



Office of Transport Safety Investigations

## FERRY SAFETY INVESTIGATION REPORT

**COLLISION BETWEEN SYDNEY FERRIES'  
*BETTY CUTHBERT* AND TWO MOORED VESSELS**

**FERN BAY**

**11 JANUARY 2006**



# FERRY SAFETY INVESTIGATION REPORT

---

## COLLISION BETWEEN SYDNEY FERRIES' *BETTY CUTHBERT* AND TWO MOORED VESSELS

FERN BAY

11 JANUARY 2006

**OTSI File Ref: 03543**

**31 July 2006**

**Office of Transport Safety Investigations  
Level 17, 201 Elizabeth Street  
Sydney NSW 2000**

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.

Established on 1 January 2004 by the *Transport Administration Act 1988*, the Office 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.

OTSI investigations are conducted under powers conferred by the *Rail Safety Act 2002* 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. Where OTSI investigators exercise their powers of compulsion, information so obtained cannot be used by other agencies in any subsequent civil or criminal action against those persons providing information.

OTSI investigation reports are submitted to the Minister for Transport for tabling in both Houses of Parliament. Following tabling, OTSI reports are published on its website [www.otsi.nsw.gov.au](http://www.otsi.nsw.gov.au).

OTSI's investigative responsibilities do not extend to overseeing the implementation of recommendations it makes in its investigation reports. OTSI monitors the extent to which its recommendations have been accepted and acted upon through consultation with the relevant Transport Safety Regulator.

Information about OTSI is available on its website or from its offices at:

Level 17, 201 Elizabeth Street  
Sydney NSW 2000  
Tel: (02) 9322 9200

PO Box A2616  
Sydney South NSW 1235

The Office of Transport Safety Investigations also provides a Confidential Safety Information Reporting facility for rail, bus and ferry industry employees. The CSIRS reporting telephone number is 1800 180 828.

## TABLE OF CONTENTS

<b>TABLE OF PHOTOGRAPHS</b>	<b>v</b>
<b>TABLE OF FIGURES</b>	<b>v</b>
<b>GLOSSARY OF TERMS AND ABBREVIATIONS</b>	<b>vi</b>
<b>EXECUTIVE SUMMARY</b>	<b>viii</b>
<b>PART 1 INTRODUCTION</b>	<b>1</b>
Notification and Response	1
Initiation of Investigation	1
Terms of Reference	1
Interim Factual Statement	2
Methodology	2
Consultation	2
Investigation Report	3
<b>PART 2 FACTUAL INFORMATION</b>	<b>4</b>
Before the Collision	4
Collision Sequence	5
Emergency Response	6
Crew Information	7
Medical and Toxicology Information	7
Property Damage	7
Location Description	7
Environmental Conditions	8
Vessel	8
Operating Modes	13
Control	13
<b>PART 3 ANALYSIS</b>	<b>15</b>
Anticipation and Management of Risk and Emergency Management	21
Other Matters	24
Remedial Actions Taken by Sydney Ferries	25
Regulatory Action	26
<b>PART 4 FINDINGS</b>	<b>27</b>
<b>PART 5 RECOMMENDATIONS</b>	<b>28</b>

## TABLE OF PHOTOGRAPHS

Photograph 1:	Aerial Photograph showing <i>Betty Cuthbert's</i> 'track', with the 'uncommanded' turn into Fern Bay indicated in red	5
Photograph 2:	<i>Betty Cuthbert</i> with launch <i>BYO</i> at the collision site	6
Photograph 3:	Control Layout, showing the Port, Centre and Starboard control stations	9
Photograph 4:	A typical <i>Schottel</i> unit	12
Photograph 5:	Equipment stored under bridge console	15
Photograph 6:	Potential sources of interference	16
Photograph 7:	Poorly crimped terminals on the Port engine	18
Photograph 8:	Starboard potentiometer box with lid removed	19
Photograph 9:	Close view of wiring inside the potentiometer box	19
Photograph 10:	Red wire broken away from solder tab on connector block inside potentiometer box	20

## TABLE OF FIGURES

Figure 1:	Illustration of a <i>Schottel</i> Controller	10
Figure 2:	Illustration of Propulsion Settings	11
Figure 3:	Illustration of Steering Settings	14

## GLOSSARY OF TERMS AND ABBREVIATIONS

Bow	Front area of vessel
CCTV	Closed Circuit Television
CRM	Crew Resource Management. Training designed to ensure the use of all available resources to achieve safe and efficient operations by enhancing communication, teamwork and the capacity to respond to emergencies.
Ebb	Periodic seawater level falling due to decreasing tidal forces
Evolutions	Ferry crew training drills and procedures undertaken by SFC as programs forming part of its safety management system (SMS)
FAID	Fatigue Audit InterDyne™ is the name given to a range of fatigue risk management software, developed by InterDynamics Pty Ltd
Ferry	A vessel which carries more than 8 adult persons, as defined by the <i>Passenger Transport Act 1990</i> (NSW)
GPH	A General Purpose Hand, or Deckhand, is a duly qualified crewmember not engaged in navigational or engineering duties
ICAM	Incident Cause Analysis Method
ISM Code	International Safety Management Code .The purpose of this Code is to provide an international standard for the safe management and operation of ships and for prevention of pollution at sea. Promulgated by the International Maritime Organisation (IMO).
ITSRR	The Independent Transport Safety & Reliability Regulator NSW
Knot	Unit of speed: one nautical mile per hour, or about 1.85 km/h.
kW	Kilowatt
Lloyds	One of the international ship classification societies. Ship Classification is a system for safeguarding life, property and the environment at sea. Society approval entails verification of a vessel's criteria against a set of requirements during its design, construction and operation for purposes such as insurance.
NSW	New South Wales
OTSI	The Office of Transport Safety Investigations
PTA	<i>Passenger Transport Act 1990</i> (NSW)

Port	The left-hand side when facing forward on board a vessel
Public Passenger Service	The carriage of passengers for a fare or other consideration by means of a vessel within New South Wales waterways
RPM	Revolutions, of running equipment and machinery, Per Minute
SOPs	Standard Operating Procedures that are intended to standardise operations within and/or between organisations
Starboard	The right-hand side when facing forward on board a vessel
Stern	Rear area of vessel
SMS	Safety Management System
SFC	Sydney Ferries Corporation
TAA	<i>Transport Administration Act 1988 (NSW)</i>
USL Code	Uniform Shipping Laws Code. The current maritime standard applied throughout Australia in respect of safety matters and specifically vessel construction, equipment, crewing and operation
VOM	Vessel Operations Manual. The prime reference, issued by Sydney Ferries Corporation, containing technical information and operating instructions, for each class of ferries.

## EXECUTIVE SUMMARY

---

At approximately 7.27am on 11 January 2006, the Master of Sydney Ferries' RiverCat *Betty Cuthbert* noticed, during the first service run and while in the process of berthing at Homebush Wharf, that the Starboard *Schottel* propulsion unit felt less responsive than normal. The Master was able to berth the vessel without incident and having done so he advised Sydney Ferries' Operations Controller of his situation. After examining *Betty Cuthbert's* propulsion system, the Master then advised the Operations Controller of his intention to return the vessel to the shipyard at Balmain.

Before departing Homebush for Balmain at 7.33am, the Master, assisted by a GPH, locked the Starboard propulsion unit into a centred position. This meant that this propulsion unit provided thrust only and that the Master was dependent on the Port propulsion unit, rather than both units, for steering. The Master advised that he was able to proceed along the Parramatta River without difficulty until, at a point adjacent to Spectacle Island, *Betty Cuthbert* commenced an uncommanded and sharp turn to Port. The Master attempted to correct the turn, through steering inputs in the opposite direction, but was unable to regain control. He then shut down both engines but was unable to prevent a collision with a moored yacht and subsequently a moored motor launch named *BYO*.

## Findings

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

### a. **Causation**

The collision was the consequence of human error and occurred as *Betty Cuthbert* was being operated in a manner intended to compensate for a steering problem which had been encountered during an earlier berthing.



b. ***Appropriateness of the emergency response***

Sydney Ferries' response following the collision, and the subsequent recovery of *Betty Cuthbert* and the motor launch *BYO*, was appropriate.

c. ***Anticipation and management of risk***

- i. The risks associated with the Master's recovery plan were not recognised by the Master or the Sydney Ferries' Operations Controller.
- ii. *Betty Cuthbert* was not operated at an appropriate speed after it departed Homebush.
- iii. Wiring and stowage arrangements onboard *Betty Cuthbert* were inadequate.
- iv. Safety critical components onboard *Betty Cuthbert* were not readily identifiable as such.
- v. Sydney Ferries' quality assurance regime at Balmain Shipyard was inadequate.

d. ***Other issues that would enhance the safety of ferry operations***

The standard of radio communication employed between the Master and the Operations Controller, and in Sydney Ferries more generally, is below the standard required.

## Recommendations

To prevent recurrence of this type of ferry accident, it is recommended that Sydney Ferries undertake the remedial safety actions described below:

- a. enforce the requirement that Masters, having dealt with the immediate implications of a control failure or a suspected control failure, consult with shore-based engineering staff if they do not have access to an Engineer on board before attempting any fault rectification in situ;
- b. implement a quality assurance program to monitor the standard of work carried out by contract and shipyard staff and enhance, where appropriate, its in-house expertise in the areas of marine electrics and hydraulics;

- c. clearly identify safety critical components to assist in related inspection and maintenance processes, and
- d. develop and enforce the observance of radio communication protocols onboard, between vessels and with Operations Controllers.

## PART 1 INTRODUCTION

---

### Notification and Response

- 1.1 At 8.06am on 11 January 2006, the Office of Transport Safety Investigations' (OTSI) Duty Officer was notified by Sydney Ferries Corporation (SFC) that at about 8.02am *Betty Cuthbert*, a RiverCat class ferry, had collided with two moored vessels on the Parramatta River at Fern Bay.
- 1.2 Based on the information provided by the reporter, the Chief Investigator directed the deployment of an OTSI Investigating Officer to the incident site.

### Initiation of Investigation

- 1.3 As a result of the primary evidence collected by OTSI's Investigating Officer at the incident site, the Chief Investigator initiated a Ferry Safety Investigation in accordance with s46BA of the *Passenger Transport Act 1990*.
- 1.4 On 18 January 2006, the Chief Investigator notified all Directly Involved Parties (DIPs) that OTSI was investigating the collisions and requested that an officer be nominated in each organisation to act as the point of contact for all inquiries made by the appointed OTSI Investigator in Charge. The Terms of Reference for the Investigation were provided to the DIPs with this notification.

### Terms of Reference

- 1.5 The Chief Investigator established the following Terms of Reference to determine why the accident had occurred and what to do to prevent recurrence:
  - a. identify the factors, both primary and contributory, which caused the accident;

- b. identify whether the accident might have been anticipated and assess the effectiveness of any strategies that were in place to manage the related risk/s;
- c. assess the effectiveness of emergency actions in response to the accident, and
- d. advise on any matters arising from the investigation that would enhance the safety of ferry operations.

## **Interim Factual Statement**

- 1.6 An Interim Factual Statement notifying OTSI's investigation and describing the incident in terms of what had happened was published on the OTSI website on 16 January 2006.

## **Methodology**

- 1.7 OTSI utilises the ICAM (Incident Cause Analysis Method) approach in the conduct of its investigations and applies the Reason Model of Active Failures and Latent Conditions to its analysis of causative and contributory factors.
- 1.8 The underlying feature of the methodology is the "Just Culture" principle with its focus on safety outcomes rather than the attribution of blame or liability.

## **Consultation**

- 1.9 On 29 June 2006, a copy of the investigation Draft Report was forwarded to the Sydney Ferries Corporation, the NSW Maritime Authority and the Independent Transport Safety and Reliability Regulator (ITSRR). The purpose was to provide all DIPs with the opportunity to contribute to the compilation of this Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and providing any commentary that would enhance the structure, substance, integrity and resilience of the Investigation Report. DIPs were requested to submit their

comments by 14 July 2006. Submissions were received from Sydney Ferries Corporation and the NSW Maritime Authority.

- 1.10 The Chief Investigator considered all representations made by DIPs and where appropriate, reflected their advice in this Final Report. On 19 July 2006, the Chief Investigator informed DIPs which matters from their submissions had been incorporated in this Final Report and where any proposal was excluded, the reasons for doing so.

## **Investigation Report**

- 1.11 This report describes the collisions which occurred at 8.02am on 11 January 2006 and explains why they occurred. The recommendations that are made are designed to contribute to the maintenance of safe ferry operations and to minimise the potential for a recurrence of this type of accident.

## PART 2 FACTUAL INFORMATION

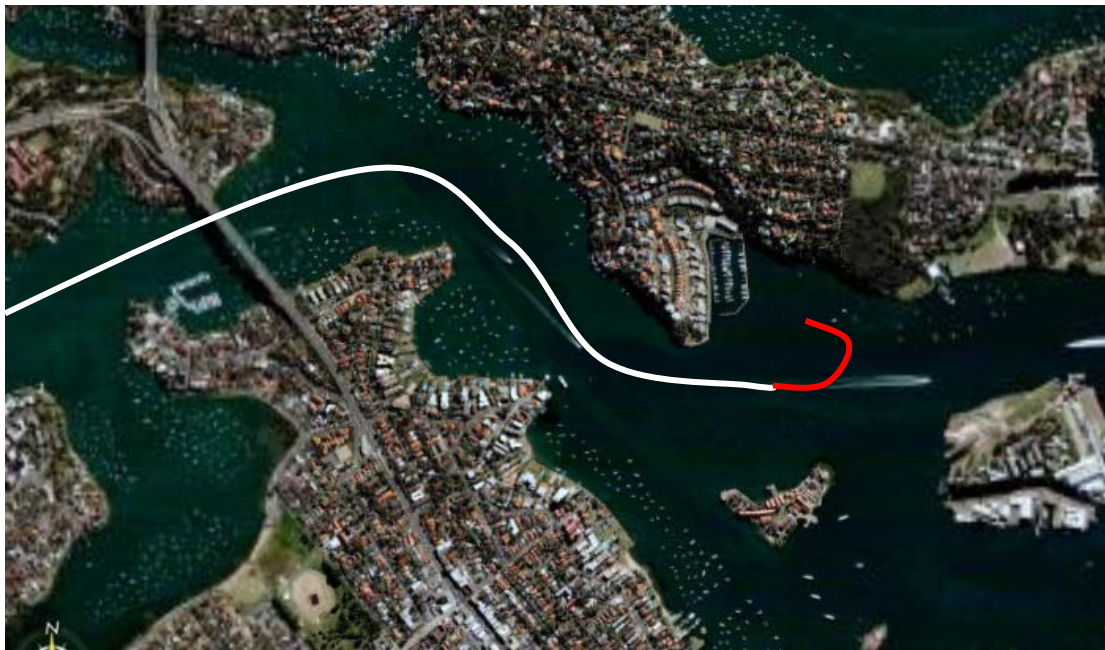
---

### Before the Collision

- 2.1 On the morning of Wednesday 11 January 2005, Sydney Ferries' RiverCat *Betty Cuthbert* left the Balmain Shipyard to commence regular passenger services and subsequently picked up several passengers and an additional crew member at Circular Quay. It then proceeded to Abbotsford and Meadowbank without incident. On reaching the wharf at Homebush, the Master commenced a turn to Port and in the process felt that the Starboard controller was stiffer and less responsive than normal.
- 2.2 The Master notified Sydney Ferries' Operations Controller that he had encountered a problem with the Starboard propulsion unit and that he was inspecting the unit to determine the exact nature of the problem. The Master subsequently found that a warning indicator on the Starboard *Schottel* control panel had been activated. During an examination of *Betty Cuthbert's* propulsion system, the Master determined that the Starboard propulsion unit could be steered via a hydraulic valve in the engine compartment, but not from the normal steering position in the wheelhouse.
- 2.3 Assisted by a General Purpose Hand (GPH) who monitored the Starboard thrust indicator on instrumentation in the wheelhouse, the Master turned the Starboard propulsion unit hydraulically, from within the engine compartment, to the straight ahead/centred position. The GPH confirmed, via radio, that the thrust indicator reflected a centred setting. The Master then advised the SFC Operations Controller that he intended to proceed to Balmain Shipyard with the Starboard propulsion unit locked in a centred position. The Operations Controller acknowledged this communication.
- 2.4 CCTV footage captured at Homebush showed *Betty Cuthbert* arriving at 7.26am, disembarking eight passengers and subsequently departing Homebush at 7.33am.

## Collision Sequence

- 2.5 The Master advised that the ferry responded normally to steering and throttle control inputs as he proceeded at the normal operating speed, which varies between 14 and 23 knots, along the Parramatta River. After passing Pulpit Point to his left and approaching Spectacle Island on his right, the vessel made an uncommanded turn to Port. The Master attempted to correct the turn by steering in the opposite direction and reducing throttle settings, but the vessel did not respond to his steering inputs. He shut the engines down but in the process *Betty Cuthbert* collided with a moored yacht and subsequently a moored motor vessel named *BYO*. *Photograph 1* depicts the approximate 'track' of *Betty Cuthbert*, as indicated by the Master.



**Photograph 1: Aerial Photograph showing *Betty Cuthbert*'s 'track', with the 'uncommanded' turn into Fern Bay indicated in Red**

- 2.6 As a result of the collision, the motor vessel *BYO* became wedged between the forward sections of both hulls of *Betty Cuthbert*, as depicted in *Photograph 2*.



Photograph 2: *Betty Cuthbert* with launch *BYO* at the collision site

## Emergency Response

- 2.7 An initial assessment by the Master confirmed that there were no persons onboard the moored vessels and that *Betty Cuthbert* had not sustained major structural damage.
- 2.8 Having been notified by the Master, Sydney Ferries informed Harbour Control, relevant emergency services, OTSI and the NSW Maritime Authority of the collisions. The Water Police and NSW Maritime's investigators attended the scene and Sydney Ferries subsequently towed *Betty Cuthbert*, with *BYO* still wedged between its hulls, back to Balmain.
- 2.9 Sydney Ferries' responded to the collision and the subsequent requirement to recover *Betty Cuthbert*, entangled with *BYO*, appropriately.



## Crew Information

2.10 At the time of the collision, *Betty Cuthbert* had a crew of three; the Master and two GPHs, one of whom was functioning as a cashier. The Master held a Master Class 4 qualification and a Marine Engine Driver 2 Certificate and had qualified to operate RiverCats in 2003. Prior to obtaining this qualification, he had qualified on the First Fleet, Harbour Cat, JetCat and SuperCat classes. The two GPHs held the appropriate endorsement from the NSW Maritime Authority.

## Medical and Toxicology Information

2.11 NSW Water Police breath-tested *Betty Cuthbert's* three crew members, all of whom returned negative results. The crew was also drug tested in accordance with Sydney Ferries' drug and alcohol policy, and the results were again negative.

## Property Damage

2.12 There was little damage to the first vessel struck by *Betty Cuthbert*. However, the second vessel struck, the motor launch *BYO*, sustained substantial damage. *Betty Cuthbert* received minor damage, mostly confined to a non-structural bow tarpaulin.

## Location Description

2.13 The collisions occurred in Fern Bay which lies on the Southern side of the Woolwich Peninsula. There is a marina at the Western end and several moorings within the bay. The distance between the Western end of the bay, known as Pulpit Point, and Spectacle Island is approximately 400m.

## Environmental Conditions

- 2.14 The weather on the morning of the collision was fine and clear, with a slight breeze from the South and a temperature of around 24°C. The tide was on the ebb, with the high tide occurring earlier, at approximately 6.00am. As such, the weather and tidal conditions are not considered to have contributed to the collisions.

## Vessel

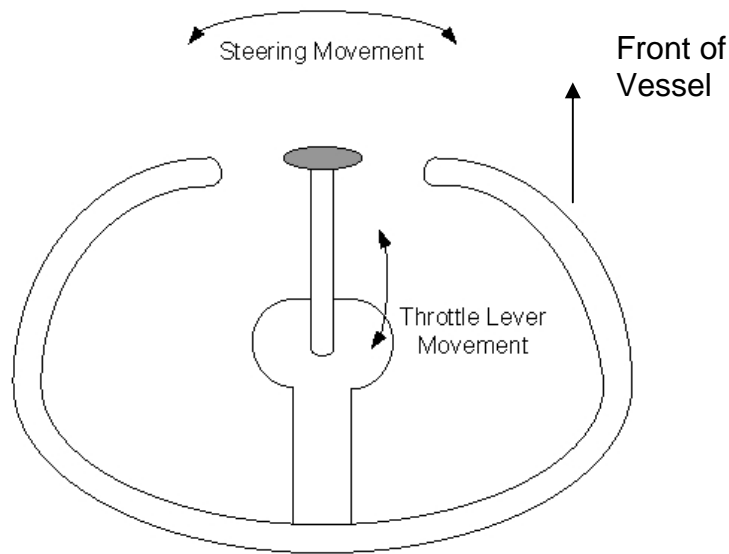
- 2.15 *Betty Cuthbert* is one of seven RiverCat class ferries operated by Sydney Ferries. RiverCats are aluminium catamarans measuring 36.8m in length and 10.5m in width. They have a displacement of 58 tonnes, are surveyed to carry 230 passengers and are designed for high speed operations in calm waters.
- 2.16 RiverCats are propelled by twin *Schottel* rudder propeller units, powered by two GM (General Motors) supercharged and turbocharged V8 diesel engines. The engines are fitted with a solenoid which shuts the engines down when required, by cutting the supply of fuel. A second solenoid is used as a separate emergency shut down.
- 2.17 The power from the engines is transmitted to the *Schottel* propulsion units via hydraulic gearboxes with a 2:1 reduction and an electronically operated clutch. The engines idle at around 600rpm and are governed to a maximum speed of 2000rpm. Given the gearbox reduction, this means that the propeller shaft revolves within the range of 200-1000rpm.
- 2.18 Power is transmitted from the engine to the propulsion units through shafts on a horizontal plane above deck then transferred through gears to a vertical shaft and back to a horizontal shaft below the water line to the propellers. The propulsion units are able to pivot around the horizontal axis below the water line, creating directional thrust. The propellers are constant pitch, variable speed and uni-directional. Turning a propulsion unit 180° provides

thrust in the opposite direction, with movement in between these positions controlling steering. The two propulsion units provide a Master with a high degree of manoeuvrability as both thrust and direction can be independently controlled on each unit.

- 2.19 The wheelhouse has three stations for controlling the vessel: Port, Centre and Starboard. Each station has a pair of controllers consisting of a 360° rotatable semi-circular wheel and throttle lever, one for each *Schottel* unit (see *Photograph 3* and *Figure 1*). Movement of the controller clockwise will turn the associated propulsion unit anti-clockwise, inducing a turn to Port. Turning the controller to face rearwards will command astern thrust. Turning the controller to face forward will command ahead thrust.

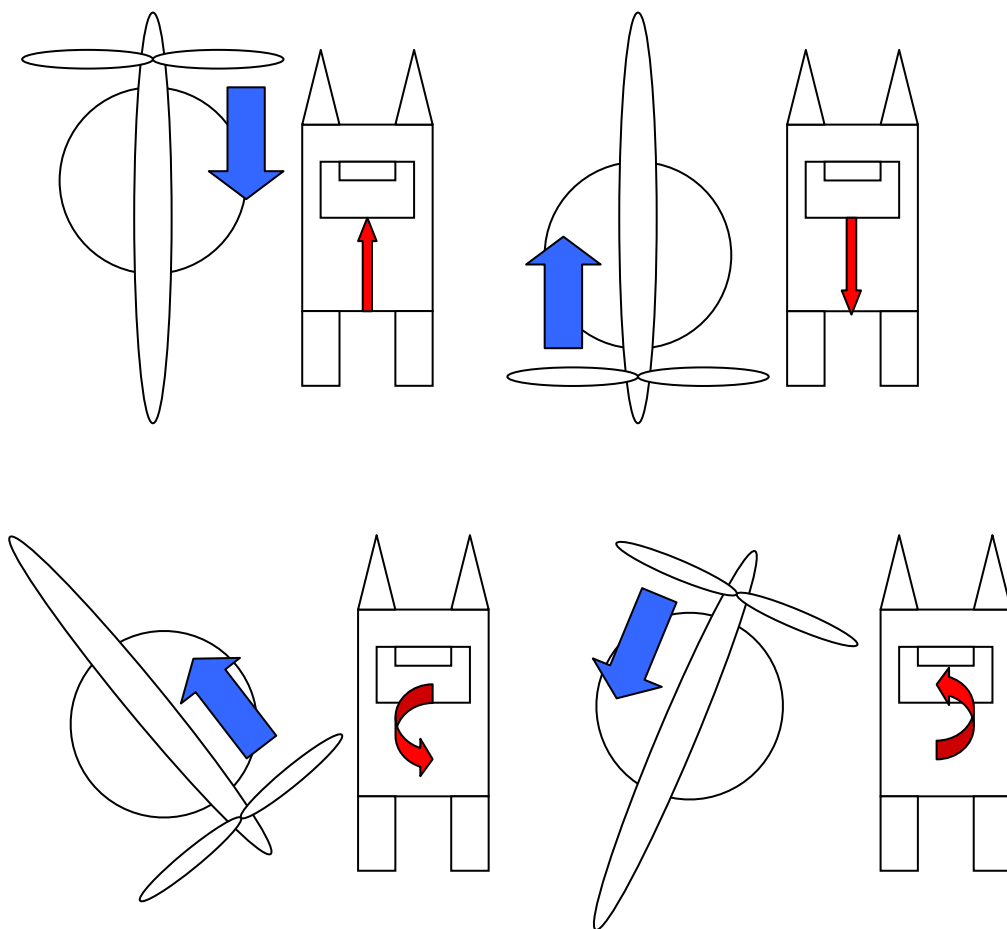


**Photograph 3: Control Layout, showing the Port, Centre and Starboard control stations**



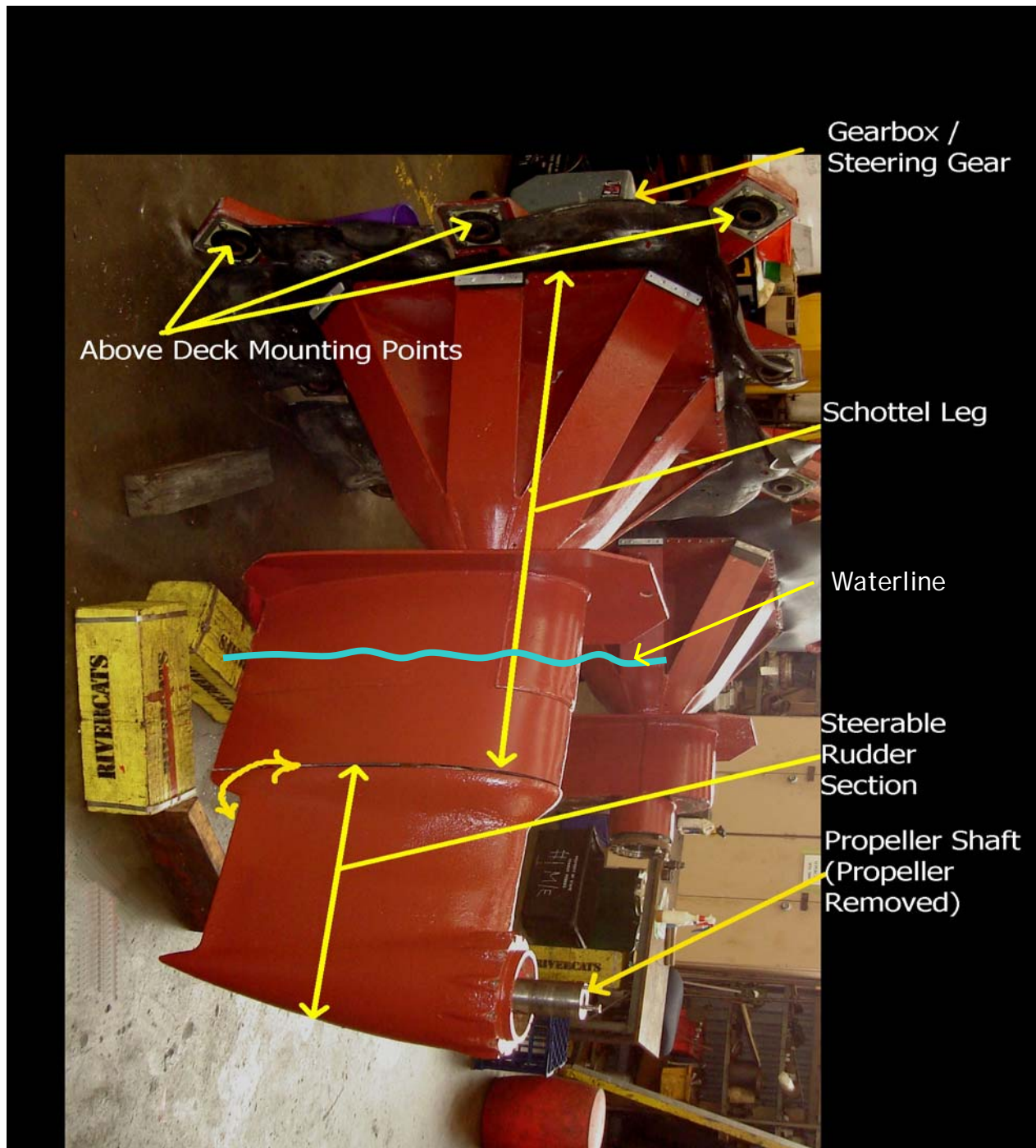
**Figure 1: Illustration of a *Schottel* Controller**

- 2.20 The throttle levers slide back and forward and move in unison with the controller. Sliding the throttle forward will engage the clutch and further movement increases the rpm of the related engine. When the throttle lever is fully reversed, the clutch remains disengaged and the engine is set to idle speed.
- 2.21 Synchronous movement between the *Schottel* controllers across all three stations is achieved by a series of shafts and gearboxes. However, only the centre controls have potentiometers and micro-switches to measure control inputs and provide signals to the engines and propulsion units. The propulsion units resemble an outboard motor that can rotated through 360°. *Figure 2* illustrates the relationship between the position of the propulsion units which pull, rather than push, the vessel through water, and a vessel's response, with the blue and red arrows indicating respectively, the direction of thrust and the vessel's reaction to this thrust. For ease of illustration, only one unit is shown.



**Figure 2: Illustration of propulsion settings**

Photograph 4 shows the major components of a typical *Schottel* unit.



**Photograph 4: A typical *Schottel* unit**

- 2.22 In normal steering circumstances, the Master will generally make minor course variations by using the power from one propulsion unit, while thrust is provided from both. To turn the vessel with maximum efficiency, both controller units are turned in unison. Manipulation of each controller unit independently can provide lateral manoeuvring, crabbing and holding thrust.

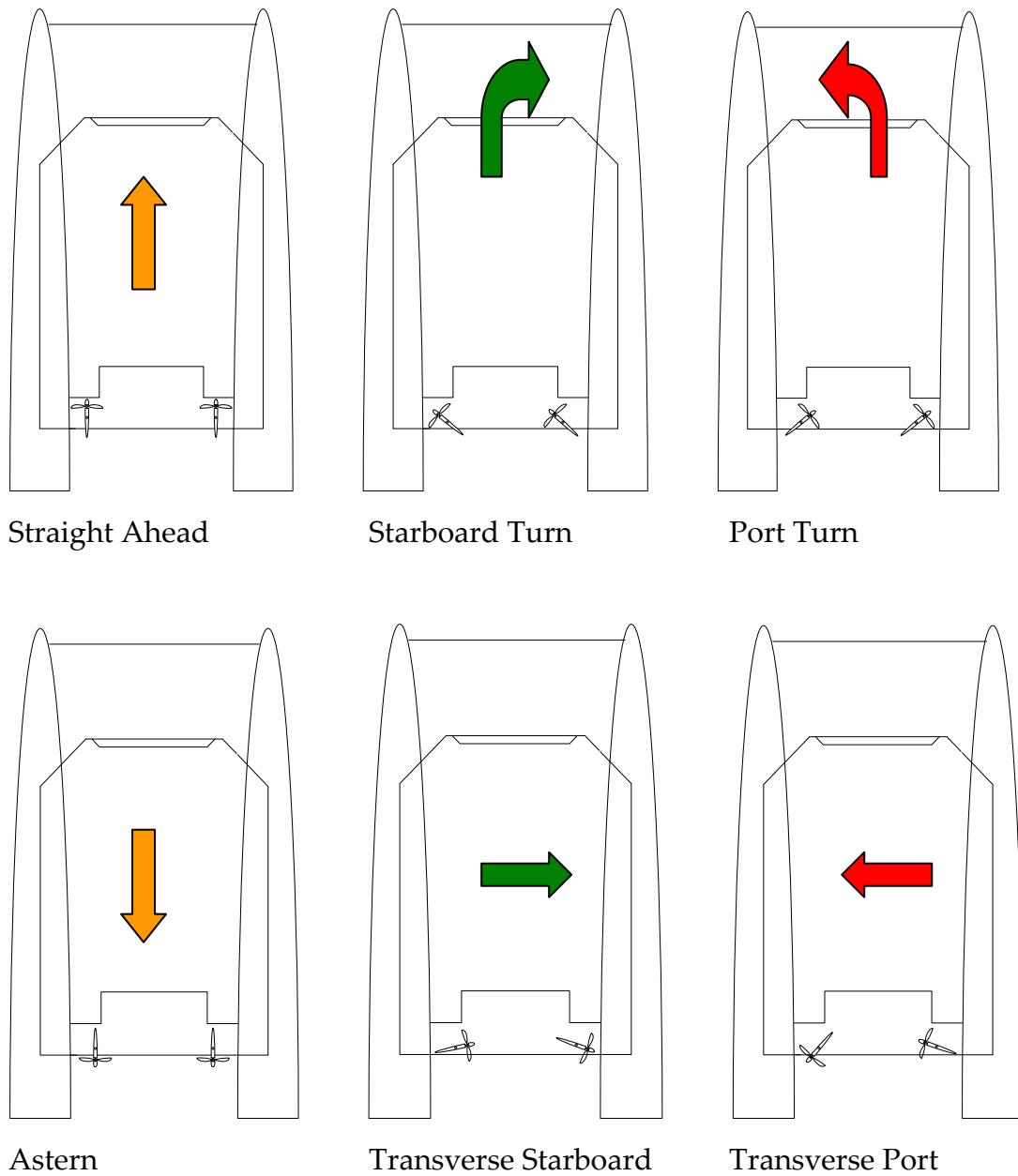
## Operating Modes

- 2.23 The vessel is capable of being operated in a Back-up mode for throttle, steering or both combined, with each system offering a level of redundancy by bypassing normal control circuitry. The clutches can be set to *engaged*, *disengaged* or *automatic*. Back-up steering is achieved by turning a normally-centred switch to the left or right which rotates the corresponding propulsion unit. Throttle control in this mode is via a switch for each engine.

## Control

- 2.24 When manoeuvring into and out of a berthing, the Master controls the vessel with the controller for each side's propulsion unit from the Centre, Port or Starboard station, manipulating the controllers to control vessel speed and direction. At higher speeds, the Master will generally use only one controller, commonly the right-hand controller for right-handed Masters and the left-handed controller for left-handed Masters. As illustrated in *Figure 3*, the Master will turn both controllers around 180° to pull the vessel astern and use variations in positions of each controller to obtain the desired vessel movement. Controlling a vessel with two controllers is challenging initially, but Masters generally adapt quickly to the RiverCat's control configuration.





**Figure 3: Illustration of Steering Settings**



## PART 3 ANALYSIS

---

3.1 OTSI sought to establish whether there was any connection between the Master's earlier report of a less than responsive Starboard propulsion unit and the subsequent uncommanded turn to Port. The excessive stiffness of the steering reported by the Master would have to have been the consequence of excessive friction or interference at the mechanical linkages or the controllers on the bridge, as there are no mechanical connections between the bridge and the engines or the propulsion units. OTSI's examination of the related areas identified a number of potential sources of interference. The area below the bridge console was readily accessed via a locker door and as illustrated in *Photo 5*, this area was used for storage. *Photo 6* shows points at which mechanical movement might have been obstructed or limited by stored items.



**Photograph 5: Equipment stored under bridge console**



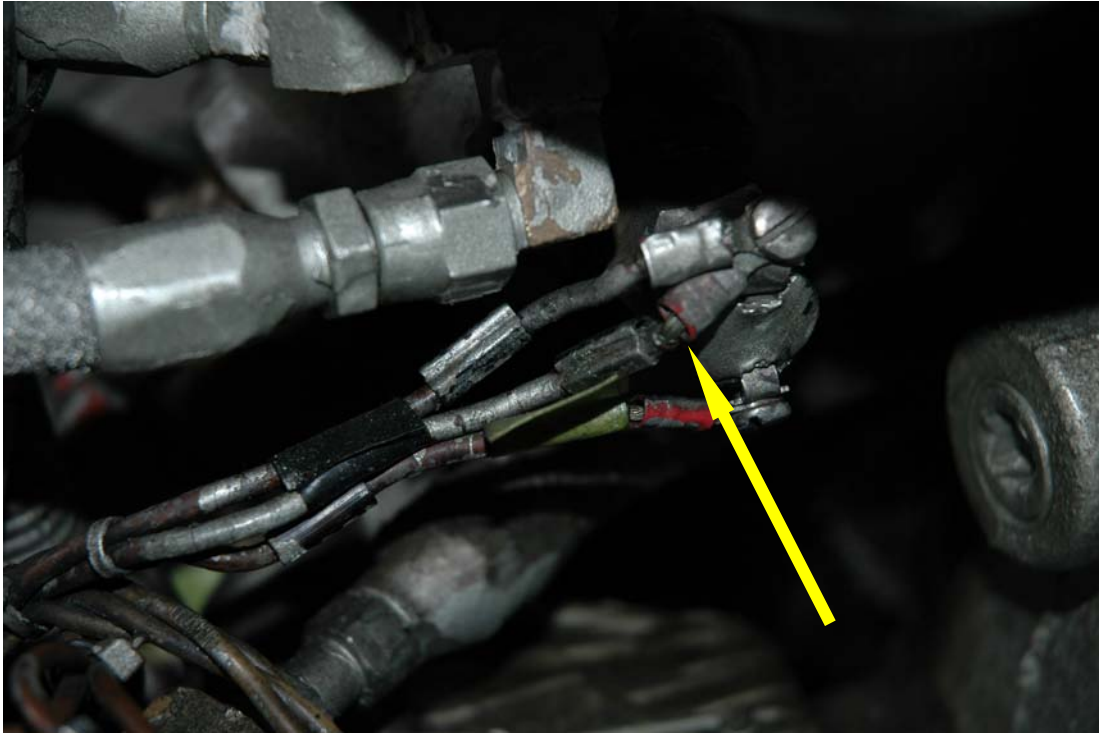
**Photograph 6: Potential sources of interference**

- 3.2 The steering and propulsion systems for both engines were subsequently examined. Oil samples were taken from both engines, both main engine gearboxes and both steering hydraulic systems prior to *Betty Cuthbert* being moved from the scene of the collision.
- 3.3 The ‘fault tree’ methodology was employed to determine what might have triggered the uncommanded turn and the following four scenarios were identified:
- a. a shutdown or loss of drive from the Port main engine, causing the vessel to turn to Port due to an imbalance of thrust created by the Starboard main engine still powering the vessel, resulting from:
    - i. the failure or disengagement of the port main engine clutch;
    - ii. the failure of the *Schottel* unit gearbox, or
    - iii. an engine failure or shutdown;
  - b. a dramatic differential in thrust between the Port and Starboard units;

- c. the Port hull or propulsion being snagged on mooring lines or other objects, or
- d. either or both propulsion units being turned in a clockwise direction, inducing a turn to Port.

3.4 During the initial examination of *Betty Cuthbert* at the scene, the Port propulsion unit was found to be facing approximately 30° anti-clockwise, with the Starboard unit facing straight ahead. Given that the Master advised that he shut both engines down immediately prior to the collision, it would be reasonable to assume that this alignment of the propulsion units was indicative of their position immediately prior to impact, as once the engines were stopped, there would have been insufficient hydraulic pressure to have rotated the propulsion units.

3.5 Whilst pursuing the possibility that the Port engine had shut down, some wiring on the engine's protection system, which automatically shuts down the engine in the event of a loss of oil pressure or overheating, was found to be in poor condition. Specifically, wiring on some crimped terminals and spade connectors to the oil pressure switch was loose and in some instances, poorly insulated, as indicated in *Photograph 7*. The condition of the wiring on the Port engine could be partly attributed to its age and the combined effects of heat, vibration and oil contamination. However, OTSI also noted that the type of connector, routing of wiring and the method of crimping and connection could also have contributed to malfunctions. Further investigation revealed that the engine protection circuit had also been bypassed at some time. On the other hand, OTSI noted that the Starboard engine had recently been replaced and the associated wiring was more adequately secured.



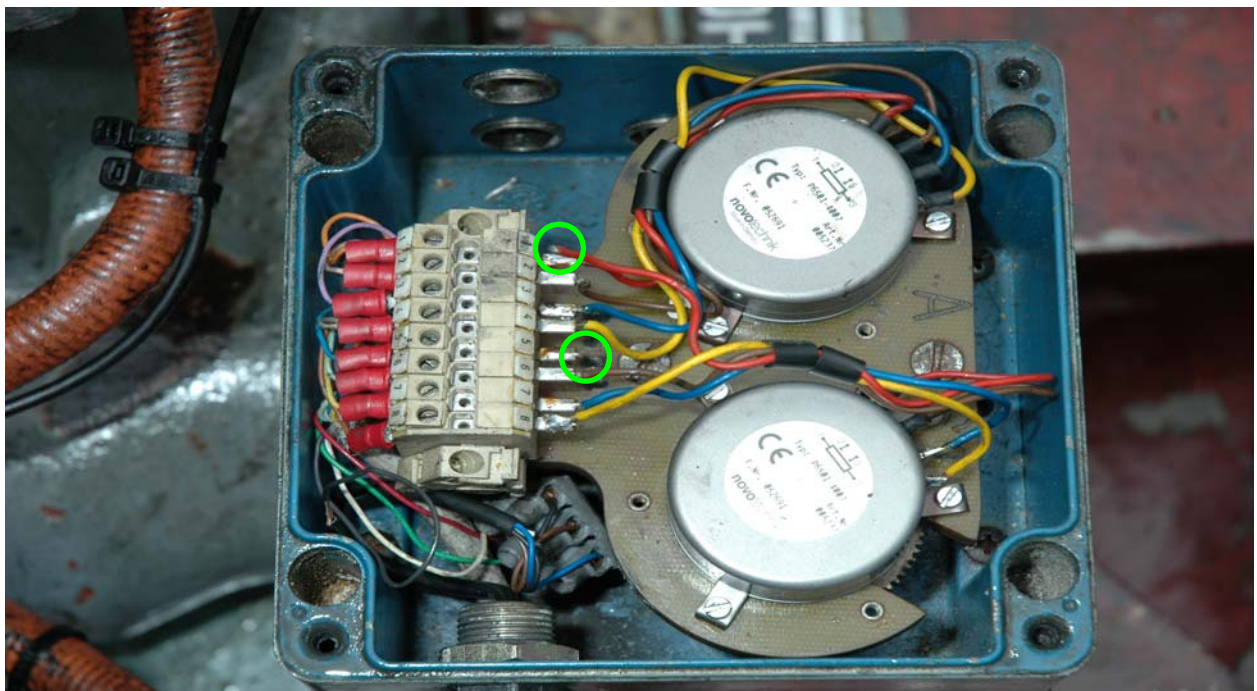
**Photograph 7: Poorly crimped terminals on the Port engine**

- 3.6 On examining the Starboard engine, it was found that the 'rose' joint securing the Morse™ cable at the engine end of the Speedtronic™ engine speed controller was loose. During trials, it was established that this condition caused the Starboard engine to idle at approximately 850rpm compared to 650rpm at the Port engine. However, the trials also established that this was insufficient to have induced the uncommanded turn.
- 3.7 During preparation for the trials, an alarm on the Starboard propulsion unit was found to be activated. An electrician subsequently located a broken wire inside the feedback potentiometer box (see *Photographs 8 -10*).

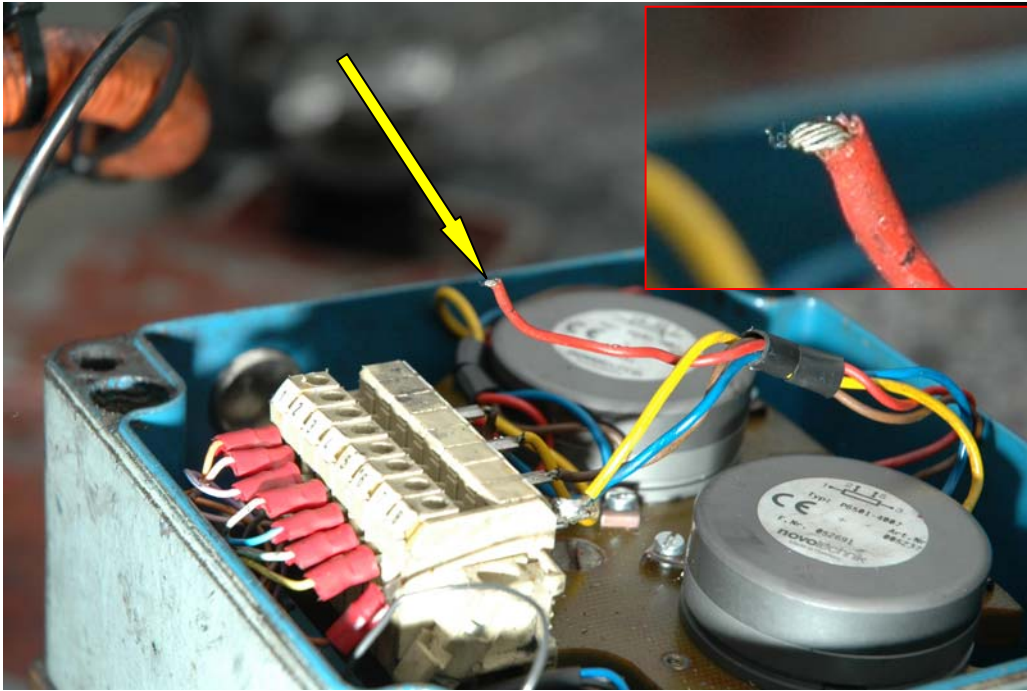




Photograph 8: Starboard potentiometer box with lid removed



Photograph 9: Close view of wiring inside the potentiometer box



**Photograph 10: Red wire broken away from solder tab on connector block inside potentiometer box**

- 3.9 When the wire was re-soldered, the alarm was de-activated and the controls responded normally. During trials, the same wire was deliberately disconnected several times and on each occasion the Starboard propulsion unit rotated approximately 15° in an anti-clockwise direction, initiating a turn to Starboard. Once rotated, the propulsion unit essentially remained locked in that position. However, throttle control could still be achieved. With the Starboard propulsion locked in such a position, the effect was to induce a turn to Starboard. This allowed OTSI to discount the possibility that the disconnected wire induced the uncommanded turn to Port. However, it did explain the unresponsive steering that the Master experienced whilst berthing at Homebush.
- 3.10 Using the fault tree methodology, all but one of the possible causes of a sudden turn to Port were re-created during trials. The one scenario not re-created, and for obvious reasons, was that of the hull or a propulsion unit being snagged. The trials established that the use of a single propulsion unit for steering increased the turning radius of the vessel and that steering was generally less responsive. The operation of the vessel with the Starboard

propulsion unit providing only straight ahead thrust, while steering via the Port propulsion unit, required continual steering corrections. Any tendency to over-correction, using the available Port controller, induced a tighter than expected turn. Significantly, nothing other than steering inputs during these scenarios induced a hard turn to Port. Steering the vessel in this configuration was markedly different and required significant concentration, especially when operating the vessel at, or close to, its normal operating speed.

- 3.11 The Master had a number of options open to him following the initial control problem at Homebush. They included securing *Betty Cuthbert* and seeking assistance from engineering staff; reverting to Back-up mode; seeking to be recovered and/or escorted back to Balmain and operating at a significantly reduced speed back to Balmain. Instead, the Master decided to operate the ferry at normal speed but with steering available on only one propulsion unit. His decision was based on the belief that this course was the most efficient method of recovery and that the vessel would be more responsive at speed and with both engines providing thrust. However, he did not appreciate that the vessel's handling characteristics would be so markedly different with the Starboard propulsion unit centred, nor the risks associated with operating at normal speed in such a configuration.

## **Anticipation and Management of Risk and Emergency Management**

- 3.12 The Master's decision to disembark passengers at Homebush after the initial onset of control problems was entirely appropriate. OTSI believes, however, that the Master's subsequent decision to operate the *Betty Cuthbert* in the manner he did, was not the most appropriate course of action .
- 3.13 The following transcript, taken from voice recordings between the Master (M) and the Operations Controller (OC) following the initial steering problem reveal that, at no stage, did the Operations Controller (OC) attempt to influence the course of action proposed by the Master (M), or to propose additional safety precautions ( in the following transcript the Master's and

Operations Controller's names have been deleted and replaced with the characters # and \* respectively ).

**M:** Control *Cuthbert*.

**OC:** Yeah go ahead #.

**M:** Yeah, \*, Um, we just lost our ah starboard *Schottel*, I don't know what's happened, but um, doesn't seem to be working

**OC:** Where are you #?

**M:** Homebush, I'll just go down the back and have a look and um see what the story is, I'll get back to you.

**OC:** Okay mate.

**M:** Control *Dawn Fr*, um *Cuthbert*,

**OC:** Yeah go ahead #.

**M:** Yeah um, there's two alarms up down there on the *Schottel* thing, we can turn in manually from the engine room but we can't turn it from up in the wheelhouse, so um we'll take it back to the yard I spose.

**OC:** Well I would say she's not a boat at the moment

**M:** No, no it's not a boat (OTSI comment: Meaning that the vessel could no longer be considered as serviceable)

**OC:** Don't know why you took the bloody thing into service. Alright mate, get it back to Balmain and we'll see what we can do.

**M:** Okay.

**OC:** #, you got any passengers on board there?

**M:** Yeah got one bloke, we're just um putting him off at um, what is it, Homebush.

**OC:** Alright, so you're ready to come downstream aren't you?

**M:** We're ready to go, yeah one guy at Homebush who needs a lift.

**OC:** Alright you've got the seven forty five coming down behind you mate it's all we've got at the moment.

**M:** Um, ferry control, *Betty Cuthbert*



**OC:** *Betty Cuthbert*

**M:** Um we've just gone out of control and um just ran over a boat, there was no one on it, it was on a mooring. We're um, just near um Spectacle Island, okay.

**OC:** Alright #, are you, you okay?

**M:** Yeah, yeah um, yeah, yeah I'm okay.

**OC:** Alright do you wanna, is there anywhere you can stop there and I'll get the ah *Dawn Fraser* to come up and meet you

**M:** Mate, we sank this boat, um, ah, it's about a thirty five foot cruiser or something, um, I don't know if there's any damage to the boat, to our boat

**OC:** Just stand by.

**M:** Control *Betty Cuthbert*

**OC:** Yeah *Cuthbert*

**M:** This is wedged under us about a third of the way up, it's still upright, um, most probably need the water police and a tug to come um and take us off this and tow us back. I've shut the whole thing down, don't need an anchor 'cause it's holding us in place, so ah, yeah.

**OC:** Alright #, I'll get everybody up to you as quickly as we can mate. Just stand by, stand by #.

- 3.14 OTSI does not propose that Operations Controllers should override Master's decisions. However, it does believe that they should play an active role in the management of recovery and emergency operations. The Controllers must be prepared to raise issues with a Master if they believe they have not been provided with sufficient information and/or they have identified issues of concern. Moreover, they should have the benefit of a standard operating procedure which would allow them to direct a Master to delay the implementation of a proposed course of action until it has been subjected to additional scrutiny by a person, or persons, with additional competencies and/or authority, e.g., the Marine Superintendent or the GM Operations.

## Other Matters

- 3.15 **Communication.** OTSI believes that the transcripts of the communication between the Master and the Operations Controller do not reflect the employment of appropriate radio procedures and it has made the same observation in its reports into other incidents involving vessels operated by Sydney Ferries. Good radio communication is characterised by its deliberateness, clarity, brevity and the confirmation of key issues through the use of a 'read-back' protocol. The risk of informal exchanges is that key information may not be communicated or not understood; and that communication becomes imprecise and long-winded at a time when urgent action is required. OTSI also noted that the communication following the collision was similarly unstructured.
- 3.16 **Quality Management.** A number of latent conditions were identified during the examination and trials of *Betty Cuthbert*. These conditions did not contribute to the accident but are indicative of limitations in risk assessments and quality assurance. OTSI noted that *Betty Cuthbert* and *Dawn Fraser*, another RiverCat powered by GM engines, had both had a number of engine replacements. Given that these vessels operate for extended periods and are under high load each day, this is to be expected.<sup>1</sup> However, OTSI had difficulty in understanding why what was obviously worn wiring was not replaced during engine changeovers. OTSI also noted that safety critical items onboard *Betty Cuthbert* were not clearly identified as such or secured through any form of tagging or sealing. For example, the cover plate on the steering sensors is secured with Socket head screws or Philips head screws, rather than tamper resistant (security) fasteners.
- 3.17 Sydney Ferries' repair and maintenance work involves, to a significant extent, the use of contract workers. Best practice dictates that repair and maintenance work be subject to some form of quality assurance and especially so when the work is outsourced or performed in-house but by

---

<sup>1</sup> OTSI was advised by Sydney Ferries that the remainder of the RiverCat fleet are powered by more modern and powerful *Caterpillar* engines which, in conjunction with a more sophisticated engine management system, have required less frequent changeovers.

contractors. In the absence of such a regime, the quality of work carried out by contractors can only be assumed. Further, the workmanship of Sydney Ferries' own maintenance staff may decline and an opportunity to identify training needs is lost. An in-house quality assurance regime requires people with the requisite skills, knowledge and experience and OTSI notes that Sydney Ferries has very few employees with a detailed knowledge of marine electrics or hydraulics.

### **Remedial Actions Taken by Sydney Ferries**

- 3.18 As a result of the technical issues identified during the examination of *Betty Cuthbert* and the related trials, Sydney Ferries contracted marine electricians to re-wire its engines and propulsion control units. Like work was also performed on the similarly configured *Dawn Fraser*.
- 3.19 In consultation with the NSW Maritime Authority, Sydney Ferries modified the engine shut-down system from buttons and timer circuits, to positive action switches. All RiverCats were similarly inspected and modified as required and Technical Maintenance Plans were amended to reflect revised inspection and maintenance requirements. In addition, Sydney Ferries has advised that *Betty Cuthbert* is being re-engined, under contract arrangements, and will be fitted with a new control system.
- 3.20 On 10 May 2006, Sydney Ferries published a FOTM (Ferry Operations Temporary Memorandum) which requires that Masters, having dealt with the immediate consequences of any emergency, contact its Controlling Officers and await directions from management before they commence any recovery action. OTSI believes that this requirement, properly observed, should see the risks associated with recovery operations being more appropriately managed.

## Regulatory Action

- 3.21 The New South Wales Maritime Authority also investigated this accident and subsequently issued the Master with an infringement notice for Negligent Navigation, as well as making a number of recommendations to Sydney Ferries in relation to procedural matters.

## PART 4 FINDINGS

---

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

a. ***Causation***

The collision was the consequence of human error and occurred as *Betty Cuthbert* was being operated in manner intended to compensate for a steering problem which had been encountered during an earlier berthing.

b. ***Appropriateness of the emergency response***

Sydney Ferries' response following the collision, and the subsequent recovery of *Betty Cuthbert* and the motor launch *BYO*, was appropriate.

c. ***Anticipation and management of risk***

- i. The risks associated with the Master's recovery plan were not recognised by the Master or the Sydney Ferries' Operations Controller.
- ii. *Betty Cuthbert* was not operated at an appropriate speed after it departed Homebush.
- iii. Wiring and stowage arrangements onboard *Betty Cuthbert* were inadequate.
- iv. Safety critical components onboard *Betty Cuthbert* were not readily identifiable as such.
- v. Sydney Ferries quality assurance regime Balmain Shipyard was inadequate.

d. ***Other issues that would enhance the safety of ferry operations***

The standard of radio communication employed between the Master and the Operations Controller, and in Sydney Ferries more generally, is below the standard required.

## PART 5 RECOMMENDATIONS

---

- 5.1 To prevent recurrence of this type of ferry accident, it is recommended that Sydney Ferries undertake the remedial safety actions described below:
- a. enforce the requirement that Masters, having dealt with the immediate implications of a control failure or a suspected control failure, consult with shore-based engineering staff if they do not have access to an Engineer on board before attempting any fault rectification in situ;
  - b. implement a quality assurance program to monitor the standard of works carried out by contract and shipyard staff and enhance, where appropriate, its in-house expertise in the areas of marine electrics and hydraulics;
  - c. clearly identify safety critical components to assist in related inspection and maintenance processes, and
  - d. develop and enforce the observance of radio communication protocols onboard, between vessels and with Operations Controllers.