Ferries Corporation
- Independent Transport Safety and Reliability Regulator (ITSRR)

Submissions were received from the following Directly Involved Parties:

- Sydney Ferries Corporation
- NSW Maritime Authority

ITSRR acknowledged the Draft Report but made no submissions about it.

The Chief Investigator considered all representations made by DIPs and where appropriate reflected those representations in this Final Report.