



Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Marine Occurrence Investigation
MO-2011-005
No. 286
Final

**Investigation into the capsizing of the
Australian registered tug**

Adonis

at Gladstone, Queensland

11 June 2011

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

© Commonwealth of Australia 2013

In the interests of enhancing the value of the information contained in this publication you may download, print, reproduce and distribute this material acknowledging the Australian Transport Safety Bureau as the source. However, copyright in the material obtained from other agencies, private individuals or organisations, belongs to those agencies, individuals or organisations. Where you want to use their material you will need to contact them directly.

ISBN and formal report title: see 'Document retrieval information' on page ix

SAFETY SUMMARY

What happened

At about 1246 on 11 June 2011, the harbour tug *Adonis*, with four persons on board, capsized during an operation with a second tug, *Wolli*, to relocate a barge in the port of Gladstone, Queensland. Three of the persons on board escaped the capsizing tug but the fourth did not and drowned in the tug's wheelhouse.

What the ATSB found

The ATSB found that while the masters of the two tugs involved with the tow were aware of the risks of tugs capsizing, neither of them realised that *Adonis* had entered a classic capsize scenario when it moved abaft of the barge's port bow before the barge had begun to slow down. The barge's speed was not reduced in time to allow *Adonis*'s master to regain control of the tug and manoeuvre it back into a safe position ahead of the barge. The tug's crew were not able to release the towline using the towing hook's quick release arrangement before the tug capsized.

Investigation of the accident found that the retrospective fitting of a set of 'H' bitts to the tug, aft of the towing hook, had a detrimental effect on the tug's manoeuvrability. The fitting of the 'H' bitts, and a towing winch, also resulted in *Adonis* being unstable when undertaking towing operations over the stern. This fact was not identified by the tug's owners because the tug's stability had not been recalculated following the fitment of the additional equipment.

What has been done as a result

Sea Swift, the owners of *Adonis*, have produced new procedures covering the quick release arrangements on its tugs and enhanced the training and familiarisation of its crews with these arrangements. The company has also carried out a review of all its tugs' towing and quick release arrangements and introduced regular testing of this equipment.

In addition, a program for the review of all stability data for its tugs which were purchased overseas has been instigated, and an experienced training manager has been employed to review and monitor the company's health and safety policies and practices. A review of Sea Swift's training assessment for new masters or potential masters for the towing fleet has extended the period of training to include mentoring runs and supernumerary runs with other masters to facilitate the development of a greater understanding of towage requirements.

Safety message

The masters of tugs, regardless of size, need be actively aware of the signs that a tug might be in danger of capsizing and what to do to lessen this danger. For multiple tug operations, the masters of the tugs should plan the passage and consider the speed of passage and when it is time to release the towline. It is also important that the masters regularly communicate during the passage and that any concern regarding speed is immediately brought to the other master's attention.

CONTENTS

DOCUMENT RETRIEVAL INFORMATION	ix
THE AUSTRALIAN TRANSPORT SAFETY BUREAU	xi
TERMINOLOGY USED IN THIS REPORT	xiii
1 FACTUAL INFORMATION	1
1.1 <i>Adonis</i>	1
1.1.1 Towing hook	3
1.2 <i>Wolli</i>	4
1.3 <i>Chrysus</i>	5
1.4 Gladstone	6
1.5 Expansion of facilities in Gladstone harbour	7
1.5.1 Local knowledge requirement for masters of vessels operating within the MCAA	7
1.6 Sea Swift operations in Gladstone	8
1.7 The accident	9
2 ANALYSIS	20
2.1 Evidence	20
2.1.1 Tug and barge position information	21
2.2 The capsize	22
2.2.1 Towline forces	24
2.3 Stability	26
2.3.1 Recalculating a tug's stability following modifications	28
2.3.2 Calculation of stability by the master	29
2.4 Watertight openings	30
2.5 <i>Adonis</i> 's towing hook quick release arrangement	31
2.5.2 Release lever locked on departure	34
2.5.3 Locking pin design	35
2.6 Requirement for two tugs	35
2.7 Experience in two tug operations	37
2.8 Towage procedures and guidance	39
2.9 Risk assessment and job safety analysis	42
3 FINDINGS	45
3.1 Context	45
3.2 Contributing safety factors	45

3.3	Other safety factors.....	46
4	SAFETY ACTION.....	47
4.1	Sea Swift.....	47
4.1.1	Requirement about when to let <i>Adonis</i> go	47
4.1.2	Quick release arrangements guidance.....	48
4.1.3	Additional response from Sea Swift concerning safety actions taken following the capsizing of <i>Adonis</i>	48
4.2	Mampaey Offshore Industries	48
4.2.1	Location of locking pin.....	48
	APPENDIX A: ADONIS GENERAL ARRANGEMENT	51
	APPENDIX B: SHIP INFORMATION.....	53
	APPENDIX C: SOURCES AND SUBMISSIONS.....	55

DOCUMENT RETRIEVAL INFORMATION

Report No.	Publication date	No. of pages	ISBN	ISSN
286-MO-2011-005	February 2013	68	978-1-74251-296-9	1447-087X

Publication title

Investigation into the capsizing of the Australian registered tug *Adonis* at Gladstone, Queensland, on 11 June 2011.

Prepared By

Australian Transport Safety Bureau
PO Box 967, Civic Square ACT 2608 Australia
www.atsb.gov.au

Acknowledgements

The chart section in this publication is reproduced by permission of the Australian Hydrographic Service. © Commonwealth of Australia 13 October 2002. All rights reserved. Other than for the purposes of copying this publication for public use, the chart information from the chart sections may not be extracted, translated, or reduced to any electronic medium or machine readable form for incorporation into a derived product, in whole or part, without the prior written consent of the Australian Hydrographic Service.

The cover photograph is from Philip Hansen. Figures 1, 7, 8, 10 and 11 were provided by Sea Swift. Figure 3 was adapted from drawings provided by Mampaey Offshore Industries. Figures 6, 15 and 27 were obtained from Google Earth. Figure 14 was provided by Brett Crouch. Figures 18, 19 and 21 were obtained from Holger Kelle's report to Maritime Safety Queensland.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

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

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (for example engine failure, signal passed at danger, grounding), individual actions (for example errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB’s assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

1 FACTUAL INFORMATION

1.1 *Adonis*

Adonis (Figure 1) was a conventional tug which was built in 1995 by Mofaz Marine, Malaysia. It had an overall length of 21.3 m, a breadth of 6.72 m and a draught of 2.721 m. The tug had a gross tonnage of 91 and a bollard pull¹ of 10.78 tonnes.²

Figure 1: *Adonis* berthed in Cairns



The tug's propulsive power was provided by two Caterpillar 3406 diesel engines, each producing 272 kW and driving a fixed pitch propeller. This gave the tug a speed through the water of about 9 knots.³ Each propeller was mounted in a fixed nozzle, immediately forward of a rudder.

Adonis was equipped with twin rudders which had a normal operating range of 35° each side of midships. The rudders were linked so that they operated in unison.

Entry from deck to *Adonis*'s wheelhouse was via two sliding doors, one on each side of the wheelhouse. Within the wheelhouse, a ladder led down to the tug's galley, located on the main deck, and from there into the crew accommodation on the deck below. A door on each side of the tug led from the main deck directly into the galley. Entry to the engine room from the main deck was by a door immediately below the funnels, on each side of the tug. These doors opened onto an athwartships grating and from there, a ladder led down into the engine room.

¹ A measure of the pulling power of a tug, expressed in tonnes.

² As obtained from the DNV 'Certificate of bollard pull', dated 30 June 1995 in Singapore.

³ One knot, or one nautical mile per hour equals 1.852 kilometres per hour.

At the time of the accident, *Adonis* was owned by Sea Swift, Australia. It was registered as an Australian ship with the Australian Maritime Safety Authority (AMSA) and classed with Det Norske Veritas (DNV).

There were three crew members (a master, an engineer and a deckhand) and a local knowledge advisor (advisor) on board the tug at the time of the accident.

The master held a Queensland master class 5 certificate of competency and a Western Australia marine engine driver's (MED) grade 2 certificate, both of which were first issued in 2000. He began his seagoing career on fishing boats off the Queensland coast. After that, he spent a period of time as coxswain of a pilot boat in the Torres Strait before moving to small tug operations in the Torres Strait. He joined Sea Swift in 2007 and had been engaged in small tug/barge and landing barge activities in far north Queensland and Torres Strait waters. After a 12 month break from work, he returned to Sea Swift and took command of *Adonis* just before it sailed from Cairns to Gladstone in May 2011.

Adonis's engineer began his seagoing career on prawn trawlers off the Queensland coast. In 2005, he started working as an engineer on small trading ships in north Queensland and, in 2007, obtained his MED grade 1 certificate. Since then, he had worked as an engineer on a number of small tugs and landing barges. He first joined Sea Swift in 2007 and worked on company ships in the Torres Strait for about 8 months. He returned to Sea Swift in September 2010 and worked on board *Adonis* in barge towing operations from Cairns. Along with its master, he sailed the tug to Gladstone prior to it beginning operations in that port.

The deckhand started his seagoing career in 1991 as a fisherman on board boats operating in the Gulf of Carpentaria. In 1998, he obtained a Queensland skipper grade 3 certificate of competency and in 2008, he obtained a Queensland master class 5 certificate of competency. He first worked with Sea Swift at the end of 2009, in a tug and barge operation out of Cairns to Lockhart River and the Torres Strait islands. He rejoined Sea Swift, and *Adonis*, for its Gladstone operation at the end of May 2011, about 2 weeks before the accident.

The advisor began his piloting career as a harbour pilot in Gladstone in the late 1970s. After about 4 years, he was transferred to Thursday Island in the Torres Strait as harbour master. From there, he became a Brisbane harbour pilot and in about 1988, returned to Gladstone and piloted ships in that port until his retirement in January 2008.

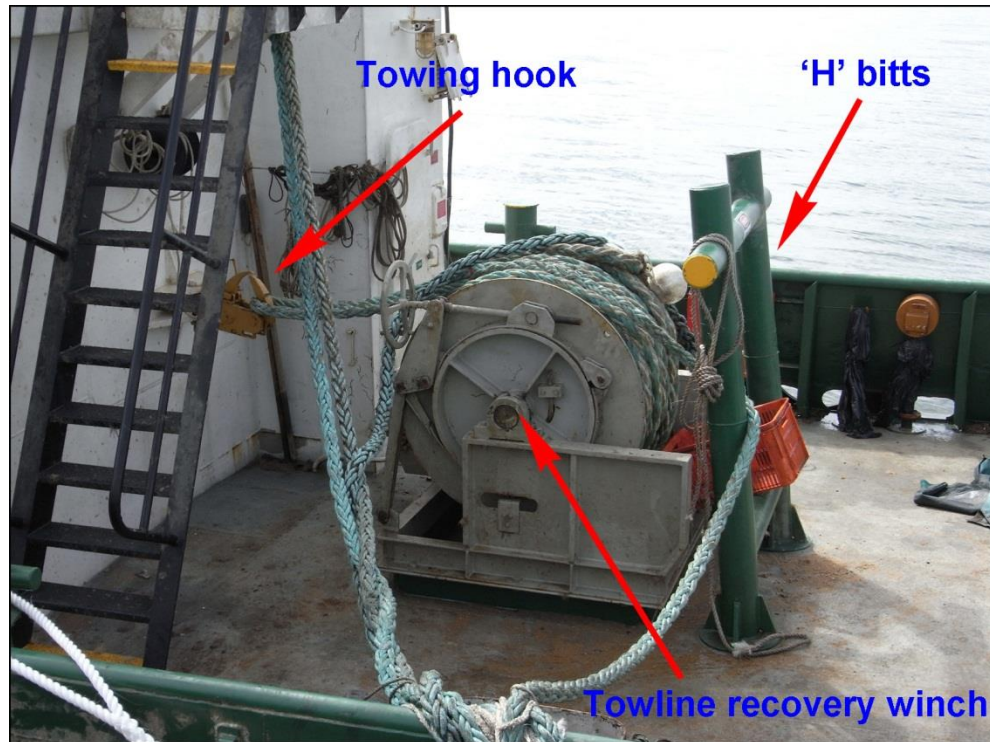
Following his retirement as a pilot, he spent some time as the master of a number of small ships and several months as a trainee tug master in Gladstone. In January 2011, he was issued with a 'Temporary Authority' by Maritime Safety Queensland (MSQ) in Gladstone to enable him to mentor, impart local knowledge and conduct formal assessments of potential exempt masters in the port of Gladstone.⁴ This authority was renewed in April 2011. He had been engaged by Sea Swift in that capacity since May 2011 to assist the masters of *Adonis* and *Wolli* obtain their pilotage exemption and local knowledge certificates.

⁴ A forerunner to the introduction of the MSQ 'Restricted Pilot's Licence' introduced into Gladstone after the capsizing. Non-pilot advisors were introduced into Gladstone to mentor and assess masters because, at the time, there were a large number of masters wanting pilotage exemptions and there were not enough licenced pilots in the port to facilitate their training and to conduct the ongoing operations of the port, with regard to large ship arrivals and departures.

1.1.1 Towing hook

Adonis was equipped with a Mampaey Offshore Industries towing hook mounted on the bulkhead at the after end of the accommodation superstructure. The hook had a safe working load of 15 tonnes and was fitted during the tug's construction. Mounted immediately aft of the hook was a towline recovery winch and 'H' bitts (Figure 2). Both these items of equipment had been fitted to the tug some time following its initial build; the 'H' bitts were fitted by Sea Swift in 2010 and the winch by previous owners of the tug.

Figure 2: Towing hook, towline recovery winch and 'H' bitts



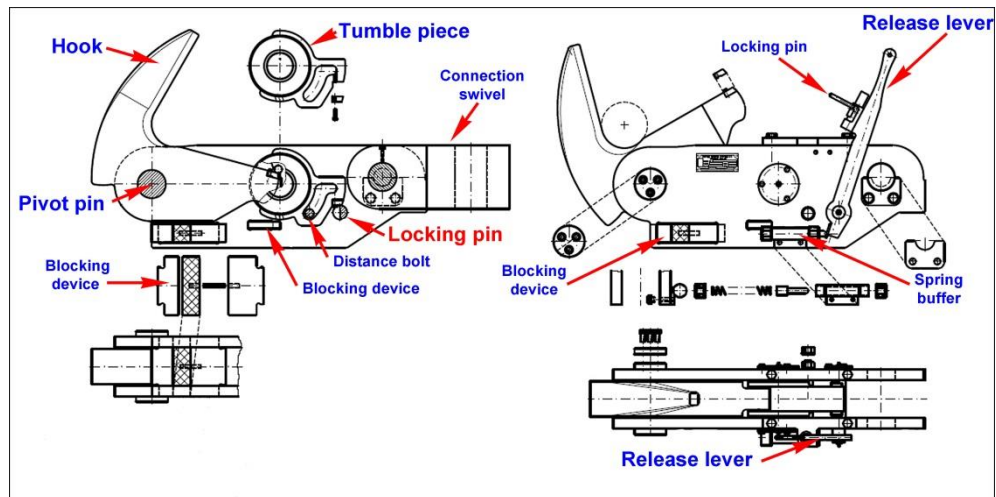
The towing hook was equipped with a quick release arrangement to enable the hook to be 'tripped' during a tow, thus releasing the towline (Figure 3). The release lever, when pushed forward, turned a locking pin (labelled in red in Figure 3) which allowed a tumble piece to rotate in a downwards direction. This released the hook, which in turn rotated counter-clockwise around a pivot pin, thus releasing any attached towline.

To enable remote tripping of the hook, a wire cable ran from the quick release lever, up the after end of the accommodation, through a series of sheaves to a handle mounted under the chart table at the after end of the wheelhouse. The release lever could also be manually operated by someone standing next to the hook.

The release lever was fitted with a manual 'locking pin'. During towing operations (i.e. when a towline was on the hook), the pin needed to be in the raised 'unlocked' position. If it was not in this position, the release lever could not be moved and the quick release arrangement would be rendered inoperable.

The towline used on 11 June was 2 x 22 m lengths of 64 mm 8 strand plaited polypropylene rope which had a breaking strain of 69.768 tonnes.

Figure 3: Diagram of the towing hook



1.2

Wolli

*Wolli*⁵ (Figure 4) was built in 1970 at the Carrington Slipway, Newcastle, Australia. It is 29.88 m in length, has a breadth of 9.73 m and draught of 3.443 m. The tug has a gross tonnage of 223 and a bollard pull of 26 tonnes.

Figure 4: *Wolli* berthed in the Gladstone marina



Propulsive power is provided by two Daihatsu 8PSHTB-26D four stroke diesel engines, each driving an azimuthing propeller. Together, these give a power output of 1,398 kW at 750 rpm and a service speed of about 9 knots.

At the time of the accident, *Wolli* was owned by Sea Swift. It was registered as an Australian ship, in survey with MSQ as a Uniform Shipping Law (USL) Class 2E⁶ vessel and classed with Lloyd's Register (LR).

⁵ In the days following the accident, *Wolli*'s name was changed to *Aphros*.

⁶ Surveyed to operate as a commercial ship within defined smooth water limits.

Wolli's crew consisted of a master, a mate, a deckhand and an engineer. The master held a Queensland master class 4 certificate of competency which was first issued in 1997. He began his seagoing career in 1992, working on small tug and barge operations in north Queensland. He worked on harbour tugs in a number of north Queensland ports from 1994 until 2008 before being employed by Sea Swift as *Wolli*'s master in May 2011.

The mate had been employed by Sea Swift since the beginning of May 2011, about 5 weeks before the accident. He held Queensland master class 4 and MED grade 3 certificates of competency, both of which were first issued in 1996. Prior to being employed by Sea Swift in Gladstone, he had been the master of a 15 m tug towing a 55 m dredge/excavator barge in Queensland.

The deckhand had 14 years of seagoing experience as a fisherman in Queensland waters. In May 2011, after a number of years working ashore, he was employed by Sea Swift for its Gladstone operation. He held a Queensland skipper grade 3 certificate of competency which was first issued in 1997.

1.3 ***Chrysus***

Chrysus (Figure 5) is an Australian registered unmanned steel, flattop dumb barge⁷ which was built in 2009 by Yangzhou Hanjiang Juidian Eastern Shipyard, China. It has a length of 54.86 m, a breadth of 15.26 m and a depth of 3.05 m. At a draught of 2.20 m, the barge has a deadweight of 1,400 tonnes.

Figure 5: *Chrysus* moored at the Gladstone cyclone moorings (viewed from its port bow)



To allow vehicular access to the barge's deck, *Chrysus* has two 9.5 m x 8.0 m ramps, one fitted forward and one aft. Two deck houses are located at the forward end, and these accommodate hydraulic motors for the ramps and diesel generators for the barge's pumps. Filling/discharge lines run the length of the barge's port and starboard sides and service the barge's ten tanks, five each on the port and starboard sides.

Chrysus was owned by Sea Swift and classed with DNV as a barge.

⁷ A long, large, usually flat bottomed vessel used for the transportation of freight. A dumb barge is generally designed without its own means of mechanical propulsion and is towed or pushed by other vessels, such as a tug.

At the time of the accident, *Chrysus* was being used to transport fresh water, in six of its tanks, from Gladstone to Curtis Island. For propulsion, *Wolli* was hipped⁸ up to the barge's port quarter with the mate on board *Wolli* acting as the barge master of *Chrysus*. He had previous experience as master of a barge with a similar carrying capacity as *Chrysus*. *Wolli*'s deckhand also acted as the deckhand of *Chrysus*.

Both the barge master and deckhand were on board *Chrysus* for the passage from Auckland Point wharf to the cyclone moorings to the northwest of the Fishermans Landing wharves.

1.4 Gladstone

The port of Gladstone is located on the Central Queensland coast near latitude 24°S, about 250 miles⁹ north of Brisbane. In the financial year ending 30 June 2011, 1,362 ships visited the port, and a total of 76.4 million tonnes of cargo was handled in the port.¹⁰ About 20 per cent of Australia's coal exports pass through Gladstone, making it the country's third largest coal port. In the financial year ending 30 June 2011, more than 53 million tonnes of coal was exported from Gladstone,¹¹ making up over 69 per cent of the total cargo handled at the port. The port's other main cargoes are bauxite, alumina, cement and caustic soda.

The harbour is entered through South and Gatcombe Channels leading from sea to the outermost berths at South Trees Point. From there, Auckland, Clinton and Targinie Channels together lead 9 miles further west-north-west giving access to the berthing complexes at Barney Point, Auckland Point, Clinton coal wharves and Fishermans Landing.

The Clinton and Targinie Channels also lead up to the port's cyclone moorings and areas of reclamation being undertaken within the north-western areas of the harbour (Figure 6).

The Australia Pilot¹² describes tidal streams within Gladstone harbour as generally turning at the time of high water at Gladstone and that the tidal streams can be affected by the wind and may set very strongly through the channels in the harbour. Predicted directions and maximum rates of tides are shown on the navigational charts for Gladstone harbour which indicates tidal rates of up to 4 knots may be experienced in the Targinie Channel, abreast Hamilton Point, to the north of the mouth of the Calliope River.

⁸ Made fast directly alongside the barge, thereby operating as one unit.

⁹ A nautical mile of 1,852 m.

¹⁰ Gladstone Port Corporation Annual report 2010/11.

¹¹ *ibid.*

¹² NP 15 – Eleventh edition, 2009.

Figure 6: Image of the upper section of Gladstone harbour



1.5 Expansion of facilities in Gladstone harbour

Late 2010 saw the beginning of an expansion in the port facilities at Gladstone. This expansion concentrated on areas of the harbour to the north-west of the city, in the vicinity of Fishermans Landing and the south-western portion of Curtis Island (Figure 6).

To assist with the management of the expected increase in vessel activities associated with the development of the infrastructure in this area of the harbour, MSQ published a *Standard for Marine Construction Activities within Gladstone Harbour* (the Standard).¹³

The Standard defined a 'marine construction activity area (MCAA)' within the harbour. The MCAA included the harbour area from the Auckland Point wharves to the southern point of Worthington Island, about 2.5 miles up the channel from Friend and Laird Points. The Standard also listed requirements for vessels operating within the MCAA, crew requirements (including local knowledge of the masters of vessels operating within the MCAA), operational plans, vessel operating procedures and emergency response plans.

1.5.1 Local knowledge requirement for masters of vessels operating within the MCAA

Section 3.1.1 of the Standard required that the master of any vessel operating in the MCAA must hold a pilotage exemption certificate (PEC) issued by the Gladstone

¹³ Dated March 2011.

regional harbour master, thus enabling the master to have the conduct of a specific vessel within the MCAA, without having a harbour pilot on board.¹⁴

In addition to the exemption required in section 3.1.1 of the Standard, section 8.1 of the Gladstone port procedures stated that

...unless a current PEC is held by the master of a ship, pilotage is compulsory for a vessel towing another vessel where the combined length of the vessels is 50 metres or more.

This towage PEC requirement was applicable to towage operations in the MCAA. Regardless of whether the master of a vessel in the MCAA had been issued with a PEC for a specific vessel (in accordance with section 3.1.1 of the Standard), if that master wished to undertake tows, the length of which exceeded 50 m, within the MCAA, he or she was required to have a pilot on board while gaining the necessary local knowledge to enable him/her to sit for the towage PEC, in accordance with section 8.1 of the port procedures.

To comply with both these requirements, Sea Swift had engaged the services of an advisor to assist their masters with this task. At the time of the accident, because neither the master of *Adonis* nor *Wolli* had obtained the towage PEC, the advisor was, from a local knowledge perspective only, overseeing the passage of *Chrysus* from Auckland Point wharf to the cyclone moorings.

Adonis's master had completed his MCAA local knowledge examination on 6 June 2011 and, at the time of the accident, was waiting for the regional harbour master to issue his PEC to navigate *Adonis* within the MCAA without a pilot. He was in the process of gaining the required knowledge of the area while he was in charge of a tow.

Wolli's master had not completed his MCAA local knowledge examination and had not been issued with a PEC to navigate *Wolli* in the MCAA. However, under Sea Swifts's Marine Execution Plan for its operations in Gladstone, *Wolli*'s master was in charge of the operation on 11 June.

1.6 Sea Swift operations in Gladstone

At the time of the accident, Sea Swift operated a fleet of about 23 coastal ships, landing barges, tugs and dumb barges in north Queensland. The company's head office was in Cairns but it had offices in Weipa, Bamaga and on Horn and Thursday Islands.

In 2010, Sea Swift was awarded a contract to supply fresh water to the liquefied natural gas construction operations on Curtis Island. This operation began in Gladstone in April 2011.

Originally, Sea Swift planned to use one tug and a barge for the work, but following a direction from the Gladstone regional harbour master, *Adonis* was relocated from

¹⁴ Since the accident, MSQ has introduced a scheme of restricted pilot's licences to perform a mentoring role for exempt masters. Newer versions (post-October 2011) of the *Standard for Marine Construction Activities within Gladstone Harbour* outline the current procedure for obtaining a pilotage exemption qualification within Gladstone harbour and the criteria for obtaining a 'restricted pilot's' qualification.

Cairns to provide a second tug when the barge was being towed in the vicinity of the Clinton coal loading facility.

Crew for *Adonis*, *Wolli* and *Chrysus* were specifically employed by Sea Swift for the Gladstone operation. The crew came from a ‘pool’ of Sea Swift employees and by direct recruitment. The crew brought with them experience in small ships and barge operations and, once in Gladstone, underwent specific training for the fresh water carrying operation. This included vessel and contractor induction training, familiarisation with berthing and unberthing at the cyclone moorings, local knowledge training and a ‘practice run’ associated with the delivery of fresh water from Auckland Point wharf to Curtis Island. This practice run took place on 7 June 2011, 4 days before the capsizing of *Adonis*.

1.7 The accident

Tuesday 7 June 2011 - a practice run

In preparation for the first laden run from Gladstone to Curtis Island, the crews of the tugs *Adonis*, *Wolli* and the barge *Chrysus* completed a practice run, taking an unladen *Chrysus* from the cyclone moorings in Gladstone harbour to Auckland Point and back again. *Adonis* was made fast to *Chrysus* in a ‘push/pull’ configuration, with a line up from its bow to the forward port bollard on board *Chrysus* (Figure 7).

Figure 7: *Adonis* made fast to *Chrysus* over its bow on 7 June 2011



Wolli was hipped up to *Chrysus*'s port quarter. At about 1205,¹⁵ the two tugs put the barge starboard side to Auckland Point number one wharf and at about 1220, the tugs lifted the barge off the wharf and began to turn it, stern to port with *Adonis* pushing up on the barge's port bow (Figure 8).

Once the turn was completed, the tugs began the passage up the channel towards the Clinton coal wharves. During this time, *Adonis* lay back alongside *Chrysus*. When they were past Clinton wharves, *Adonis* was let go and moved around to sit off

¹⁵ All times referred to in this report are local time, Coordinated Universal Time (UTC) + 10 hours.

Chrysus's starboard quarter, with no line up onto the barge. By 1315, *Chrysus* was secured to buoys at the cyclone moorings.

Figure 8: Adonis and Wollie swinging Chrysus off the berth

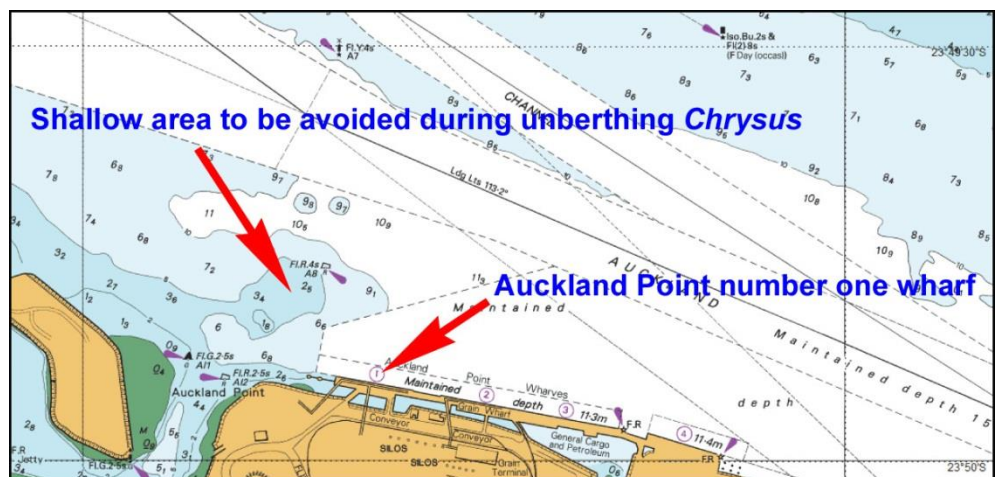


Joining the crew of *Wollie* for the practice run was Sea Swift's advisor and two other advisors who were, or were about to start, training other masters of small vessels within the MCAA. They were on board to familiarise themselves with the type of operation they might be involved with in the future.

During the passage to the cyclone moorings, *Wollie*'s master, who was in overall charge of the operation, and two of the advisors discussed the manoeuvre just undertaken to take *Chrysus* off the berth at Auckland point number one wharf.

While turning the barge's stern to port was successful that day, the first time the manoeuvre would be done with a partially loaded barge, the following Saturday 11 June, the tide would be flooding and there would be a strong current running in the channel adjacent to Auckland Point wharf. They were concerned that on a strong flood tide, *Adonis* might have trouble maintaining position on the barge's port bow and turning *Chrysus*'s stern to port might result in the tugs and barge being set down on a shallow patch of water in the vicinity of the A8 beacon, just upstream of Auckland Point number one wharf (Figure 9).

Figure 9: Section of navigational chart Aus 244 showing the shallow area near Auckland Point wharves



Consequently, it was decided that on 11 June, the barge should be taken off the berth and then turned head to port to enter the channel. For this manoeuvre, the lashing arrangement regarding *Adonis* would need to be different to that which the crews had just practiced. It was agreed between *Wolli*'s master and the two advisors that *Adonis* should be made fast to *Chrysus* with a line up from its stern, to better assist the tug to maintain position in the expected strong current and with pulling the barge's head around to port.

Friday 10 June and Saturday 11 June

Early on the morning of Friday 10 June, *Wolli* and *Chrysus* departed the Gladstone cyclone moorings bound for Auckland Point wharves.

As the tug and barge approached the Clinton coal wharves, *Adonis* met them. At 0705, *Adonis* was made fast to *Chrysus*'s port bow with a line up from the tug's bow, as it was made fast during the practice run. *Adonis* then lay alongside the barge and accompanied *Wolli* and *Chrysus* for the rest of the passage to Auckland Point. By 0725, *Chrysus* was made fast starboard side to Auckland Point number one wharf. *Adonis* was let go and it returned to its berth in the Gladstone marina. Both *Chrysus* and *Wolli* remained at Auckland Point overnight while about 800 tonnes of fresh water was loaded.

On the morning of 11 June, loading of the fresh water was completed. *Chrysus*'s departure draughts were 1.4 m forward and 1.6 m aft.

At about 1140, *Adonis*, with three crew members and Sea Swift's advisor on board, departed its berth in the marina and made its way back to the Auckland Point wharves. At 1156, *Adonis* tied up alongside *Wolli*. *Adonis*'s master, deckhand and the advisor went on board *Wolli* for a meeting to discuss the plan to unberth and move *Chrysus* back to the cyclone moorings.

During the meeting, *Wolli*'s master said that he wanted *Adonis*'s master to make fast to *Chrysus*'s port bow using a line over the tug's stern and not over its bow as had been practised 4 days earlier. This was the first time *Adonis*'s master was aware that there was to be a change in how his tug would be made fast to *Chrysus* and he did not object to the arrangement.

Wolli's master also suggested that 15 m of 64 mm diameter polypropylene towline would be sufficient. However, *Adonis*'s master and the advisor disagreed and said that the towline should be at least 30 m in length. It was then agreed that two lengths of polypropylene towline would be joined together and that this would be used as the towline.

It was also agreed that when the tugs and barge were clear of the wharf, *Wolli* would be the primary means of turning *Chrysus* to port, and that *Adonis* would assist the turn by pulling the towline to guide *Chrysus*'s bow to port. Then, during the passage up the channels, *Wolli* would be the primary tug and provide propulsive power for the operation. *Adonis* would remain on *Chrysus*'s port bow as the assisting tug, with a line up to the bitts on the barge's port deck house. *Adonis*'s master was to endeavour to ensure that the towline would not be slack but that there would not be weight on it either.

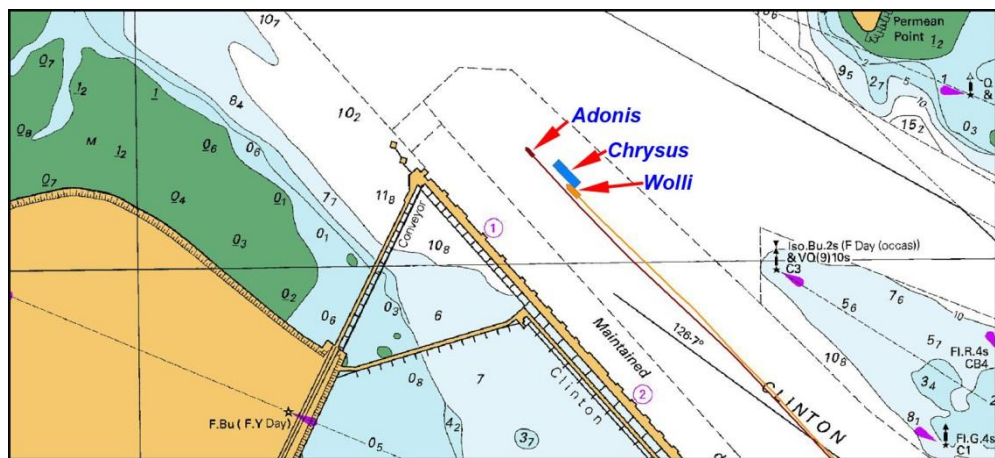
Following the meeting, *Adonis*'s crew and the advisor returned to their tug. At about 1225, *Adonis* was moved to *Chrysus*'s port bow. The towline was made fast to the barge's forward port bitts, led through *Adonis*'s 'H' bitts and then placed on

The tow was moving at a speed¹⁶ of about 6.7 knots and making good a course of about 310° (T).

On board *Adonis*, the master was at the helm and the advisor was sitting on a stool in the after starboard part of the wheelhouse. The deckhand and engineer were standing at the after end of the wheelhouse deck, between the funnels, overlooking the after deck.

At 1238, the tugs and barge passed Clinton number four berth. The speed of the tow was 7.7 knots and the course made good was about 313° (T). Five minutes later, the tow was passing Clinton number one berth and the speed of the tow had increased to 8.2 knots. *Adonis*'s course made good was 318° (T), slightly different to *Wolli*'s, which was 315½° (T) (Figure 12).

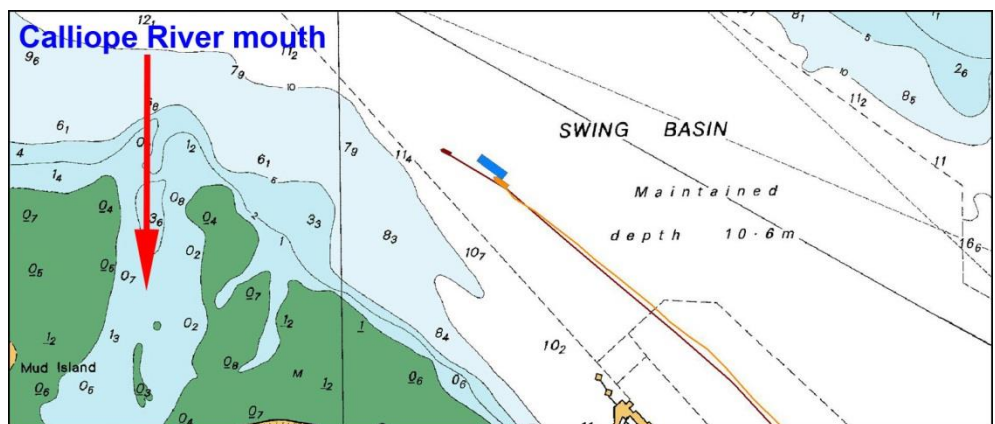
Figure 12: AIS data replay at 1243



By this time, *Adonis*'s engineer had left the wheelhouse deck and was making his way to the engine room. The deckhand remained between the funnels.

At 1245½, the tugs and barge were approaching the southern end of the Targinie Channel, at a speed of 8.3 knots (Figure 13). The weather had closed in, with passing rain squalls, and the wind reported as south-easterly at 15 to 20 knots. There was about 1½ knots of flooding tide.

Figure 13: AIS data replay at 1245½



¹⁶ All speeds referred to in this report are 'made good/over the ground' and have been obtained from automatic identification system (AIS) data.

At about this time, *Adonis*'s master told *Wolli*'s master via ultra high frequency (UHF) radio that he was going to reduce his speed in preparation for letting go the towline. On hearing this, *Wolli*'s deckhand moved to *Chrysus*'s forward end to stand-by to release the towline. Shortly afterwards, *Adonis* started to drift to starboard, moving in front of the barge.

Wolli's master called *Adonis*'s master on the UHF radio and told him that he was 'going the wrong way'. In reply, *Adonis*'s master apologised and said that he would bring the tug back onto *Chrysus*'s port bow. *Adonis* started to move back onto *Chrysus*'s port bow, but instead of stopping where it had been positioned previously, the tug continued to move to port, increasing the angle it was off *Chrysus*'s port bow.

The weight on the towline increased markedly as *Chrysus* began to move ahead of *Adonis*. The tug then started to list to starboard. As this was happening, *Adonis*'s master called *Wolli*'s master on the UHF radio, telling him that he couldn't steer the tug. *Adonis*'s master tried to bring the tug's head around to starboard to get the tug back in front of the barge by using the tug's rudders and then splitting the tug's engines ahead and astern, but these efforts were unsuccessful. Instead of turning to starboard, *Adonis*'s bow was now turning to port as more weight came on the towline.

Adonis started to ship water onto its starboard main deck and the master yelled to the deckhand to release the towline. The deckhand then started to make his way to the port side ladder which led to the main deck. As he got to the top of the ladder, he saw the engineer coming up the ladder and he yelled to the engineer to let go the towline.

The engineer quickly made his way to the port side of the towing hook. He reached over the towing hook, lifted the locking pin to the 'unlocked' position and tried to push the quick release lever forward to let the towline go. However, despite repeated attempts, he could not move the release lever. He knew that there was a hammer just inside the port side engine room door so he went to get it. By this time, *Adonis* was abaft the beam of *Chrysus*'s bow and the weight on the towline had increased.

About 20 seconds after being abeam of the barge's bow, *Adonis* quickly swung around on the towline and struck *Wolli*'s port bow with its stern and then bounced off the larger tug. The impact pushed *Wolli* into the push-plate of *Chrysus*, damaging the plate.

As this was happening, *Wolli*'s master put his tug's engines to full astern in an effort to slow the barge.

Adonis was now almost beam on to the direction of travel of *Chrysus* and *Wolli*, with its main deck taking on water as the tug was heeled over to starboard. *Wolli*'s engineer, who was standing on the tug's port bridge wing, yelled at the men he could see on board *Adonis* to get off the tug and then almost immediately *Adonis* capsized.

The deckhand jumped clear of the capsizing tug. The engineer, who was just about to enter the port side engine room door, found himself on the port side of the tug's accommodation. He ran forward, along the side of the accommodation, looking into the wheelhouse which was filling with water. He did not see anyone in the wheelhouse and, believing that the master and advisor had got clear from the

wheelhouse, jumped into the water from the tug's port bow. Both the deckhand and the engineer swam clear of the capsized tug. It was now about 1247.

Adonis's master had been thrown violently to starboard when the tug capsized. Having been possibly knocked out for a couple of seconds, he came around as water was engulfing the wheelhouse. He tried feeling his way through the water looking for the advisor. After a short time, he located him at the back of the wheelhouse, in its port corner. He tried to grab hold of the advisor around his neck so that he could pull him to safety. However, the advisor slipped out of the master's hands.

The master swam clear of the tug's wheelhouse so that he could surface and get his breath. He then tried to get back into the wheelhouse but could not. He resurfaced and swam towards the other crew.

Wolli's crew also threw life buoys into the water for *Adonis's* crew. The mate and deckhand went forward on *Chrysus* to drop the barge's anchor.

At about 1248, *Wolli's* master made an emergency call on very high frequency (VHF) channel 13. This was answered by Gladstone vessel traffic services (VTS). The Gladstone water police were also monitoring channel 13 and they acknowledged *Wolli's* master's emergency call, telling him they were on their way. By 1249, the police vessel *Wrembreck* was leaving the marina, en route to the capsize location. A minute later, another nearby vessel was making its way to the location.

At about 1250, *Wolli's* master made a telephone call to Sea Swift's Gladstone operations manager, telling him of the accident. The operations manager then began notifying authorities ashore and Sea Swift management in Cairns. He then waited at the Gladstone water police office for more information.

At 1251, *Wolli's* master told VTS that divers were required because a crew member was missing. VTS passed this information onto the police officers on board *Wrembreck* and also advised the assistant regional harbour master of the accident.

At 1255, the police on board *Wrembreck* advised VTS that the three crew members in the water had been recovered and that there was one person still missing. The rescued crew members were then taken to the water police office where they received medical attention before being taken to hospital.

Figure 14: The capsized *Adonis*, as seen from *Chrysus's* deck



At about 1300, *Wolli*'s deckhand was directed to cut through *Adonis*'s towline with an axe (Figure 14).

By 1312, the police officers on board *Wrembreck* had advised VTS that local commercial divers were unable to be of assistance because of the weather conditions and the danger posed to them by the strong tidal flows in the area. Consequently, police divers from Brisbane needed to be called in to assist in the search for the missing man.

By about 1330, *Wrembreck* had returned to the position of the capsized tug. The police requested that Gladstone marine authorities establish a 100 m exclusion zone around the position of the capsized tug and at 1356, VTS made a broadcast on VHF radio advising vessels in Gladstone harbour of the exclusion zone. As an additional safety measure, the regional harbour master implemented restricted vessel movements in that vicinity of the harbour.

Sometime between 1430 and 1530, *Adonis* sank in position 23° 48.6'S 151° 13.5'E, to the north of Mud Island (Figure 15). It settled on its starboard side in about 6 m of water.

Figure 15: Image showing the position where *Adonis* settled



By 1520, an incident control centre had been established at the water police office and surface search operations involving several vessels in the immediate area of the capsized tug, had begun. Two helicopters were also tasked to perform an aerial search. However, as the afternoon progressed, they were called away for two other distress incidents in the Gladstone area.

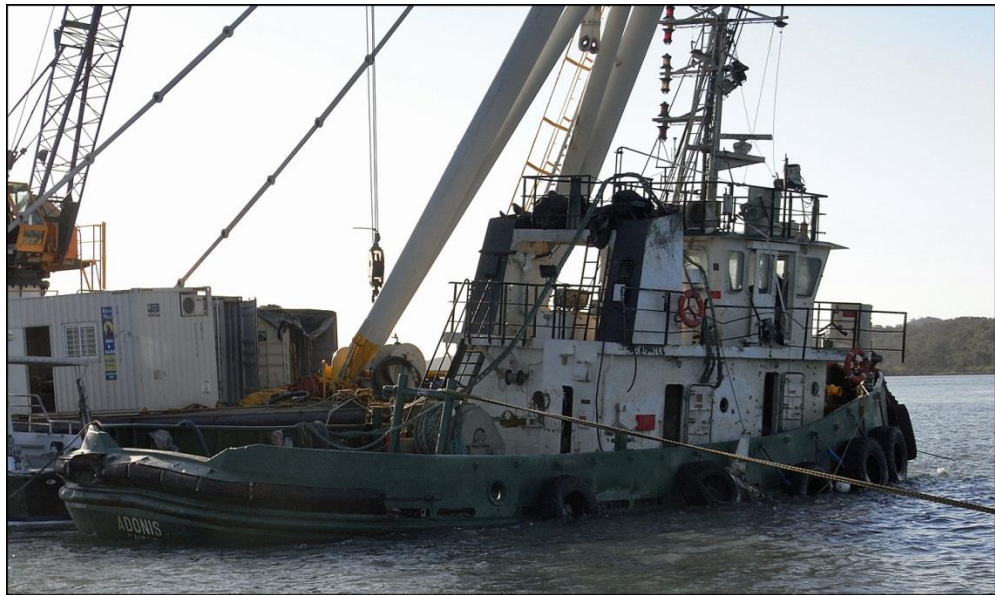
The search for the missing advisor was suspended at last light with a view to resuming the search the following morning. *Wolli* and *Chrysus* remained at the capsized tug's location overnight. Large spotlights were put on board the barge and these were used to illuminate the position of the capsized tug during the hours of darkness.

At about 0615 on 12 June, *Wrembreck* left its berth in the marina with the police divers and their equipment on board. When they arrived at the capsized tug's location, the divers began making their preparations for the dive. During the morning, they dived on the sunken tug. Meanwhile, the water police continued to coordinate an expanded surface search for the missing advisor.

At 1153, the water police called off the surface search when the body of the advisor was located in the wheelhouse of the tug. His body was recovered by the police divers and taken ashore.

Towards the end of June, salvors were appointed by Sea Swift to refloat *Adonis*, and in mid-July, the tug was brought clear of the water (Figure 16).

Figure 16: *Adonis* immediately following its refloating



The tug was moved from its salvaged location to the Gladstone cyclone moorings where representatives of its owners and of the Australian Transport Safety Bureau, Maritime Safety Queensland and other interested parties inspected the vessel.

In early August, *Adonis* was moved to Cairns where it was lifted from the water on 15 August. The tug was scrapped in the latter part of 2011.

2.1 Evidence

On the afternoon of 12 June 2011, two investigators from the Australian Transport Safety Bureau (ATSB) arrived in Gladstone, Queensland, to begin a safety investigation into the sinking of *Adonis*. On 13 June, the Maritime Safety Queensland (MSQ) regional harbour master and the assistant regional harbour master were interviewed and they gave their accounts of the accident and the events which led up to it. The investigators also took copies of documents pertaining to the operation the tug was engaged in at the time of the accident.

Also on 13 June, the investigators interviewed *Adonis*'s master, deckhand and engineer, *Wolli*'s mate, and Sea Swift's Gladstone operations manager. Each provided their accounts of the accident and of the events which led up to it.

On 14 June, the investigators interviewed *Wolli*'s master and deckhand and they both provided their accounts of the accident and of the events which led up to it. The investigators also spoke with the Gladstone pilot manager to get some background information on the local knowledge advisor (advisor) who died as a result of the capsizing.

On 15 June, the investigators interviewed two other advisors. Each of them provided information on the 'marine construction activity area (MCAA)' processes and their involvement in the practice run 4 days before the accident.

On 15 July 2011, ATSB investigators flew to Gladstone to witness the refloating of *Adonis*. When able, they boarded the tug and evidence relevant to the investigation was obtained.

On 27 September and 17 October 2011, an ATSB investigator attended the testing of *Adonis*'s towing hook which took place in Brisbane.

Following the capsizing, MSQ, the Queensland government agency responsible for overseeing safe ship operations in the port of Gladstone, commissioned several independent reviews into the accident. This included a review of the overall barge relocation operation and an investigation into the tug's steering and towing hook. Another review looked at the tug's stability to see what part it may have played in the capsizing.

During this latter review, the consultant naval architect undertook a number of investigations into the hydrostatic and dynamic stability of *Adonis* at and around the time of capsizing. This included developing a hydrostatic model of the tug to independently assess the condition that led to its capsizing.¹⁷ In addition, he undertook a number of calculations to establish the maximum drag forces on the tug's hull so as to derive possible towline forces at the time of capsizing.

¹⁷ The software used to prepare the naval architect's report was 'Maxsurf' and 'Hydromax'. The software was used for the calculation of the ship's hydrostatic and dynamic stability as well as the evaluation of stability criteria as reported in his report. The *Adonis* model created was based on the original lines plan of *Adonis*. The Maxsurf/Hydromax model was validated against the form parameters presented in the tug's original stability booklet.

The ATSB has reviewed the naval architect's calculations and analysis and those parts of his report that are reproduced and/or referenced in this report are accepted and supported by the ATSB.

During the investigation, further information was provided by Sea Swift, MSQ, the Queensland Police Service, the Australian Maritime Safety Authority (AMSA) and Mampaey Offshore Industries, the Netherlands, the manufacturers of *Adonis's* towing hook.

2.1.1 Tug and barge position information

The tug and barge positions and times used in this report were obtained from automatic identification system (AIS) data supplied by the Gladstone regional harbour master.

Using this data (time and course/speed made good), the ASTB was able to recreate the passage from Auckland Point wharf to where *Adonis* capsized, establish the approximate capsize time, and the speed of *Adonis* and *Wolli/Chrysus* in the minutes before the capsize. This information is presented in the following table and figure (Figure 17).

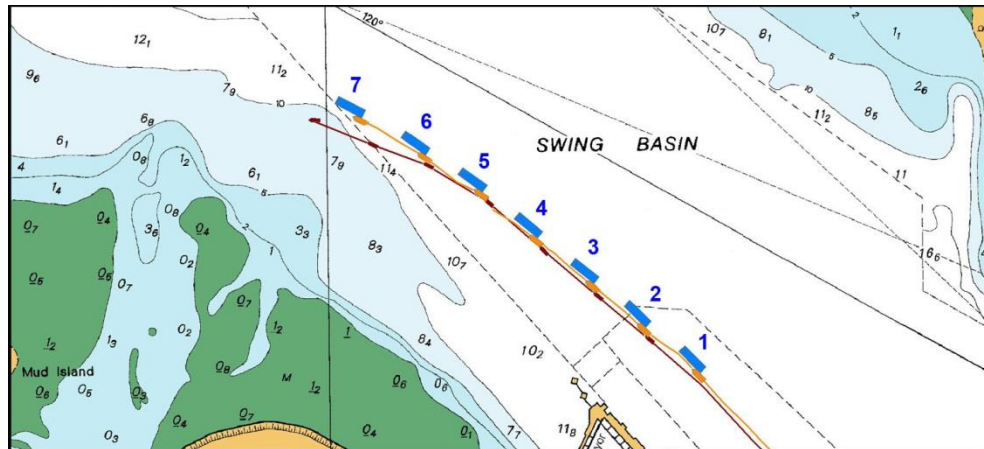
Table 1: AIS data for 11 June 2011

Tug	Time	Speed (knots)	Course	Position on Figure 17
<i>Adonis</i>	12:43:30	8.0	310.7°	1
<i>Wolli</i>	12:43:25	8.1	315.4°	1
<i>Adonis</i>	12:43:58	7.9	309.2°	2
<i>Wolli</i>	12:43:55	8.1	314.6°	2
<i>Adonis</i>	12:44:29	8.3	317.2°	3
<i>Wolli</i>	12:44:25	8.3	308.5°	3
<i>Adonis</i>	12:44:59	8.3	312.1°	4
<i>Wolli</i>	12:44:55	8.3	309.6°	4
<i>Adonis</i>	12:45:26	8.2	296.4°	5
<i>Wolli</i>	12:45:29	8.3	306.1°	5
<i>Adonis</i>	12:45:58	6.9	295.2°	6
<i>Wolli</i>	12:45:55	8.4	305.0°	6
<i>Adonis</i>	12:46:28	4.3	271.2°	7
<i>Wolli</i>	12:46:26	8.1	297.8°	7
<i>Wolli</i>	12:46:37	7.5	295.4°	
<i>Wolli</i>	12:46:45	7.3	294.7°	
<i>Wolli</i>	12:46:55	6.1	301.5°	
<i>Wolli</i>	12:47:05	5.0	291.9°	
<i>Wolli</i>	12:47:16	4.2	287.6°	

As the data shows, there is a noticeable reduction in *Adonis's* speed at 12:45:58. This reduction in speed continues until the tug's AIS unit stops transmitting at

12:46:28. It is therefore reasonable to conclude that the tug started to enter a capsize situation at about 1246 and within 30 seconds had capsized.

Figure 17: AIS positions of the tugs and barge



The data also shows that there was a measurable reduction in the speed of *Wolli/Chrysus* 10 seconds after *Adonis* capsized and that this reduction continued. It is likely that the initial drop in speed, and course change to port, was the result of *Adonis* acting as a ‘drag’ on the other two vessels and the effect of *Wolli*’s engines going astern.

2.2 The capsize

For a conventional tug towing over the stern, the speed of the craft being towed in relation to its own speed is the greatest risk factor that contributes to capsize (girting).¹⁸ The higher the speed during the tow, the greater the induced towline forces are acting on the tug and the greater the turning moment acting around the tug’s longitude centre of gravity. As a result, the tug can become uncontrollable and exposed to the danger of capsize. This was the situation faced by *Adonis*’s crew as they prepared to let the towline go on 11 June 2011.

As the *Adonis*, *Wolli* and *Chrysus* tow proceeded, the speed being made good was in excess of 8 knots. This speed, which included a tidal flood of about 1½ knots, was getting towards the upper limit of *Adonis*’s speed. The relatively high speed meant *Adonis*’s master had little power in reserve to counteract the increasing towline forces when he started to have difficulty manoeuvring the tug.

At about 1243, as the tugs and barge passed the Clinton coal wharves, *Adonis*’s master commented to the advisor that they were picking up ‘quite a bit of speed’. However, he did not express his concerns to *Wolli*’s master. In his interview with ATSB investigators, *Adonis*’s master said that he was aware that there was a potential of ‘things happening’, meaning more weight coming on the towline, and that *Adonis* was having difficulty maintaining its position in front of *Chrysus*.

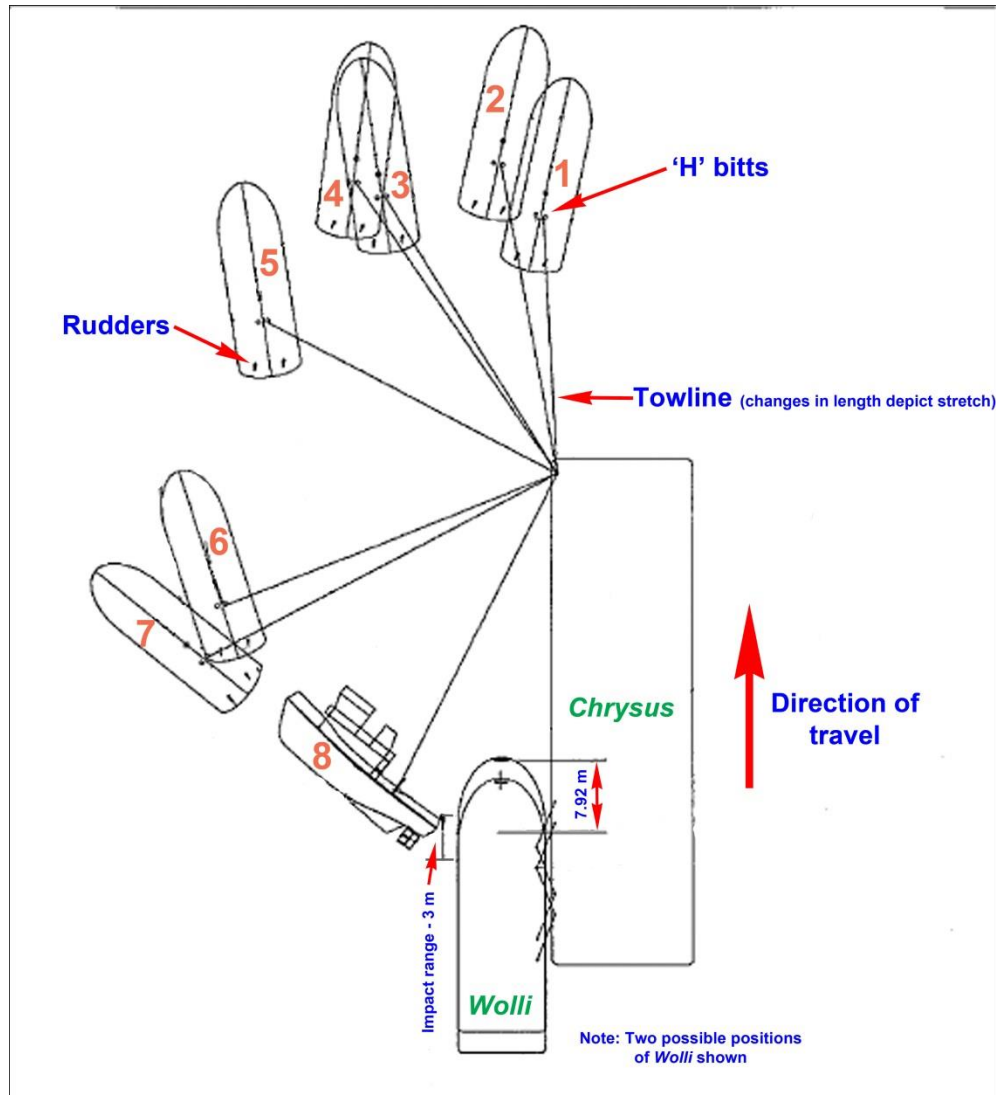
At about 1245½, when *Adonis*’s master told *Wolli*’s master he was going to slow down, in preparation to let the towline go, *Wolli*’s master asked *Adonis*’s master if he wanted *Wolli* to slow down. The answer was yes. However, no agreed speed to

¹⁸ *Tug use in Port – a practical guide*. The Nautical Institute. London, 2nd edition 2003, p88-89.

undertake the task was mentioned and AIS speed data shows that, at that time, *Wolli*'s speed did not reduce.

Consequently, when *Adonis* began to move to port (Figure 18), the speed of the barge had not decreased and as a result, the towline forces acting on *Adonis* began to increase. As *Adonis* moved further to port, the master commented that he was having trouble steering the tug, indicating that he could not manoeuvre the tug back to a position at the front of the barge. Still, the speed of the barge was not reduced.

Figure 18: Diagram showing *Adonis*'s possible positions and aspect to the direction of travel before capsizing



While the masters of both tugs were aware of what it meant to 'girt a tug', neither of them recognised that *Adonis* was entering a classic girting scenario when *Adonis*'s master said that he had lost steerage of the tug. If swift action had been taken to reduce the speed of the tow as soon as *Adonis*'s master said that he had lost steerage, the towline forces would have reduced and that may have enabled *Adonis*'s master to regain steerage and take the weight off the towline, thereby avoiding the capsizing.

2.2.1 Towline forces

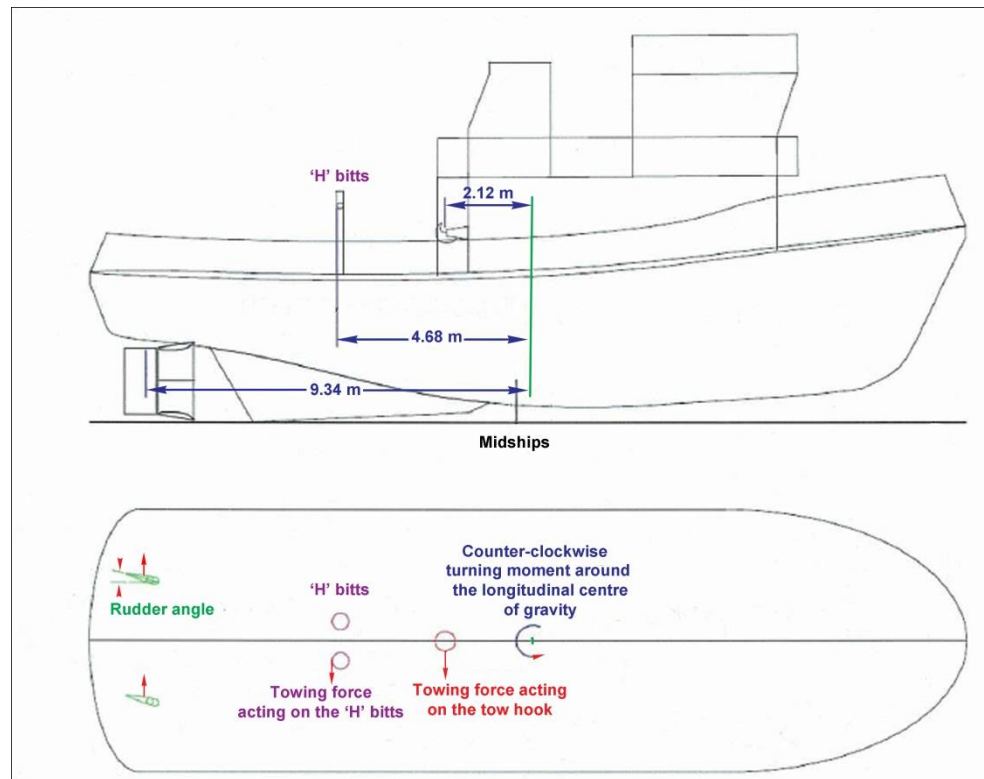
Towline force can have a counteracting effect on the manoeuvrability of the tug.

A towline pulled transversally over the side of the tug induces a course changing moment around the tug's longitudinal centre of gravity (LCG). The rudders also act around the LCG and the rudder forces have to be large enough to counteract the turning moment induced by the towline. Therefore, one way to reduce the effect of the towline on manoeuvrability is to bring the towing point¹⁹ as close to the longitudinal centre of gravity as possible.

Adonis's LCG was close to midships, as indicated by the green line in Figure 19.

In its original configuration, *Adonis's* towing hook was its towing point. The towing hook was mounted on the aft bulkhead of the accommodation superstructure, 2.12 m aft of the LCG (Figure 19). Hence, any towline force acting on the towing hook applied a counter-clockwise turning moment to the tug through a lever of 2.12 m.

Figure 19: Rudder and towline turning moment around LCG



However, when the 'H' bitts were fitted in 2010, their placement aft of the towing hook meant that when a towline made contact with the 'H' bitts, as it did on 11 June 2011, the towing point became the 'H' bitts. Therefore, the tug's towing point moved 2.56 m further aft and any towline force acting on the 'H' bitts applied a larger turning moment to the tug, now through a lever of 4.68 m. As a result, the

¹⁹ The towing point on a tug is the point from where the towline goes in a straight line from the tug towards the craft it is towing. For tugs towing on a line, the towing point is not necessarily the towing hook or towing winch.

fitting of the 'H' bitts had effectively doubled the magnitude of the turning moment applied to the tug by any given towline force.

The naval architect's calculations show that in its original condition (i.e. without the 'H' bitts fitted), at a speed over the ground of 8.4 knots, *Adonis*'s rudders would have had to be at about 11.5° to maintain a heading and compensate for a transverse towline force of 10.78 tonnes, the defined bollard pull of the tug. However, with the 'H' bitts fitted, this rudder angle required was about 25° to compensate for the same towline force.

Furthermore, the naval architect's calculations showed that, in the tug's original configuration, the rudders at hard-over (about 37°) could provide enough 'lift' to change the tug's course if a towline force of 37 tonnes was applied to the towing hook. However, a towline force of only 17 tonnes applied to the 'H' bitts was all that was required to overcome the same amount of rudder 'lift'.

The naval architect's analysis of the towline forces acting on *Adonis* at the time of capsizing indicate that the forces were probably in excess of the tug's bollard pull of 10.78 tonnes. If dynamic amplification factors are considered (like towline dynamics and the inertia forces resulting from the drag through the water the tug produced as it swung around towards, and then contacted, *Wolli*), the towline forces were likely to be in the order of 30 tonnes, the breaking load of the towing hook. Because of the angle of the towline as it led from the tug up to the bow of *Chrysus*, all this force would have been concentrated at the point where the towline made contact with the 'H' bitts.

What this means is that, at about 1246 on 11 June 2011, while *Adonis*'s master was desperately trying to manoeuvre the tug back to the front of *Chrysus*, the counter-clockwise turning moment set up by the towline forces being exerted on the 'H' bitts, acting to turn the tug to port, was greater than the ability of the rudders and the power of the tug's engines to turn the tug to starboard.

Consequently, *Adonis*'s master lost steerage of the tug and the tug's movement came under the direct control of the towline forces. This resulted in the tug swinging around on the towline and colliding with *Wolli*'s bow (Figure 18).

By this time, between 1246 and 1246½, the tug was broadside to the direction of the tow's travel and the towline fleeting angle²⁰ was close to 90° to the centreline of *Adonis*. This would have resulted in the maximum towline forces being exerted on the 'H' bitts. In turn, this 90° fleeting angle would have translated the maximum transverse force into the 'H' bitts, causing a heeling moment that rapidly capsized the tug.

After *Adonis* was refloated, an examination of the 'H' bitts showed that, along with extensive paint removal on the starboard side of the 'H' bitts, there were scuff marks across the length of the horizontal member (Figure 20). Given that for most of the tow from Auckland Point wharf, the towline would have been leading to starboard and up towards the bow of the barge through the 'H' bitts (indicated in the yellow box in Figure 20), this scuff marking may have indicated that the towline, under strain, moved across this surface during the period of time leading up to the capsize. The naval architect's calculations show that this movement from starboard

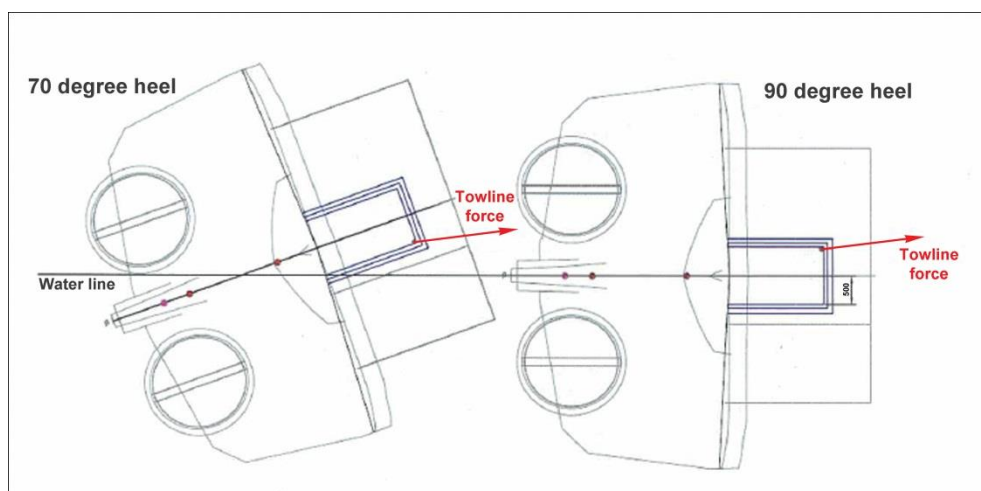
²⁰ The angle at which the towline leaves the 'H' bitts: a low fleeting angle is when the towline leaves the tug over its stern and a high fleeting angle is when the towline leaves the tug off the port or starboard side. The fleeting angle is measured from the tug's longitudinal axis.

to port probably occurred when the tug reached a heel angle of 70° to 90° (Figure 21).

Figure 20: Scuff marks on 'H' bitts



Figure 21: Heeling of *Adonis*, indicating the towline position in the 'H' bitts



2.3 Stability

The consultant naval architect's review of *Adonis*'s stability booklet revealed that several errors were present in the booklet at the time of the tug's construction. The height of the towing hook was not applied correctly in the stability booklet and the bollard pull of the tug was given in the original stability booklet as 10.0 tonnes instead of 10.78 tonnes. Both these errors would have overestimated the tug's stability and underestimated the heeling moment resulting from towline forces.

The combination of both errors compounded the effect and would have led to dynamic capsizing at relative small heel angles (starting from 19°); in comparison the deck edge immersion angle is 14.5°. For the departure case, the most stable, an 18 tonne to 20 tonne load on the towline would have capsized the tug dynamically, for the arrival condition, capsizing could have happened at 60 per cent of the bollard pull to 100 per cent of the bollard pull, i.e. 6.5 tonnes to 10.78 tonnes.

The dynamic assessment and the assessment against the statutory and rule criteria shows that very little safety margin was built into the rule and that marginally failing a criterion means that capsizing was highly likely.

The review also revealed that, following the installation of the winch and ‘H’ bitts,²¹ the tug’s stability had not been recalculated. The installation of the winch (including 220 m of 64 mm diameter polypropylene rope) and ‘H’ bitts added an estimated weight of 2.4 tonnes to the tug and raised the vessel’s centre of gravity by about 0.2 m.

According to the naval architect’s report:

The general arrangement in the stability booklet and associated weight/stability calculation and the example towing stability calculation do not include the tow winch weight and H-bitt weight and the associated increase of towing lever arm and moment. Commonly, a change in light ship weight of less than 2% does not trigger that a stability booklet has to be revised.

The 1.7% change associated with the [*Adonis*] winch has only a very small effect on the non-towing stability condition. However, the winch and the H-bitt alter significantly the stability under tow condition.

The effect of retrofitting the winch and H-bitt alters three conditions:

- a) The centre of gravity increases, which reduces stability.
- b) The towing lever arm increases significantly, in comparison: the original towing hook is at 4.84 m above baseline the H-bitt centre of effort is now 5.45 m above baseline and 500 mm off the centreline.
- c) The longitudinal position of the H-bitt is further aft, now able to induce a significant course changing moment around the vertical axis of the longitudinal centre of gravity. Affecting the ability to control steering and course with rudders every time a transversal acting force was put through the H-bitt.

Despite these errors and omissions, the stability results calculated by the naval architect showed that *Adonis*, when not engaged in towing operations, marginally met the stability criterion set out in the International Maritime Organization’s (IMO) regulations: a GZ²² of at least 0.2 m at an angle of heel equal to or greater than 30°.

However, the naval architect’s calculations also showed that *Adonis* was not stable under a number of relevant operational towing conditions, including towing over the stern, as it was on the day it capsized, because it did not meet the minimum GZ criterion set out by Det Norske Veritas (DNV) in their 1995 towing criteria.

The DNV minimum GZ requirement was 0.314 m. However, when the correct bollard pull and inclusion of the winch and ‘H’ bitts are taken into consideration, *Adonis*’s actual maximum GZ for its original summer draught arrival condition was calculated to be 0.291 m. In addition, this figure fell to 0.264 m when the correct towing hook height (4.84 m) was used.

On 11 June, for the assumed stability condition of *Adonis*, the force on the towline required to capsize the tug, with the ‘H’ bitts and the 2.17 tonne winch installed as they were, was less than the 10.78 tonnes bollard pull when applied transversally through the ‘H’ bitts to either port or starboard.

²¹ The ‘H’ bitts by Sea Swift and the winch by previous owners of the tug.

²² The ‘righting lever’ of a ship: the perpendicular distance between the centre of gravity of a ship and a vertical running through its centre of buoyancy.

In submission, Sea Swift stated that, following the capsizing:

Sea Swift has instigated a program of reviewing all current tug stability books which have been developed overseas for vessels which have been purchased by Sea Swift and are now employed within the company's business.

A naval architect has been retained to review the Information contained in each of the company's tugs and witness an inclining experiment to verify the light ship particulars, and therefore the benchmark reference point for each vessel's calculable operational parameters.

2.3.1 Recalculating a tug's stability following modifications

Chapter 7.1.2 (Determination of light-ship displacement and centres of gravity) of the IMO Code on Intact Stability for All Types of Ships Covered by IMO Instruments,²³ and section 8.1.4 (Determination of lightship parameters) of IMO's International Code on Intact Stability, 2008,²⁴ contain guidance about when a ship should be re-inclined²⁵ following modifications. This guidance states:

Where any alterations are made to a ship so as to materially affect the stability, the ship should be re-inclined.

The intent of this descriptive provision is to ensure that owners/operators do not focus solely on weight that is added or removed from their vessel but also consider the impact any modification may have on its stability.

The IMO requirements apply to all vessels of 24 m in length and greater. However, the risks for smaller vessels like *Adonis* (21.3 m) engaged in towage operations are no different to those for larger vessels of a similar configuration and therefore the IMO requirements are equally applicable.

Although *Adonis* was less than 24 m in length, it was classed with Det Norske Veritas (DNV) and therefore subject to regular DNV survey. With regard to modifications to vessels, DNV had particular requirements covering the reassessment of a tug's stability and the notification thereof. However, neither Sea Swift nor its previous owners had advised DNV of the fitting of the winch or the 'H' bitts.

In submission, DNV stated that the classification society should have been advised of the fitting of this equipment and that:

For a tug, any modifications onboard affecting the heeling lever calculation will require a reassessment/approval of stability. ...under DNV Class Rules (part 1, chapter 1, section 3 B600), these alterations would have triggered a review of the alterations and this would have included a review of the tug's stability.

In Australia, small commercial vessels like *Adonis* are required to be constructed and surveyed in accordance with the National Standard for Commercial Vessels (NSCV). There are NSCV requirements that deal with the stability of these vessels.

²³ Resolution A.749(18), adopted on 4 November 1993.

²⁴ Resolution MSC.267(85), adopted on 4 December 2008.

²⁵ To heel a ship over in controlled circumstances so as to determine the 'righting moment'.

Section 3.3 (Determination of lightship particulars) of Part C, section 6, subsection 6C (Stability tests and stability information) of the NSCV states:

5.4.4 Relevance

Stability information shall be kept up to date to

- a. ensure that it properly reflects the current geometric and mass characteristics (sic) of the vessel.
- b. address the loading and potential stability hazards associated with the vessel's current operation.

In submission, AMSA, on behalf of the National Maritime Safety Committee, stated that:

We believe that clause 5.4.4 is relevant to any stability consideration. This clause would have triggered an action to re-determine and correctly document the vessel's stability characteristics. A reasonable consequence of clause 5.4.4 would have been that a re-calculation would have taken place.

We have checked with several jurisdictions experienced in and responsible for domestic commercial vessel regulation and all agree that following the alteration to the *Adonis* the National Standard for Commercial Vessels would have mandated stability revision.

Our technical advice is that stability revision might not necessarily require a vessel to be re-inclined. The nature of the alteration will determine the method adopted.

Both the DNV and NSCV requirements above give effect to the intent of IMO's stability requirements and therefore mean that the respective owners of *Adonis* should have reassessed the tug's stability after the winch and 'H' bitts were fitted.

2.3.2 Calculation of stability by the master

The naval architect commented on the ability of *Adonis*'s master to calculate the stability of the tug. In his report, he states that:

Another aspect that should be considered is that, although, the stability booklet was not updated it includes sufficient information for a calculation that would have allowed a knowledgeable master or surveyor to evaluate the changed load-condition, however, it is less likely that a master would have identified the errors in the stability booklet. The [report] shows the result of such a hand calculation, the hand calculation demonstrates that the tug *Adonis* fails the criteria with only 10 tonne bollard pull (i.e. even without correcting the errors in the stability booklet).

He goes on to say that:

At the time of capsizing the tug was operating in an unseaworthy condition, due to lack of stability and failing of key regulatory stability criteria. Anyone concerned with the *Adonis* stability could have possibly arrived at this conclusion by undertaking simple hand calculations that are described in the stability booklet as master's instructions.

and:

... although the stability booklet included misleading information that the master could have concluded that the tug was unstable, when used for towing over the

stern through the H-bitts.

During his time in command of *Adonis*, the master knew that something was ‘not quite right’ with the behaviour of the tug. As he told ATSB investigators, he had to slow it down when ‘going around corners’. If he did not, the tug would heel to what he thought was too large an angle. This was under the usual towing operations he had been engaged in before he accompanied the tug to Gladstone. However, he did not bring this to the attention of Sea Swift management.

Adonis’s master had a master class 5 certificate of competency. With regard to his knowledge of stability, the Australian Uniform Shipping Laws (USL) Code,²⁶ under which he was issued his certificate, had the following requirement for stability knowledge:

A general understanding without calculations of the stability of a small vessel, and the use of basic stability information provided on a vessel to ensure safety in relation to: adding and removing weights; water on deck; slack tanks; rolling period; stiff and tender vessel; additions or alterations to vessels.

Given the limited knowledge of stability required of the master, it is not reasonable to expect that he would have undertaken any stability calculations regarding the operation of the tug. This was more appropriately a role for the tug’s owners, its classification society and the survey authority.

In submission, Sea Swift stated that, following the capsizing of *Adonis*:

The company is assisting each master in reviewing their current calculation methods against the revised data to ensure their confidence and ability to calculate the vessel's actual stability in any given scenario.

2.4 Watertight openings

When diving on the sunken tug, the divers found that the two doors leading from the deck into the accommodation block were open (one each on the port and starboard side leading into the galley). They also noted that the starboard side engine room door was open, a hatch to the steering gear compartment on the after starboard side of the main deck was open and the door to the CO₂ room (also on the starboard side) was open. The port and starboard side engine room flaps were also found open.

With regard to watertight openings on tugs, the Nautical Institute publication *Tug use in port – a practical guide* states:

...openings in superstructures, deckhouses and exposed machinery casings situated on the weather deck of tugs should be fitted with watertight doors. These openings should be kept closed during towing operations, so enhancing tug safety. If these openings are not closed, water can easily flow into a tug when she is forced into a list.²⁷

This is exactly what happened when *Adonis* heeled over to starboard on 11 June 2011. That said, the naval architect’s report states that:

²⁶ Australian Transport Advisory Council, 1 January 1991. Section 2 – *Qualifications and manning, trading vessels*, p 10.

²⁷ Page 93.

... in general, the towline forces were sufficient to have capsized the tug with all watertight hatches closed. If the hatches were not closed, this would have exacerbated the heeling motion and subsequent capsizing.

It is considered good seamanship for the crews of tugs to ensure that all watertight doors and hatches are closed while a vessel is in service. Furthermore, Sea Swift had provided guidance in work instructions (AWI-014) with regard to the need to keep watertight openings closed at sea. In addition, there were signs on the doors to remind those crew passing through them to keep them 'closed at sea'.

While photographs taken of *Adonis* after it departed Auckland Point wharf on 11 June 2011 show that the watertight doors on the tug's main deck were closed, it is possible that at some point during the passage, they were opened and not closed again or at least they were not properly resecured after being opened.

While, in this case, the open hatches and doors did not cause the tug's capsize, the tug capsized more quickly as a result of water entering through these openings. Consequently, there was less time available for those on board to abandon the tug before it capsized.

2.5 *Adonis's* towing hook quick release arrangement

Adonis's towing hook quick release arrangement was the last line of defence in preventing a capsize and therefore should have been immediately operable both locally from the after deck and remotely using the release handle located in the wheelhouse.

The intention of having a towline quick release in the wheelhouse is so the master of a tug can quickly release the towline as soon as he thinks the tug might be getting into a position where capsize is possible. For this reason, the remote release arrangement in a tug's wheelhouse should be easily accessible to the tug's master while he/she is at the steering/conning position and that any local locking arrangement on the hook should be set so that the remote release is operable before a tow is commenced.

The wheelhouse remote release for *Adonis's* towing hook was situated at the after end of the wheelhouse, under the chart table (Figures 22 and 23). In that position, it was not possible for *Adonis's* master to reach the remote release handle while he was actively trying to manoeuvre the tug. Consequently, on 11 June 2011, he called out to the deckhand who was standing aft of the wheelhouse to release the hook. The deckhand then passed this instruction to the engineer who was closer to the hook at the time and better placed to move the release lever on the hook itself.

The engineer reached over the hook and moved the release lever's locking pin to the unlocked position. However, despite the hook tripping earlier that day when tested, the engineer could not move the release lever before the tug capsized.

When divers inspected the towing hook after the capsize, the locking pin was in the unlocked position. The diver was also able to push the release lever forward, indicating that the release lever itself was operational.

Figure 22: Wheelhouse overview



Figure 23: Position of the wheelhouse towline release handle

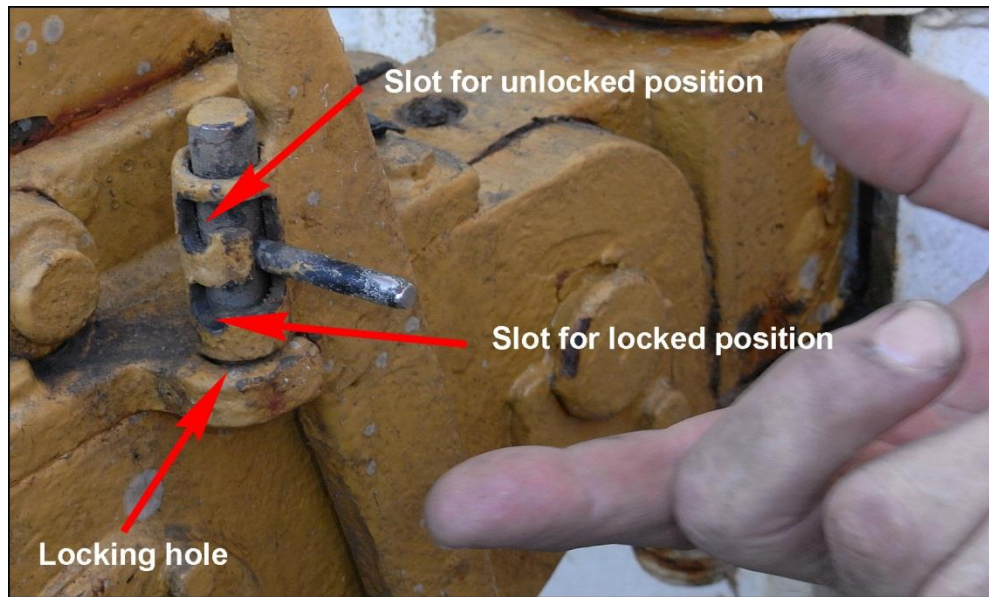


When the tug was refloated, the locking pin was observed to be neither locked nor unlocked (Figure 24). The pin was very easy to move and it is possible that during the refloating of the tug, the pin moved from the unlocked position to that of the partially locked position.

Why the release lever did not move when *Adonis*'s engineer pushed on it could not be determined during the investigations.

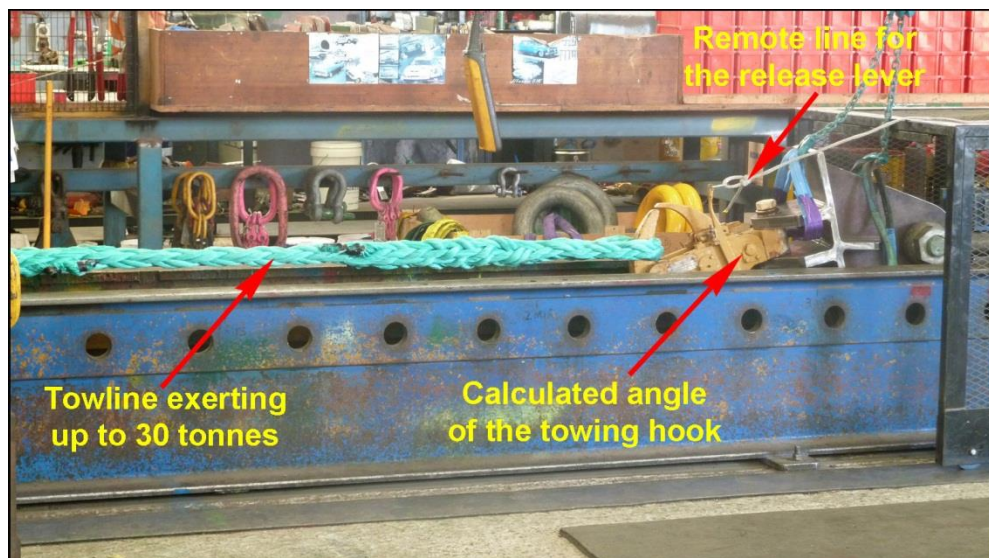
The towing hook was operating within its design parameters, the quick release had been tested twice before *Adonis* departed the Auckland Point wharf and the diver was able to easily move the release lever underwater.

Figure 24: Towing hook on refloating with locking pin partially in the locked position



In an attempt to recreate conditions which the towing hook was subjected to immediately before the tug capsized, a test rig was made to simulate the angles that the towing hook was calculated to be at when *Adonis*'s engineer tried to release the towline (Figure 25). The towing hook was fitted to the test rig and its operation was tested at various loads up to and including 30 tonnes. On each occasion, the towing hook release operated satisfactorily.

Figure 25: Testing of the towing hook in Brisbane



The ATSB sought advice from the towing hook's manufacturer as to a possible reason why the release lever did not move. In their reply, Mampaey Offshore Industries stated:

As we understand..., the locking device was unlocked during operation, and assuming that the load on the hook was lesser than the testload [breaking load of 30 tonnes], and assuming that there were no mechanical failures of the hook, then the hook should open during the correct operation of the release-lever.

Having received your information about the hook-test at the local test bench, which resulted in a proper release, we cannot find a cause for the hook not being released under the mentioned conditions.

In submission, Mampaey Offshore Industries stated that:

Apart from the statement of the engineer, all the evidence shows that the hook and the locking mechanism were in working order at all times. This is shown by the hook being tested by both the engineer and master of *Adonis* before the towing operation, by the divers after the accident, and by laboratory tests conducted subsequently.

Accordingly, the weight of the evidence shows that there was no malfunction of the hook or of its locking device. There is no evidence showing any defect in the design of the hook or its locking device.

Given the free movement of the release lever, as shown by the diver after the sinking, and the post-accident test results which saw the towing hook release the towline at loads up to 30 tonnes, there are two possible reasons why the towing hook release lever did not move on 11 June.

Given the frantic activity on board *Adonis* at the time the master ordered the towline released, in the ‘heat of the moment’, the engineer might not have put the pin right over in the unlocked slot and, given the ease of its movement, the pin may have slipped back into the locked position (Figure 24), thereby preventing the release lever from being able to be pushed forward.

The other possibility is that the engineer, again in the midst of the frantic activity on board the tug, pulled the lever back towards him, instead of pushing it forward. Pulling the lever back would merely be pulling it against the stopper and the towing hook would not be tripped.

2.5.2 Release lever locked on departure

The release lever locking pin feature is standard on Mampaey towing hooks. According to information provided by Mampaey Offshore Industries, the presence of the locking pin enables the towing hook to be used as a mooring hook if required. In towing operations, it prevents the accidental release of the towline while the towline is being placed on the hook and the accidental hitting of the release lever which results in the hook’s tumble piece (Figure 3) becoming ‘unlocked’ but the hook not tripping while making a towline fast. However, once the towline is secured to the hook, it is imperative that the locking pin is moved to the unlocked position before the tow operation begins. If the locking pin is left in place, then the wheelhouse remote release will not work.

Adonis was the only tug in Sea Swift’s fleet to be equipped with a Mampaey towing hook. Before departing Auckland Point, *Adonis*’s crew tested the tow hook release arrangement and then reset it. However, the locking pin was left in the locked position. While the master and engineer were aware of how to release the towing hook, the fact that the tug’s engineer needed to move the pin out of the locked position indicates that they were not aware of the need to ensure that the locking pin was in the unlocked position before the tow commenced on 11 June. With regard to this, there were no instructions in the tug’s operating procedures about this need nor was there any warning sign mounted near the towing hook to ensure this critical action was carried out.

Following the capsizing of *Adonis*, Sea Swift produced an additional annex to its safety management system (SMS) covering safe work procedures for each vessel. This annex includes tow hook emergency release procedures. The company also:

carried out a review of all the company's tugs' towing arrangements and safety release mechanisms. This was in conjunction with a marine directive issued by Maritime Safety Queensland (MSQ) for all tugs operating within Queensland waters as a result of this casualty. This [review] resulted in two hooks being rebuilt out of five operational tugs to comply with MSQ's directive. All of the company's tugs have since been inspected by MSQ and the directive was lifted within a period of three months of the incident.

Further improvements have been undertaken by the installation of highly visible signs identifying the use of the 'safety pin' when engaged in towing operations from the tug's hook.

2.5.3 Locking pin design

The design of the release lever locking pin is such that if the pin is not properly secured in the unlocked position (i.e. by putting the pin in the top slot), there is the possibility that the pin will fall into the securing hole, thereby locking the release lever (Figure 25).

This means that the arrangement is not 'fail safe'. That is, if it were to be bumped, vibrated or moved out of the unlocked position in any way, the pin would fall into, rather than out of, the locking hole. Were the design of the locking pin mount on the release lever reversed and mounted on the release lever under the locking hole, then the pin would fall out of the locking hole. The possibility of inadvertently locking the release lever would thereby be 'designed out' of the system.

2.6 Requirement for two tugs

For the water transfer operation in Gladstone, Sea Swift had produced a Marine Execution Plan (MEP) in accordance with the requirements set out in section 3.2 (Operational aspects) of MSQ's *Standard for Marine Construction Activities within Gladstone Harbour* (the Standard).²⁸

Another requirement from MSQ, given in section 2.1.2 (Barges) of the Standard, was that:

All barge traffic operating at facilities behind the Clinton Wharves, RG Tanna coal facility irrespective of the cargo carried by the barge shall employ 2 tugs. Under this arrangement one tug will act as a primary tug and one tug will act as an assist. A lines or work boat will not be considered to be an assist tug.

The intent of this requirement was that, in the close confines²⁹ between the Clinton coal wharf infrastructure and the R.G. Tanna coal export facility (Figure 26), all barges would have two tugs in attendance to keep the barge clear of the export facilities.

²⁸ March 2011.

²⁹ The distance between the shore and the closest point of Clinton coal wharf number 4 is about 240 m.

At the time of the accident, a new wharf was in the process of being constructed between the Clinton coal wharf infrastructure and the R.G. Tanna coal export facility and future fresh water transfer operations to Curtis Island were to be conducted from there. Until that wharf construction was completed, all fresh water transfer operations were being undertaken from Auckland Point number one wharf.

Figure 26: Image showing the intended area where two tugs are required during barge operations



Sea Swift's MEP contained the instructions (known as 'vessel manoeuvring plans') for berthing *Chrysus* at Auckland Point wharf and the new R.G. Tanna wharf, using *Wolli* and *Adonis*. The plan contained instructions regarding departing with a loaded barge from the R.G. Tanna wharf and included the following:

Once clear of Clinton Wharves and at [a] distance considered by the *Wolli* Master to provide enough sea room from any port infrastructure or other vessels, to allow a safe recovery of the barge in the event of any mechanical failures, the tug *Adonis* will retrieve her line and assume an escort position off the starboard quarter of the barge.

Consequently, Sea Swift's MEP met the requirements of sections 2.1.2 and 3.2 of the Standard.

However, the wording of the MEP section regarding the departure of *Chrysus* from the R.G. Tanna coal export area, specifically 'Once clear of Clinton wharves...', while probably meaning clear of the area behind the Clinton wharves, could be interpreted as meaning once clear of the Clinton wharves, in the Clinton Channel.

This is the interpretation the crews of *Adonis* and *Wolli* made of the guidance in the MEP when they undertook the practice run on 7 June, when *Adonis* remained made fast on a bow line to *Chrysus* and lay alongside the barge until it was let go when the tow had passed the Clinton coal wharves.

While the MEP contained guidance about unberthing *Chrysus* from the new R.G. Tanna wharf, it did not contain any information about unberthing the barge from the

Auckland Point wharf. So, when the plan was changed to put *Adonis* on a stern line on 11 June, the crews agreed that the tug would remain fast to *Chrysus* until clear of the Clinton coal wharves, in the Clinton Channel, as they had done in the practice run.

Information provided by Sea Swift during the investigation was that it was never the intention of the company for *Adonis* to remain made fast to *Chrysus* for the passage up the Clinton Channel. The guidance in the MEP was for the tug to be let go when clear of the coal loading facility and the Clinton wharves.

There was no requirement from MSQ for two tugs to be made fast to a barge to tow it up the main shipping channel past the Clinton coal wharves. However, the MEP requirement to let *Adonis* go after clearing the Clinton coal wharves was ambiguous and consequently, the crews of *Adonis* and *Wolli* misinterpreted the MEP requirement and the tug remained with a line up over its stern after the turn off Auckland point wharf was completed and the barge steadied in the channel.

2.7 Experience in two tug operations

The water transfer operation in Gladstone was the first time that the crews of *Adonis* and *Wolli* had worked together in the water transfer operation and it was the second time they had undertaken a two tug operation where one tug was the primary tug (providing propulsion for a dumb barge) and the other tug was an assisting tug (the first being the practice run). Neither master had any real experience in this type of operation.

This operation was very different to a single small tug operation where the master of that tug ‘ran his own show’ and made all the decisions concerning the tug and tow. In that type of operation, the master does not have to consider the speed, presence or actions of another tug, especially when it comes to disconnecting a towline. The master might only have to communicate with the crew of the craft being towed and, in small tug operations like the type *Adonis* had been involved in before Gladstone, the presence of a pilot would be unusual so there would not normally be any need for the two-way communications necessary when the master is not in charge.

The two tug towage operation being used on the day was also different to the usual multi-tug harbour operation berthing and unberthing large ships under the direction of a harbour pilot where the masters of the tugs work under the direction of the pilot.

Adonis’s master was experienced in operations where he was in charge of a tug towing on a line over the stern but that was where his tug was the only tug involved. He had not worked with a pilot, or another tug master, who was in charge of an operation. Consequently, on 7 and 11 June 2011 in the early stages of the Gladstone operation, he was in the process of gaining the knowledge and experience necessary for him to become familiar with his role as the master of an assisting tug.

Wolli’s master had been involved in harbour towing operations during his career, under a pilot’s direction, but the operation in Gladstone was the first time he had been in charge. With *Wolli* hipped up to *Chrysus*, *Wolli*’s master was effectively the pilot on board a ship which was being assisted by a single conventional tug.

With that role came additional responsibilities, including ensuring that a proper passage plan (including speeds at critical times during the passage) was implemented, that the crew on both tugs were aware of the plan, and that good communications existed between *Wolli* and *Adonis* so that if the master on board either tug had any concerns, those concerns were raised as soon as they became apparent.

However, because the operation in Gladstone was only the second time he had assumed that role, his knowledge of what to do was limited by his experience.

The operation to move *Chrysus* to the cyclone moorings was set out in Sea Swift's MEP, with procedures provided to the crews of the two tugs by Sea Swift. It involved *Adonis* being made fast to the barge's port bow using a line over the tug's bow, in a 'push/pull' configuration. Once the barge had been turned in the channel, *Adonis* was to have been let go and then it was to accompany *Wolli* and *Chrysus* up to the cyclone moorings, with no line made fast to the barge. In this plan, speed on the passage was not an issue and neither was the need to keep any towline forces to a minimum because there was no line made fast from *Adonis* to *Chrysus*.

The crews of the tugs were familiar with the plan contained in the MEP and had practised it on 7 June with no operational issue arising from the manoeuvre. However, the plan was changed for the operation on 11 June and the change was not accompanied with any risk assessment and associated risk controls to make sure that the new plan was as safe as it could have been.

The crews had been employed by Sea Swift based on their qualifications and experience in tug operations. The experience of the two masters was such that the company believed that they had the skills necessary to undertake an operation where *Adonis* would be an assisting tug, made fast to *Chrysus* in a 'push/pull' configuration, and *Wolli* would be the primary tug. Consequently, the company considered that there was no need to conduct any training in two tug operations where the assisting tug would be engaged in towing on a line over its stern because the company never contemplated that the operational plan would be changed from the 'push/pull' configuration.

When the plan was changed for 11 June, those making the decision did not have the necessary experience to properly assess the risks involved in the new plan.

In submission, Sea Swift stated that:

The report correctly identifies the change which was made to the manner in which the tow would be performed on the fateful day when compared with the dry run which had been performed on 7 June. ... the report notes that after the dry run there had been discussions between the *Wolli's* master and what are described as the 'advisors', where concerns were expressed about the flooding tide which would be experienced on 11 June. It seems also from the report that a decision was made at that time, by those persons, that the manoeuvre would be performed in a different way on 11 June. ... the report then goes on to describe the meeting at which the *Wolli's* master informed those present that he wanted *Adonis's* master to make fast to *Chrysus's* port bow. Describing the [deceased] as simply 'an advisor' who was present at that meeting and had been involved on 7 June, the draft report, in our opinion, tends to diminish his role in the crucial decision which was made to change the manner of performance of the tow. He was clearly the person who the two masters regarded as the pilot who was overseeing the operation.

As the report continues to note, in particular at section 2.7, 'the company never

contemplated that the operational plan would be changed from the 'push/pull' configuration'.

In the following paragraph, which concludes section 2.7, it is asserted that 'those making the decision' (to change the plan) 'did not have the necessary experience to properly assess the risks Involved In the new plan'. Given the experience of the pilot and advisor, which is set out on page 2 of the draft report, in the last two paragraphs in section 1.1, we query whether that is an accurate statement at least insofar as the advisor is concerned.

The advisor's background was as a harbour pilot who, following his retirement, had undertaken a small amount of tug work, in a training capacity. While it might be said that the advisor was 'clearly the person who the two masters regarded as the pilot who was overseeing the operation', this perception is not entirely correct. It was the role of the advisor to assist the masters of the two tugs gain their PEC and he was involved in the water transfer operation because of his local knowledge of the port of Gladstone. In other words, he was effectively a pilot, not an advisor in the operational issues involved in the water transfer operation from Auckland Point to Curtis Island. The discussions during the practice run regarding how best to depart from Auckland Point on 11 June were primarily concerned with 'shiphandling' issues and appropriate for a pilot to be discussing with the tug master 'in charge' of the operation.

When the decision was made to change *Adonis*'s configuration, it was up to the Sea Swift staff to follow proper risk identification and minimisation strategies to make sure that any change in the MEP guidance was undertaken in the safest way possible. It was in this area that the lack of experience in this type of towage operation became apparent and the risks in having *Adonis* on a short tow line over its stern for the passage past the Clinton coal wharves were not identified.

2.8 Towage procedures and guidance

Sea Swift had produced a safety management system (SMS) for *Adonis*.³⁰ The implementation date for this SMS was 30 June 2010, almost 12 months before the Gladstone operation began.

Section 7.1 of the SMS manual (Procedures for the preparation of safety plans) states:

The Company has prepared and maintains plans for the execution of key shipboard operations concerning the safety of the ship and prevention of pollution.

Section 7.2 of the SMS manual (Special shipboard operations) states:

Special shipboard operations are those operations that can be performed as a routine operation but, could rapidly develop into a hazardous situation or an accident if the procedure is not followed correctly.

To reduce the risk of hazardous situations that may involve crew members in their normal duties, the Master should chair a safety meeting with those concerned in hazardous activities to discuss and formulate a Job Safety Analysis (JSA) which shall be drafted on Form JSA-01 located in the JSA & Work Permits section of the Work Instructions. A new JSA is to be drafted for each new task and given a

³⁰ Revision 2.

sequential number and file under the control of the Master.

Work Instructions have been prepared by the Company to cover precautions and checks that aim to correct unsafe practices before accidents occur. These include:

- Managing watertight integrity
- Navigational safety, including the correction of charts and publications
- Operations affecting the reliability of equipment and associated machinery
- Maintenance operations
- Bunkering and/or transfer operations
- Condition of stability throughout the voyage
- Anchor Watch
- Watch-keeping and Lookouts
- Emergency Steering
- Main Engine Immobilisation

Section 7.3 of the SMS manual (Critical shipboard operations) states:

Critical shipboard operations are those where an error may immediately cause an accident or situation, which could threaten people, the environment or the ship. Procedures and instructions have been prepared for the following:

- Navigation in close or high density traffic areas
- Navigation in conditions of reduced visibility
- Operations in heavy weather conditions
- The handling and stowage of hazardous cargoes and noxious substances
- Anchoring
- Berthing / Un-berthing
- Embarking / Disembarking a Pilot
- Bunkering and fuel transfers at sea
- Entry into enclosed spaces
- Working aloft and overboard
- Hot work

At the time of the accident, *Adonis* was a tug engaged in harbour towage operations, involving two tugs and a barge within the port of Gladstone. However, despite the contents of section 7 above, there was nothing in the SMS to provide guidance for that specific towage operation in that port and there was no reference in the SMS to the MEP.

However, the MEP was a comprehensive document which contained operational guidance for the Gladstone operation covering cyclones and vessel based emergencies, the handling of waste, job safety analysis and permit to work systems, communications with harbour authorities, sewage, adherence to MSQ procedures, qualifications of the tug crews, incident reporting, transit plans, and cargo movement/vessel manoeuvring plans. It was in this last mentioned plan that guidance for the manoeuvring of the tugs and barge in Gladstone was provided.

The 2010 *Adonis* SMS was a generic document that could be applied to any of Sea Swift's vessels: tugs and cargo ships alike. There were two work instructions within the SMS that were applicable to towing operations – Safety Induction for Towing Operations (SITO) and the general Towing Operations work instruction,³¹ and the scope of the towing operations work instruction was stated as:

The object of this work instruction document is to minimize the risk to the safety of persons involved in a towing operation onboard tugs due to exposure to a hazardous working environment.

There was only one mention of *Adonis*'s towing hook and quick release arrangement made in these documents, and that was contained in the induction document:

Towing hook – open face hook with a manual quick release system, as is normal it has approx 35 degrees either side of the centre line in lateral movement.

The quick release can be operated only on the Master's orders. (stay away from)

Despite the scoping statement above, no operational guidance was provided in the available work instructions (SMS or MEP) to the crew of *Adonis* in Gladstone with regard to passage planning for the water transfer operation, making a tow fast, communications during a tow, the correct use and testing of *Adonis*'s quick release arrangement for its towing hook, or for the necessity for the release lever locking pin to be in the unlocked position. These tasks were specific to this tug and all involved 'risk to the safety of persons involved in a towing operation onboard tugs due to exposure to a hazardous working environment' and therefore should have been included in the work instructions.

In their initial submission, Sea Swift stated that:

Sea Swift believes that its SMS was satisfactory at the time of the casualty. It had employed qualified and experienced personnel, it had identified an appropriate marine execution plan for carrying out the task at hand and had produced an SMS with which all personnel were familiar and complied with. Whilst Sea Swift has made changes since the casualty to some of its documentation it does not consider that there were any failings in its shipboard SMS which had any bearing on this casualty.

Given the fact that the SMS in place at the time of the capsizing did not make reference to the MEP, a document specifically covering the operations in Gladstone, it is reasonable to conclude that *Adonis*'s SMS had not been appropriately revised prior to the tug's relocation to Gladstone. Both the SMS and the MEP should have supported the other document, thereby forming part of a comprehensive system of safety to manage the risks associated with the operations of *Adonis*.

Over reliance on the master's experience

Adonis's SMS relied on the tug's master to 'be suitably qualified and experienced in towing operations'.

However, as discussed earlier in this report, *Adonis*'s master at the time of the capsizing had the minimum qualifications for a commercial operation and had no experience in the type of tug operation being undertaken in Gladstone.

³¹ Both with an effective date of April 2009.

Wolli's master had only just joined the company. He had a master class 4 certificate of competency and he too had not been involved in this type of two tug operation.

For both masters, this operation was totally new, as was the degree of interaction that was required of them as part of a larger team than they had worked with in the past. This required a greater amount of communications between the team than they were used to when coordinating the movement and speed of two tugs, not just one.

Therefore, it should not reasonably be expected of either master, on their own or collectively, to safely oversee the water transfer operation in its early stages. It should have been the responsibility of Sea Swift to ensure that the masters were provided with all the information and guidance in a ship SMS and/or operation specific MEP to enable them to safely undertake the towage operation in Gladstone on 11 June 2011.

2.9 Risk assessment and job safety analysis

There was a requirement in the MEP and the SMS of both *Adonis* and *Wolli* for the master/s to chair a meeting to discuss hazardous activities and formulate a job safety analysis (JSA) for the activity.

Prior to 11 June, a JSA had been completed for harbour towage operations by *Wolli* (JSA No. *Wolli* 005). The JSA was undated and the fields for supervisor and JSA analysis team were empty. An examination of the JSA indicates that it was completed for generic harbour towage operations where one tug was to be used. The issue of speed or letting go a tow line during a towage operation was not included in the JSA.

The JSA contained the following entry:

Job / Task Step (what are we about to do)	Hazards (what can go wrong)	Controls (what can we do to prevent it from going wrong)
On tow	Line parts due to excessive force/angle Tug girted due to unusual event Ingress of water due to angle of heel Loss of engines/vital machinery during tow operations Physical injury to vessel personnel during towing operations	Ensure correct amount of line is used relative to ships height. Good seamanship skills and vessel handling by the tug Master whilst connected. Securing of all lower watertight doors during tow operations. Constant and open communications with Pilot on ship on a designated channel. Personnel aware of safety during towing operations Training in quick release operations, danger zones and personnel responsibilities.

As can be seen, the control for preventing a girting is to use good seamanship skills and vessel handling. There is no mention of speed during a tow, during the letting go of a towline or if the master of the tug is concerned about speed or towline forces, communications with the pilot on the vessel being towed or another tug.

There was no other record of a JSA concerning any other type of towing operation in the records of *Wolli*. Any JSA records on board *Adonis* were lost when the tug sank. However, given the very short timeframe between when its master was told of

the change in towing arrangements and the tugs and barge leaving the wharf, it is unlikely that *Adonis*'s master completed any JSA.

Consequently, despite the requirements for a JSA to be completed for the type of operation *Adonis* and *Wolli* were undertaking on 11 June, no such JSA was completed following the meeting when the decision was made to change the towing configuration. Thus there was no formal risk assessment undertaken for the changed operation where *Adonis* was to undertake the tow over the stern.

Following the discussion between *Wolli*'s master and the advisor during the practice run, the Sea Swift Gladstone operations manager and the two tug masters should have produced a JSA for the task to be undertaken on 11 June as this manoeuvre differed significantly from the unberthing arrangement contained in Sea Swift's MEP.

Had this been done, it is probable that the risks of keeping *Adonis* made fast to *Chrysus* until the tugs and barge had passed the Clinton coal wharves, undertaking the passage at a high speed and possible girting might have been identified and strategies put in place to reduce this risk. These may have included an agreed speed to undertake the passage, an agreed speed at which to let *Adonis*'s towline go and a process whereby the two tug masters maintained better communications during the passage. It might also have identified that there was no need for *Adonis* to be kept on a line once the turn into the channel had been completed.

3 FINDINGS

3.1 Context

At about 1246 on 11 June 2011, the harbour tug *Adonis*, with four persons on board, capsized during an operation to relocate a dumb barge in the port of Gladstone, Queensland. Three of the persons on board escaped the capsizing tug but the fourth did not and drowned in the tug's wheelhouse.

From the evidence available, the following findings are made with respect to the girting of *Adonis*. They should not be read as apportioning blame or liability to any particular organisation or individual.

3.2 Contributing safety factors

- When *Adonis*'s master began to reduce the speed of the tug in preparation for letting go the towline, the barge *Chrysus* began to overtake *Adonis*, increasing the weight on the towline.
- *Wolli*'s master did not reduce the speed of his tug when *Adonis*'s master told him that he was getting ready to let the towline go.
- The high tow speed resulted in high towline forces being exerted on *Adonis*. This resulted in *Adonis*'s master losing steerage of the tug while attempting to reposition it forward of *Chrysus*'s port bow.
- Neither tug master recognised the fact that *Adonis* was in danger of capsizing when its master said that he could not steer the tug.
- The installation of the 'H' bitts on *Adonis* raised the towing point and moved it further aft. This had a detrimental effect on the tug's stability and manoeuvrability which was not known to Sea Swift or the tug's master.
- The towline force acting on the 'H' bitts located further aft induced a larger course changing moment than was present in the original 'hook only' design and made it more difficult for the tug's rudders to maintain a heading or turn in the direction opposing the course changing moment.
- The high towline forces, concentrated at the top of *Adonis*'s 'H' bitts, coincided with a towline fleeting angle of close to 90° and together, these forces induced a heeling moment that was sufficient to capsize the tug.
- *Adonis*'s towing hook quick release arrangement did not operate when the engineer tried to release the towline.
- During the meeting on board *Wolli* before *Chrysus*'s relocation operation got under way, there was no discussion about the speed to be maintained during the passage or when *Adonis*'s crew would be getting ready to release the towline.
- The requirement in Sea Swift's Marine Execution Plan to let *Adonis* go after clearing the Clinton coal wharves was ambiguous and this led to the crews of *Adonis* and *Wolli* misinterpreting the requirement. [*Minor safety issue*]
- The crews of *Adonis* and *Wolli* did not complete a Job Safety Analysis in accordance with the *Adonis* safety management system following the decision to

leave the berth with *Adonis* towing over the stern. Therefore, the risks of the manoeuvre were not fully considered and controls were not put in place.

- *Adonis*'s safety management system did not contain any procedure or guidance in regard to the use and correct setting of the tug's towing hook quick release arrangements. [*Minor safety issue*]
- Det Norske Veritas were not notified at any time, either before or after the fitting of the winch and 'H' bitts to *Adonis*. Consequently, the classification society's requirements, as contained in its classification rules, for having the tug's stability recalculated were never complied with.

3.3 Other safety factors

- The location of the remote release handle in *Adonis*'s wheelhouse was in a position which could not be accessed by the master while he was manoeuvring the tug.
- The location of the towing hook 'locking' pin on the upper part of the quick release lever meant that if the pin was not properly in its 'unlocked' slot, it could fall into the locking hole, thereby locking the release lever. [*Minor safety issue*]
- *Adonis*'s trim and stability booklet contained errors that overestimated the tug's stability and underestimated its towline heeling moment.

4 SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisations. In addressing those issues, the ATSB prefers to encourage relevant organisations to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

4.1 Sea Swift

4.1.1 Requirement about when to let *Adonis* go

Minor safety issue

The requirement in Sea Swift's Marine Execution Plan to let *Adonis* go after clearing the Clinton coal wharves was ambiguous and this led to the crews of *Adonis* and *Wolli* misinterpreting the requirement.

Response from Sea Swift

The ATSB has been advised by Sea Swift that:

the company does not believe there is any 'ambiguity' for the following reasons. If the rear of the Clinton Coal Wharf is deemed to be in need of protection and damage to it to be detrimental to the port's economic wellbeing then it must be assumed that the wharf face against which the overseas vessels berth must be included. That being the case, the instruction, within the MEP, to clear the wharves does not allow of any ambiguity and is compliant with the MSQ's requirements.

For the reasons discussed above, the company has not amended the MEP concerning the location at which the supporting tug is to be let go in the region of Clinton Wharves.³²

³² MSQ has subsequently removed the two tug requirement from the Gladstone Standard.

4.1.2 Quick release arrangements guidance

Minor safety issue

Adonis's safety management system did not contain any procedure or guidance in regard to the use and correct setting of the tug's towing hook quick release arrangements.

Action taken by Sea Swift

The ATSB has been advised by Sea Swift that:

the company has reviewed all emergency release mechanisms associated with its tug and barge operations. This has been conducted in association with a directive issued by Maritime Safety Queensland relating to the safe operation of the tow hook on all Queensland registered tugs, following this casualty. This review resulted in each tug's 'Safe Work Procedure' for tow hook operations and emergency release being updated. The tug crews are now required to observe and operate these releases under training and during regular testing in accordance with Sea Swift's annual drill schedule. All personnel are required to acknowledge their understanding of and competence in the operation of this release and the tow hooks operation and each entry in the 'Safe Work Procedure' is required to be verified by the tug's master.

4.1.3 Additional response from Sea Swift concerning safety actions taken following the capsizing of *Adonis*

The ATSB has been advised by Sea Swift that, following the capsizing of *Adonis*:

An experienced Training Manager has been employed by Sea Swift, together with one additional HSSE team member to review and monitor the company's [health and safety] policies and practices. The HSSE team is charged with reviewing and investigating all incidents with a view to identifying root causes and familiarising the information obtained to all personnel.

Sea Swift has reviewed its training assessment for new masters or potential masters for the towing fleet and have extended the period of training to include mentoring (sic) runs and supernumerary runs with other masters to facilitate the development of a greater understanding of towage requirements. The company has also engaged (in Gladstone) the services of Restricted Pilots to oversee training runs.

4.2 Mampaey Offshore Industries

4.2.1 Location of locking pin

Minor safety issue

The location of the towing hook 'locking' pin on the upper part of the quick release lever means that if the pin is not properly in its 'unlocked' slot, it can fall into the locking hole thereby locking the release lever.

Response from Mampaey Offshore Industries

The ATSB has been advised by Mampaey Offshore Industries that:

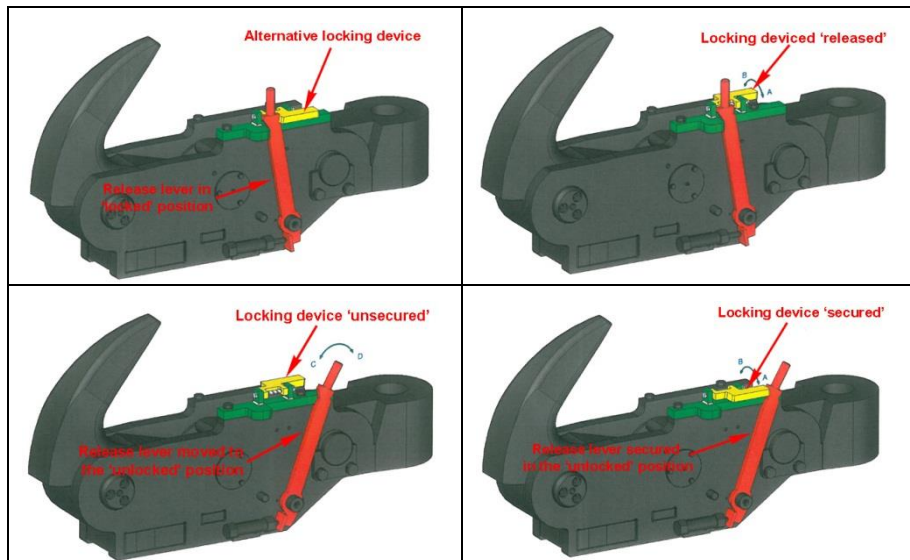
The locking device of the type in question has been sold by [Mampaey Offshore Industries] since the early 1960's, and 11,288 hooks have been sold with this feature. There has never been a reported case of a pin accidentally falling into the locking slot.

With almost any mechanical device which is switched between two positions by hand, it would be possible to find the point of balance between those two positions, so that any slight movement could move it one way or the other. This applies even to an electrical switch. The locking device in this case had a clear locked position and a clear unlocked position. It is difficult to imagine why it would be placed in a position of fine balance between these points. Whether the locking device were on top of the hook, or under the hook the same issue would apply.

If the locking device were under the hook, gravity would still be a factor, although in reverse. Such a locking device could fall out of its slot, thereby unlocking the hook, just as easily as the present locking device could fall into the slot. It could be just as dangerous for a hook to become unintentionally unlocked, as to become unintentionally locked.

Placing the locking device under the hook would make it harder to access, harder to see and harder to reach.

[Mampaey Offshore Industries] has designed and is now selling an alternative [locking] device... However, this was not introduced in relation to any safety concern. It was introduced for the sole reason that it is easier to operate when being used with thickly gloved hands, and can even be operated by foot. It is known as the 'Alaska' locking device, as it can be used in arctic circumstances, where the operators are using thick gloves.



APPENDIX B: SHIP INFORMATION

Adonis

Official number	858300
Call sign	VMQ9235
Flag	Australia
Port of registry	Cairns
Classification society	Det Norske Veritas (DNV)
Ship type	Tug boat
Builder	Mofaz Marine, Malaysia
Year built	1995
Owners and operators	Sea Swift, Cairns
Gross tonnage	91
Length overall	21.3 m
Maximum breadth	6.7 m
Moulded depth (amidships)	3.27 m
Engine	2 x Caterpillar 3406 diesel engines
Total power	544 kW
Steering	2 x fixed nozzles with rudders
Maximum speed	9 knots
Bollard pull	10.78 tonnes

Wolli

IMO number	7037143
Call sign	VJ2034
Flag	Australia
Port of registry	Sydney
Classification society	Lloyd's Register (LR)
Ship type	Tug boat
Builder	Carrington Slipways, Australia
Year built	1970
Owners and operators	Sea Swift, Cairns
Gross tonnage	223
Net tonnage	62
Draught	3.44 m
Length overall	29.88 m
Length between perpendiculars	24.9 m
Maximum breadth	9.73 m
Depth	3.89 m
Engine	2 x Daihatsu 8PSHTB-26D
Total power	1,398 kW
Steering	2 x azimuthing propellers
Maximum speed	10 knots
Bollard pull ahead/astern	28 tonnes/26 tonnes

APPENDIX C: SOURCES AND SUBMISSIONS

Sources of Information

The master and crew of *Adonis*
The master and crew of *Wolli*
Sea Swift
Maritime Safety Queensland
Mampaey Offshore Industries, Netherlands
Queensland Police Service, Gladstone
Holger Kelle, Melbourne

References

- Cole, D. *Preliminary findings report for Maritime Safety Queensland with respect to the tug Adonis which capsized and sunk with loss of life in Gladstone harbour on 11 June 2011*. Report for Maritime Safety Queensland, 2011
- Det Norske Veritas. *Rules for classification of ships, Part 0, Chapter 2*. Det Norske Veritas Classification AS, January 2003
- Det Norske Veritas. *Rules for classification of ships, Part 7, Chapter 1*. Det Norske Veritas Classification AS, July 2012
- Hensen, Captain H. *Tug use in port – A practical guide*. The Nautical Institute, London. Second Edition, 2003
- Hensen, H. *Bow tug operations with azimuth stern drive tugs – risks and effectiveness: Guidelines for tug captains, ship masters, pilots and tug operators*. A monograph. The Nautical Institute, London. 2006
- House, D. J. *Ship Handling: Theory and practice*. Elsevier Limited, UK, June 2007
- International Maritime Organization. *Code on Intact Stability for All Types of Ships Covered by IMO Instruments*. IMO London 1993
- International Maritime Organization. *International Code on Intact Stability 2008*. IMO London 2008
- Kelle, H. *Capsizing of the harbour tug Adonis on the 11th of June 2011*. Report for Maritime Safety Queensland, October 2011
- Kosh, T. *Investigation into the technical aspects of the capsize and sinking of the motor tug Adonis at Gladstone, Queensland, Australia on 11th June 2011*. Report for Maritime Safety Queensland, November 2011
- Marine Accident Investigation Branch (UK). *Report on the investigation into the loss of the tug Flying Phantom while towing Red Jasmine on the River Clyde, 19 December 2007*. Report 17/2008, September 2008

Marine Accident Investigation Branch (UK). *Report on the investigation into the loss of the tug Ijsselstroom in the port of Peterhead, 14 June 2009*. Report 4/2010, April 2010

Maritime Safety Queensland. *Standard for Marine Construction Activities within Gladstone Harbour*. Queensland Government, March 2011

Maritime Safety Queensland. Report into the capsizing of the tug *Adonis* at Gladstone Harbour on 11 June 2011. November 2012

National Maritime Safety Committee. *National Standard for Commercial Vessels Part C Section 6 Subsection 6C – Stability Tests and Stability Information*. NMSC, Sydney 2010

Queensland Transport and Main Roads. *Port Procedures and Information for Shipping, Port of Gladstone*. Queensland Government, November 2010

Western Australian Department of Transport Marine Safety. *Report into the capsizing of tugboat Biggada M&H 1530 whilst un-berthing ship Devon Express IMO 9142590, Fremantle port, Western Australia on 16 November 2009*. January 2010

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the master and crew of *Adonis*, the master and crew of *Wolli*, Sea Swift (Cairns and Gladstone), Maritime Safety Queensland (MSQ), the Gladstone regional harbour master, Mampaey Offshore Industries (Mampaey), the Australian Maritime Safety Authority (AMSA), the National Maritime Safety Committee Secretariat (NMSC), Det Norske Veritas (DNV), the Queensland Police Service in Gladstone, the Queensland Coroner, and the two Gladstone harbour local knowledge advisors.

Submissions were received from the masters of *Adonis* and *Wolli*, *Adonis*'s deckhand, *Wolli*'s mate, Sea Swift Cairns, MSQ, Mampaey Offshore Industries, AMSA (on behalf of the NMSC), DNV, the Queensland Police Service, the Queensland Coroner, and the two Gladstone harbour local knowledge advisors. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

