



Australian Government  
Australian Transport Safety Bureau

# Collision between the tug Arafura Sea Delta and general cargo ship Thorco Crystal

Weipa Harbour, Queensland | 24 June 2017



Investigation

**ATSB Transport Safety Report**  
Marine Occurrence Investigation  
332-MO-2017-005  
Final – 6 December 2017

**Cover photo:** Bhagwan Marine

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

#### **Publishing information**

**Published by:** Australian Transport Safety Bureau  
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#### **Addendum**

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# Collision between the tug *Arafura Sea Delta* and general cargo ship *Thorco Crystal*

## What happened

On 24 June 2017 at about 0735,<sup>1</sup> the tug *Arafura Sea Delta* collided with the general cargo ship *Thorco Crystal* (Figure 1) about 2 NM west of Humbug Point Wharf, Weipa, Queensland. *Arafura Sea Delta* was one of two tugs assigned to assist *Thorco Crystal's* berthing. *Thorco Crystal* was a 146 m long general cargo ship bound for Humbug Point Wharf. The collision resulted in a breach about 80 mm long in *Thorco Crystal's* hull and minor damage to *Arafura Sea Delta's* bow fender frame and bitts.<sup>2</sup>

**Figure 1: *Thorco Crystal***



Source: Bhagwan Marine, annotated by the ATSB

At about 0604, the pilot arrived on *Thorco Crystal's* navigation bridge (bridge) for the pilotage into the port of Weipa. The intended passage took the ship north of Cora Bank before swinging to port and berthing starboard side to at Humbug Point Wharf (Figure 2). The weather was fine with clear skies and the wind from the south-east at 4 to 6 knots.

At about 0622, the tugs *Arafura Sea Delta* and *Sea Hotel*, assigned to *Thorco Crystal*, departed their moorings and began to make their way to the eastern end of South Channel to meet the ship.

On board *Thorco Crystal*, the pilot established contact with the tugs, confirmed where they would meet and was advised that *Sea Hotel* would be the forward tug and *Arafura Sea Delta*, the aft tug. At about 0634, after exchanging information with the master and making the required radio calls to the vessel traffic service, the pilot took over the conduct of the ship. He discussed the intended use of the tugs with the ship's master including the fact that they were conventional tugs<sup>3</sup> and where he intended to have them make fast. At this point, he was informed by the ship's master that while there were bitts on deck aft, there were none in front of the accommodation. The ship's master and pilot also discussed the required ship's speed for making fast the tugs with the pilot advising that a speed of 4 to 5 knots<sup>4</sup> would be appropriate.

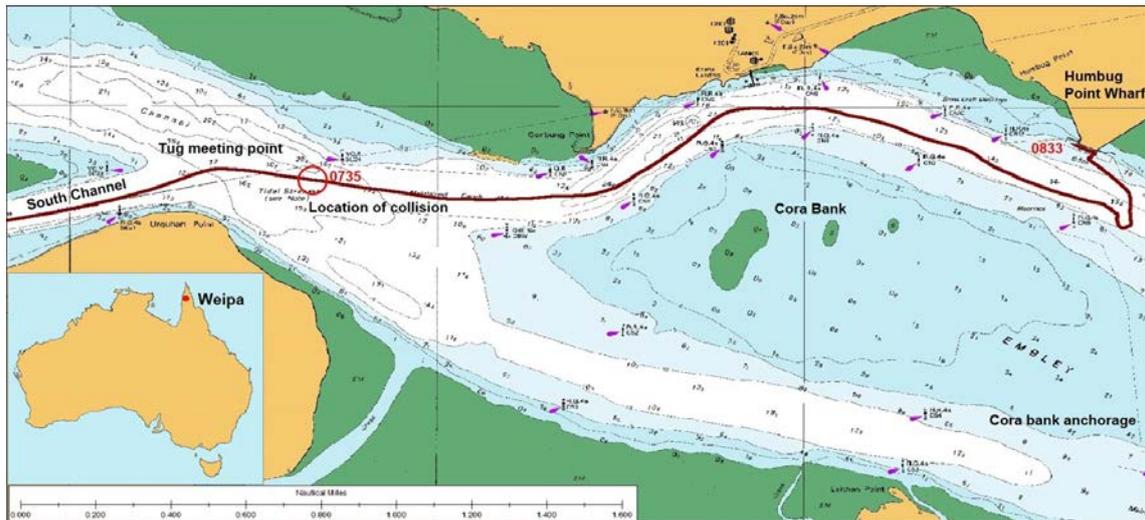
<sup>1</sup> All times referred to in this report are local time, Australian Eastern Standard Time, which is Coordinated Universal Time (UTC) + 10 hours.

<sup>2</sup> A pair of upright cylindrical steel posts projecting above the deck of a ship used for securing lines for mooring or towing.

<sup>3</sup> Conventional tugs utilise conventional means of propulsion—propellers and rudders—located aft and generally have their towing point near to midships.

<sup>4</sup> All ship and tug speeds referred to in this report are 'made good/over the ground'.

Figure 2: Section of navigational chart Aus 4 showing *Thorco Crystal's* track



Source: Australian Hydrographic Office, annotated by the ATSB

At about 0723, the pilot informed the tug masters that once clear of the channel, the ship's speed would be reduced to about 5 knots. The tugs were then to make fast on the ship's port side while ensuring no weight was placed on the tow lines. The pilot's instructions were acknowledged and he was advised that the tugs would be making fast to the ship using a single fixed tow line of 30 m length from the tugs' bows. *Sea Hotel's* master also advised the pilot that given the tugs' design, with no forward winch and a fixed tow line, there would be a time delay when changing between pushing and pulling modes. He also stated that the tugs might have difficulty holding station in the outgoing ebb tide. The pilot acknowledged these concerns and requested that the tugs inform him should they encounter any difficulty and to ensure they did not put any weight on the tow lines which could hamper the pilot's efforts to control the ship's movement. The pilot then informed the tugs that the forward tug would make fast to the port bow while the aft tug would have to make fast 'underneath the accommodation'.

At about 0731, the pilot cleared the tugs to come alongside and make fast to the ship. The order was acknowledged and both tugs started to close on *Thorco Crystal*. *Arafura Sea Delta's* master manoeuvred to about 50 m off the ship's port side and adjusted speed to about 4.5 knots to match *Thorco Crystal*.

*Arafura Sea Delta's* master, seeing no bits on the ship's deck forward of the accommodation, manoeuvred to where the ship's crew were standing, at a set of bits just aft of the accommodation. As the tug got closer, a heaving line was passed down from the ship. The tug's crew attached the heaving line to the tow line, which was heaved up and secured to *Thorco Crystal's* bits by the ship's crew.

A few seconds later, *Arafura Sea Delta's* master felt the tug take a sudden sheer to starboard towards *Thorco Crystal*. The tug master used the two main engines, rudders and bow thruster in an attempt to manoeuvre away but was unable to do so.

At about 0735, *Arafura Sea Delta's* starboard bow contacted *Thorco Crystal's* hull in the way of its port quarter. The impact of the tug's contact was felt by those on *Thorco Crystal's* bridge. The officer-in-charge of the aft mooring party reported the contact to the bridge and that there was an indent in the ship's hull.

*Arafura Sea Delta's* master called the pilot on the radio and informed him that the tug was made fast. He also informed the pilot that the tug was making 'metal-on-metal' contact with the ship's hull due to the position of the tug relative to the curve of the ship's hull.

At about 0736, *Sea Hotel's* master reported that the forward tug was made fast. *Arafura Sea Delta's* master then asked the pilot if he could drop further astern on the tow line and follow the ship to the berth. The pilot, concerned about the effect the tug could have on the ship's speed and

steering if it were to drop astern, indicated that the tug should remain where it was. The tug master acknowledged the pilot's instruction while reiterating that the tug's bits were making direct contact with the ship's hull.

The pilot also tested the ship's rudder and confirmed with *Arafura Sea Delta* that the tug had not made contact with it.

A few minutes later, *Sea Hotel's* master, concerned that the tugs would have trouble holding station in a tidal stream greater than 2 knots during the berthing, asked the pilot for an estimate of the tidal stream. The pilot contacted the vessel traffic service, but they were unable to provide an accurate rate for the tidal stream. At about 0755, as the pilot further reduced *Thorco Crystal's* speed, a mooring boat waiting to assist with the berthing conducted a drift test off Humbug Point Wharf and provided a rate of 1.8 knots for the tidal stream.

At about 0818, the pilot began swinging the ship using the tugs and the ship's bow thruster. The ship was then manoeuvred stern first towards Humbug Point Wharf using the main engine, bow thruster and assisted by the tugs. During the manoeuvre, the tugs reported experiencing difficulty holding station and staying perpendicular to the ship's side in the outgoing ebb tidal stream.

At about 0833, the Master ordered the first line sent ashore and by about 0906, *Thorco Crystal* was all fast, starboard side alongside, at Humbug Point Wharf and the tugs were dismissed.

*Arafura Sea Delta's* master inspected the damage to the tug and found that the top of the steel frame for the fender on the tug's bow was offset slightly and the starboard bits had some paint damage.

*Thorco Crystal*, when inspected, was found to have a breach about 80 mm long in the hull (Figure 3) and several indentations in the vicinity of the breach. Temporary repairs were performed on board and the ship sailed for its next port without any delays.

**Figure 3: Damage to *Thorco Crystal's* hull**



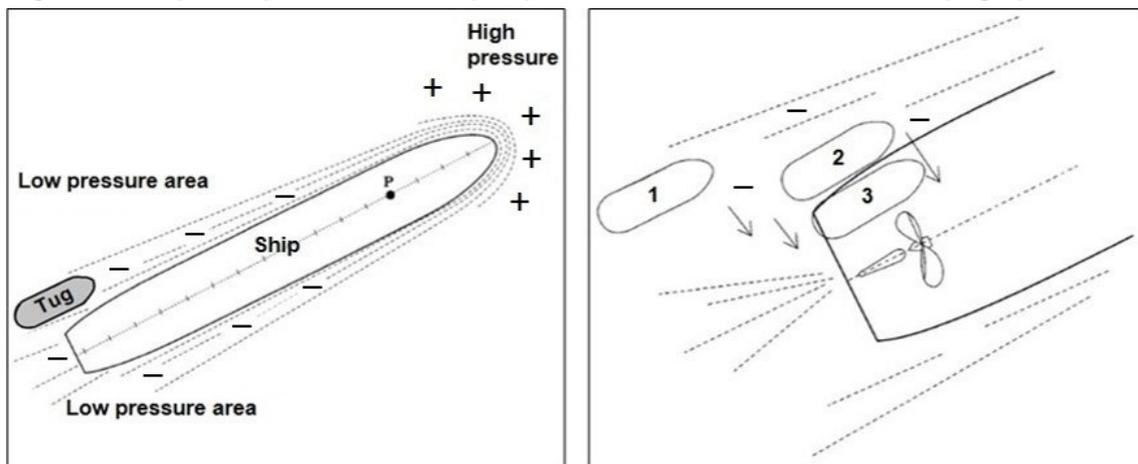
Source: Bhagwan Marine, modified by the ATSB

### Hydrodynamic interaction

A ship making headway through the water develops zones of differing water pressure surrounding it as a result of the water flow around the hull. In general, a positive pressure area builds up ahead of the ship's pivot point<sup>5</sup> (P) while the flow of water down the ship's side creates a low pressure or suction area leading down to the stern (Figure 4-Left). This aft suction area is enhanced by the flow of water into the propeller when the ship's engine is turning ahead.

Speed is the critical factor in managing hydrodynamic interaction (interaction) forces as the magnitude of interaction forces varies with the square of the ship's speed or water flow. The strength and reach of the interaction forces can increase dramatically not only with a small increase in ship's speed but also if the ship passes into narrow or shallow waters.

**Figure 4: Simplified pressure zones (Left) and the effect of interaction aft (Right)**



*Image shows the simplified distribution of pressure zones around a ship underway (Left) and the effect of interaction on a tug aft (Right)*  
 Source: Reproduced with permission from The Shiphandler's Guide, published by the Nautical Institute, modified by the ATSB

As a tug approaches a ship's quarter (Figure 4-Right, position 1), it may experience a sudden increase in speed as a result of the lower water pressure encountered. As the tug comes abeam of the ship's stern, it may experience a sudden suction force and start to take a sheer towards the ship. Without quick action using counter rudder and appropriate power, the tug will be drawn into the ship's side (Figure 4-Right, position 2). If the ship is in ballast, partly loaded or has an overhanging stern, the tug can be drawn in underneath causing serious damage to the tug's superstructure and/or the ship's side (Figure 4-Right, position 3).

### Arafura Sea Delta

*Arafura Sea Delta* is a conventional tug equipped with twin propellers in nozzles, twin rudders and a bow thruster.

Conventional tugs make up the majority of tugs in use today. They range from simple types with a single propeller and rudder to more complex combinations of twin propellers with nozzles and twin rudders. Some conventional tugs are also fitted with a bow thruster to increase manoeuvrability, however, the thruster's efficiency is reduced at speeds above 4 to 5 knots.

*Arafura Sea Delta* was owned and operated by Bhagwan Marine and was contracted for work related to a local mine development project. A marine execution plan, prepared by Bhagwan marine and approved by Maritime Safety Queensland, described the contract's scope of work, the tugs to be used and the services they would provide.

The tug, while suitable for ship operations, had been primarily used for barge work and design features such as the placement of bits forward and the fendering arrangement reflected this (Figure 5). Ship handling operations were not a normal part of the tug's duties. However, the

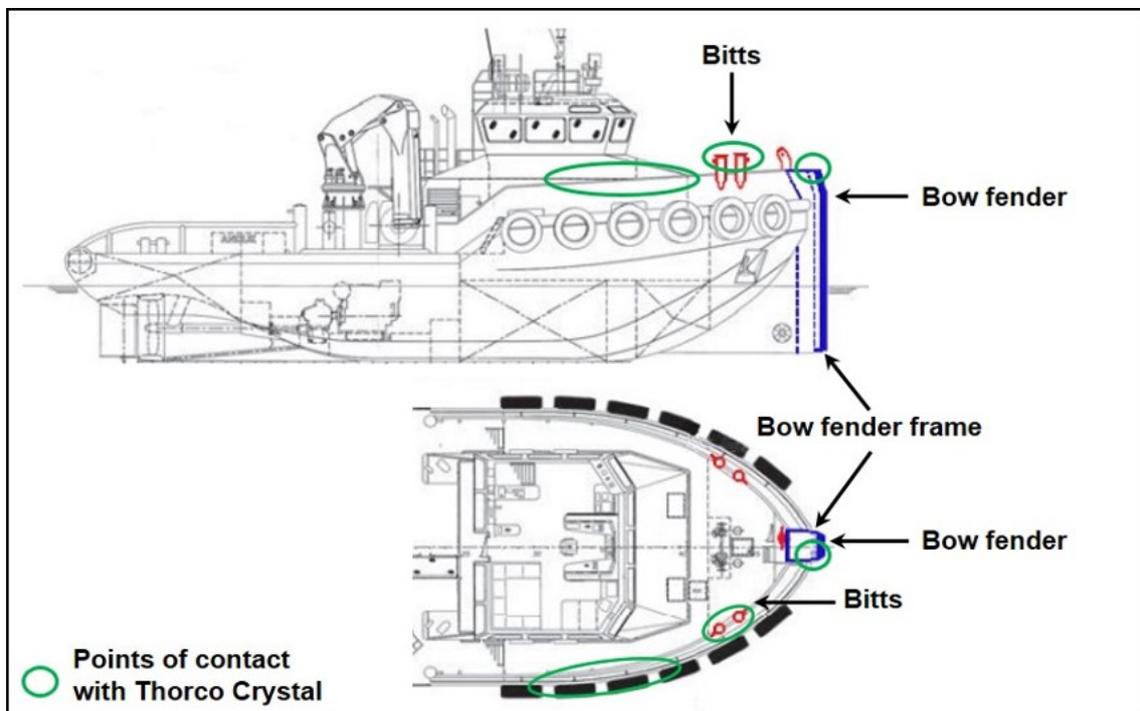
<sup>5</sup> Pivot point: The itinerant vertical axis about which a ship rotates during a turn.

scope of work for the contract included tug support for heavy lift vessels bringing in project cargo, such as *Thorco Crystal*.

Bhagwan Marine, as part of their safety management system, provided an operational work instructions (OWI) manual to guide their tug masters in conducting harbour towage operations. The manual included identified hazards, safeguards, procedures and contingency plans governing the conduct of harbour tug operations. The company also maintained a project-specific risk register which identified several hazards, their associated risks and listed control measures to mitigate these risks. However, interaction was not specifically identified as a hazard in the manual or the risk register.

*Thorco Crystal* was the second ship operation that *Arafura Sea Delta*'s master had participated in with the previous operation having been completed successfully about 3 weeks before the incident. While the tug master had completed training involving ship handling operations and was aware of the dangers of interaction, his experience was mostly limited to barge work.

**Figure 5: Layout of bitts and bow fender on *Arafura Sea Delta***



Source: Bhagwan Marine, modified by the ATSB

## Safety analysis

*Arafura Sea Delta*'s position near the ship's port quarter placed it in the low pressure zone surrounding *Thorco Crystal*'s stern. This likely subjected the tug to the hydrodynamic interaction (interaction) forces generated by the flow of water around the ship's hull. The sudden sheer to starboard experienced just before the impact is consistent with the documented effects of interaction forces on a tug operating at a ship's stern. The ship's speed of 4.5 knots and the estimated ebb tidal stream of about 1.8 knots (obtained after the collision) were both factors that had an influence on the strength of the interaction forces generated. Furthermore, tidal streams on the ebb tide are known to reach rates of up to 4 knots in the vicinity of the collision, potentially intensifying the interaction forces generated.

## Findings

- While making fast to *Thorco Crystal*, the tug *Arafura Sea Delta* was affected by hydrodynamic interaction forces and subsequently collided with the ship.

## Safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

### ***Bhagwan Marine***

As a result of this occurrence, Bhagwan Marine has advised the ATSB that they have taken the following safety action:

#### ***Operational work instructions manual***

The operator reviewed its operational work instructions manual for harbour tug operations and amended it to include a section on hydrodynamic interaction. The manual also addresses interaction as an identified hazard with associated safeguards, control measures and amended procedures. These include improved communications with pilots, safe zones when making fast to ships and safe speed limits based on factors such as tidal flow, engine power and location of tow line attachment.

#### ***Arafura Sea Delta's job hazard analysis***

*Arafura Sea Delta's* on board job hazard analysis (for harbour towage operations) has been reviewed and amended. The amendments include the identification of interaction as a hazard with corresponding control measures such as a safe speed for connection and consideration of the suitability of the connection point on the ship.

#### ***Pre-planning meeting***

A pre-planning meeting is now held between the pilot and the master of the lead tug prior to ship movements. The company has advised that this meeting allows both parties to exchange information about the ships, positioning of the tugs and weather forecasts, among other things.

#### ***Fendering arrangement***

Tugs now adjust the configuration of their fendering based on the outcome of the pre-planning meeting between the pilots and tug masters.

## Safety message

Masters of ships and tugs, pilots and others involved in handling vessels in confined waters or in proximity to other vessels are reminded of the hazards posed by hydrodynamic interaction (interaction). An awareness of the pressure zones around a moving vessel and an appreciation of the effect of speed on interaction forces can help vessel handlers foresee a potential interaction situation developing and allow them to deal with it. The effects of interaction can be amplified by an increase in vessel speed, the presence of another vessel or if the flow of water around the vessel is influenced by tidal streams or by entering a narrow or shallow channel.

Operators are encouraged to review procedural guidance and risk assessments to ensure that they reflect the hazards and associated risks of interaction.

Further guidance on interaction and its effects can be found in [Marine Guidance Note \(MGN\) 199 \(M\) – Dangers of interaction](#) published by the United Kingdom's Maritime and Coastguard Agency.

## General details

### Occurrence details

Date and time:	24 June 2017 – 0735 (UTC + 10)	
Occurrence category:	Serious incident	
Primary occurrence type:	Collision	
Location:	Weipa Harbour, Queensland.	
	Latitude: S 12° 41.0' S	Longitude: 141° 50.9' E

### Ship details

Name:	<i>Arafura Sea Delta</i>
IMO number:	9295646
Call sign:	VJN4167
Flag:	Australia
Classification society:	Bureau Veritas
Ship type:	Tug
Builder:	Damen, Netherlands
Year built:	2004
Owner(s):	Bhagwan Marine
Manager:	Bhagwan Marine
Gross tonnage:	212
Deadweight (summer):	61 t
Summer draught:	2.6 m
Length overall:	26.2 m
Moulded breadth:	9.1 m
Moulded depth:	3.6 m
Main engine(s):	2 x Caterpillar 3508B
Total power:	1640 kW
Speed:	11.7 knots
Damage:	Minor damage to bow push pad and starboard bits

Name:	<i>Thorco Crystal</i>
IMO number:	9294965
Call sign:	V2BP9
Flag:	Antigua and Barbuda
Classification society:	DNV-GL
Ship type:	Multipurpose dry cargo ship
Builder:	Damen Shipyards
Year built:	2004
Owner(s):	Marmadura Schiffahrtsgesellschaft
Manager:	MarConsult Schiffahrt
Gross tonnage:	7,769
Deadweight (summer):	10,508.17 t
Summer draught:	7.36 m

Length overall:	145.63 m
Moulded breadth:	18.25 m
Moulded depth:	10.33 m
Main engine(s):	1 x MAK 9M32
Total power:	4,970 kW
Speed:	13.2 knots
Damage:	Breach in shell plating about 80mm long

## About the ATSB

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB 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; and 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 operations involving the travelling public.

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.

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.

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.

## About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.



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## Investigation

### **ATSB Transport Safety Report** Marine Occurrence Investigation

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