Office of the Chief Investigator
Transport Safety

Marine Safety Investigation
Report No 2010/14

Capsize of
Vessel 'The Ultimate'
Off Point Nepean
12 December 2010

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THE CHIEF INVESTIGATOR

The Chief Investigator, Transport Safety is a statutory position under Part 7 of the *Transport Integration Act 2010*. The objective of the position is to seek to improve transport safety by providing for the independent no-blame investigation of transport safety matters consistent with the vision statement and the transport system objectives.

The primary focus of an investigation is to determine what factors caused the incident, rather than apportion blame for the incident, and to identify issues that may require review, monitoring or further consideration. In conducting investigations, the Chief Investigator will apply the principles of 'just culture' and use a methodology based on systemic investigation models.

The Chief Investigator is required to report the results of an investigation to the Minister for Public Transport or the Minister for Ports. However, before submitting the results of an investigation to the Minister, the Chief Investigator must consult in accordance with section 85A of the *Transport (Compliance and Miscellaneous) Act 1983*.

The Chief Investigator is not subject to the direction or control of the Minister in performing or exercising his or her functions or powers, but the Minister may direct the Chief Investigator to investigate a transport safety matter.

EXECUTIVE SUMMARY

On 12 December 2010, the fishing charter vessel The Ultimate was conducting fishing operations north of Point Nepean bank when the vessel was impacted by a steep breaking or near-breaking wave and capsized.

The vessel was carrying nine recreational fishermen and three crew members. The crew and seven passengers managed to get on board one of The Ultimate's liferafts and were later taken aboard another vessel that came to their assistance. One passenger was trapped under the vessel and was subsequently assisted out. A 52-year-old male passenger did not survive the incident.

The investigation concluded that the vessel was operating in a hazardous area that was subject to large waves, and that the master made an error of judgement with respect to an approaching wave when he did not follow conventional boat handling practices.

Although the area that the vessel was operating in was designated partially smooth waters, oceanographic evidence indicates that the waters do not meet the criteria for partially smooth waters as specified in the Uniform Shipping Laws code. Also, the area he was operating in was outside the defined area of Port Phillip Heads allowing the master of the commercial vessel to operate without the benefit of training for Port Phillip Heads operations.

The investigation found anomalies in the commissioning stability assessments of the vessel. An assessment carried out in the incident loading condition indicated that the vessel did not meet the comprehensive stability requirements for 'restricted offshore waters'. However, the investigation concluded that the non-compliance with the stability criteria was unlikely to have contributed to the capsizing of the vessel.

It was found that modifications carried out to the vessel during its conversion from a dive charter vessel to a fishing charter vessel were not recorded in the regulator's files.

The investigation recommends that Transport Safety Victoria conducts a review of commercial operations in the incident area and review their processes for maintaining the modification status of vessels. The investigation also recommends that Gamerec Charters conducts a risk assessment of its operations and amends operating procedures accordingly.

1. CIRCUMSTANCES

On 12 December 2010, the fishing charter vessel The Ultimate departed Queenscliff at about 1420 on a fishing expedition. The vessel arrived at Point Nepean bank at about 1440 and commenced fishing operations. The vessel was carrying nine recreational fishermen and three crew members.

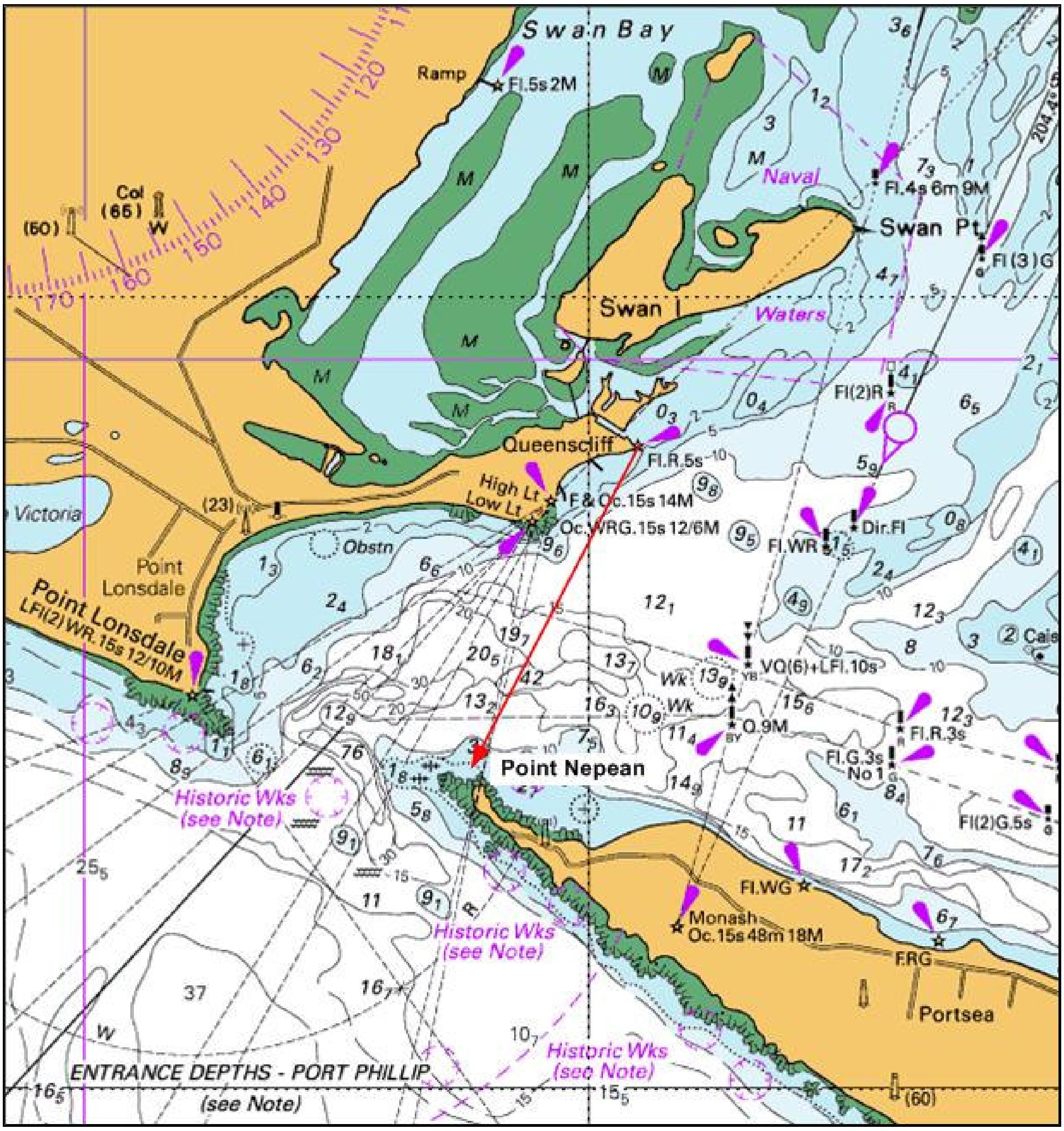

Figure 1 - Extract of chart 144 indicating Queenscliff and Point Nepean

The vessel was operating in the area immediately north of the rock formations extending west of Point Nepean and was being manoeuvred approximately in the region indicated in Figure 2.

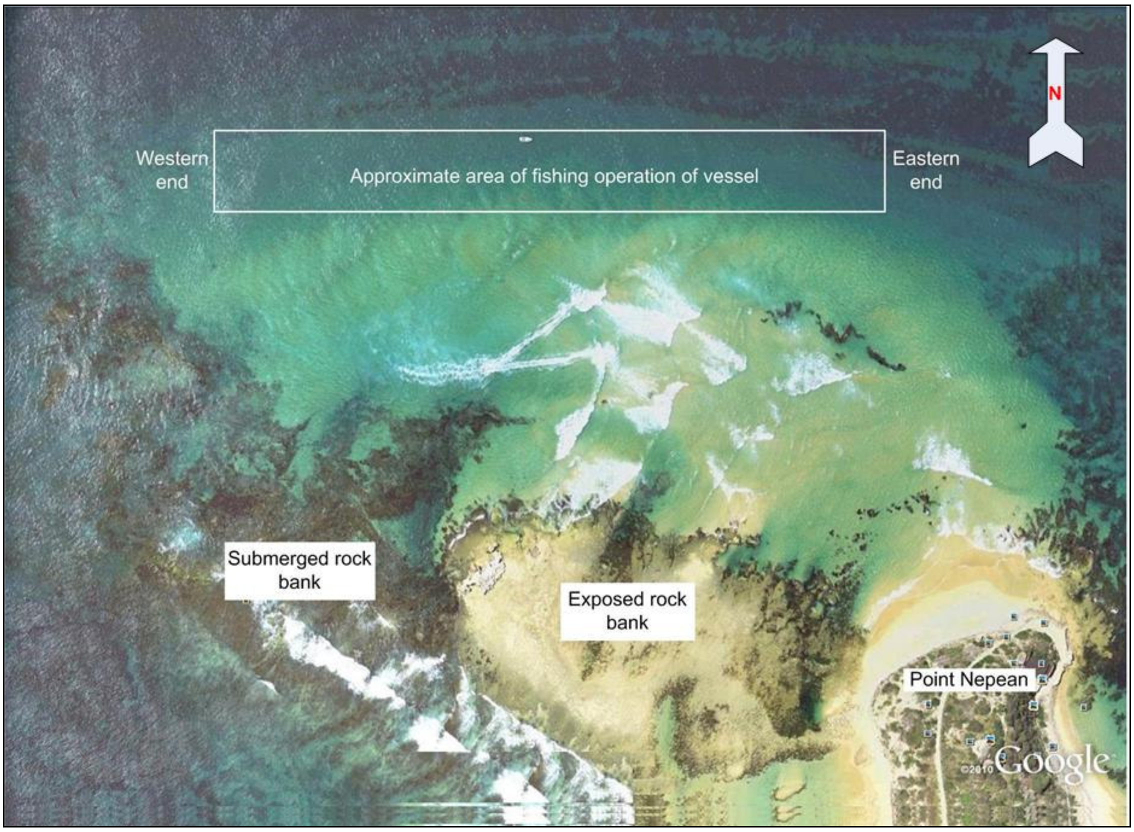

Figure 2 – Arial photo indicating approximate area of operation of vessel

Prior to the incident, the vessel had conducted two runs between the easterly and westerly extremities of the indicated region. On its third run the vessel was heading in a southwesterly direction when a wave impacted the starboard bow/beam region causing it to capsize. The capsized vessel drifted onto a sand bar about 150 metres northwest of Point Nepean and came to rest, inverted on its canopy, facing east.

During the capsize, the master, the other two crew members and seven passengers were either thrown or jumped into the water or otherwise made their way clear of the upturned vessel and managed to get on board one of The Ultimate's liferafts. They were subsequently taken aboard another vessel that came to their assistance. One passenger was trapped in the wheelhouse of the vessel and was subsequently assisted out by a dive instructor who arrived at the incident site on another vessel. The remaining passenger, a 52-year-old male, did not survive the incident.

2. Factual Information

2.1 Vessel - The Ultimate

2.1.1 Description

Figure 3 - The Ultimate before damage

The Ultimate was a 10.5 metre, aluminium alloy, monohull vessel, originally purpose-built for dive operations. The vessel had a planing hull form with a hard chine. The hull and topsides were of welded construction. The vessel had a large deck area bounded by solid bulwarks on its sides and open at the stern.

An aluminium awning covered a major portion of the weather deck and was supported by aft pillars that were also the air intake ducts for the propulsion engines. Two liferafts and four life-rings were mounted on the awning. Zip-out (removable) plastic sheets were fitted on either side of the roofed in area, between the pillars. Removable doors (slot doors) were fitted on the port and starboard sides of the vessel just aft of the wheelhouse. These doors could be manually lifted out to create an opening.

A bait table was mounted on the aft deck and a stern frame with fishing rod holders was mounted at the aft end of the duckboard. A padded seat was located in the centre, extending longitudinally under the roofed-in area, providing back-to-back seating for six to eight passengers. Storage space was provided under this seat. Ladders provided access to the roof and the railings on the sides of the vessel provided hand holds for vessel occupants.

The vessel’s propulsion system consisted of two Volvo Penta turbocharged engines of 167 kW driving stern drives. The vessel was rated for a service speed of 20 knots.

The wheelhouse controls were Volvo Penta and a mechanical-hydraulic system provided steering. A mechanical linkage provided throttle control from the wheelhouse to the engines.

2.1.2 Post incident inspection and damage

Subsequent to the incident, the vessel was transported to Queenscliff harbour and inspected. There was no noticeable damage to the vessel hull or the stern drives. However, most of the wheelhouse equipment, propulsion machinery and electrical systems were unserviceable due to seawater damage. Various tools and personal life saving appliances were scattered around the wheelhouse and rope, fishing equipment and the sea anchor were dispersed on the external deck area.

Figure 4 - The Ultimate after capsize

The wheelhouse controls were caked with sand and several gauges and an indicator panel had broken away from their mountings. A significant amount of sand was also found in the forepeak compartment of the vessel. The upper hinge of the watertight door of the wheelhouse was ripped out and the door was hanging ajar from the lower hinge that was still attached to the bulkhead.

The awning, the starboard awning support and side framing and screens had been ripped off the vessel. A number of cracks were present across the welds in the areas around the fixed awning supports and on the weather deck gunwale top and side plates.

The vessel's bait box that was located on the after-part of the weather deck was ripped off. In addition, the port side removable door, mid-ship compartment access hatch and wheelhouse compartment access hatch had been displaced.

Propulsion and steering equipment

A visual inspection was carried out on the engines and associated equipment in the machinery space. The engines could not be function tested because both engines and associated machinery compartments had been submerged in seawater. Oily seawater residue covered a significant proportion of the engine externals. On removal of the air filters casings, seawater was found inside the turbocharger housings and engine intake piping.

The fuel and lubricating oil systems were inspected with all filters opened to inspect internals. Both systems were found to be tight with no evidence of seawater ingress.

The speed control lever and mechanical linkages to both engines were in a position which corresponded to approximately 30 per cent ahead throttle. However, it was not possible to determine if the speed control had been moved during or following the incident. The speed control was manually operated and the controls on both engines functioned satisfactorily without restrictions.

2.1.3 GPS chart plotter data

The vessel was equipped with a GPS chart plotter. The chart plotter contained base map cartography and a chart card for the area of Port Phillip Bay was installed to aid navigation. The unit obtained position information from an external GPS sensor, and speed and depth information were obtained from external transducers. Data stored in the unit was retrieved and interpreted by the unit manufacturer and is shown in Figure 5.

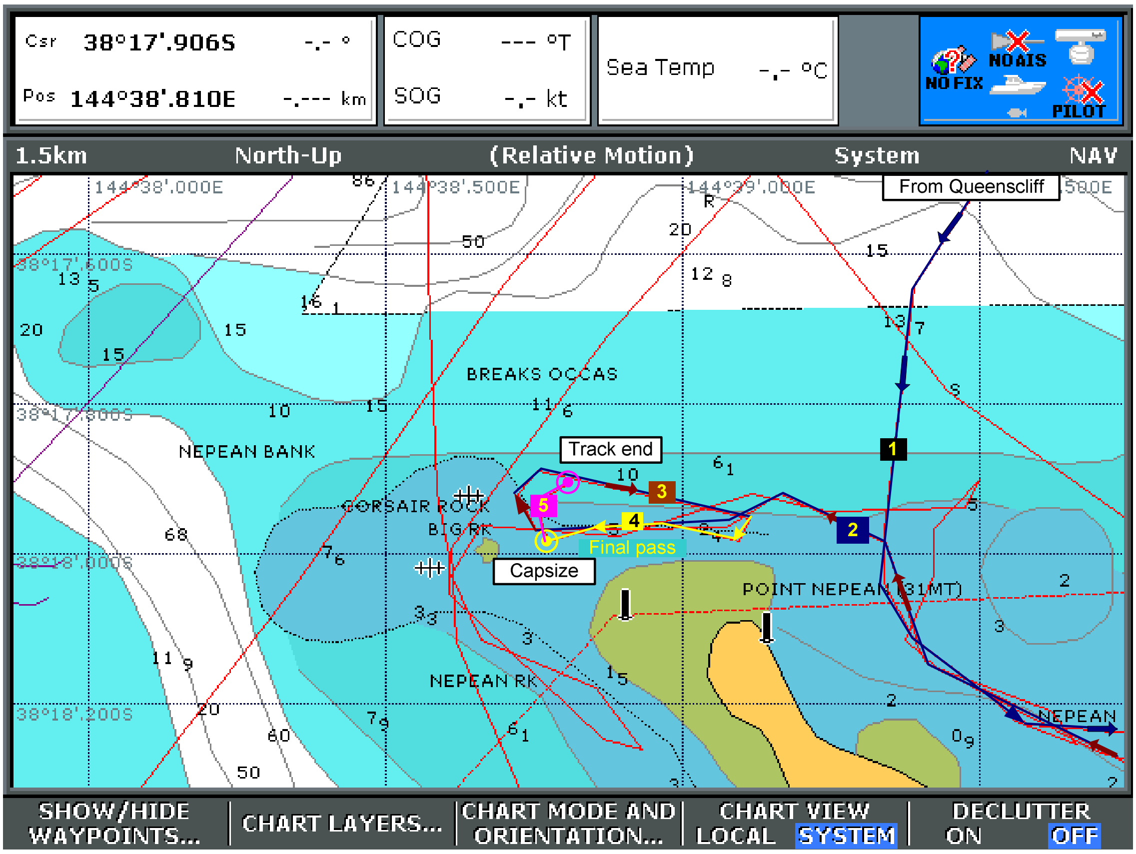

Figure 5 - Track representing the final charter voyage

The track data function was permanently enabled on the unit and showed multiple tracks in and out of Queenscliff Harbor. The image in Figure 5 shows a number of track lines (red lines) crossing through the area. These additional track lines have been made during different passages of the vessel and are probably not related to the final voyage.

For clarity, the track of the final voyage is highlighted and is shown as five segments. Track segment 1 indicates the trip from Queenscliff heading south and east. The vessel then turned and headed west, as indicated by track segment 2. Track segment 3 shows the vessel heading north and then east. Track segment 4 shows the vessel heading west, with the segment terminating at a position that is the most probable point of capsize of the vessel. The vessel then drifted north due to the tide, as indicated by segment 5. The track terminated when the unit stopped functioning due to either power failure or water damage.

From the available data it was estimated that the vessel was travelling at approximately 5 to 6 knots at the time of the incident.

2.1.4 Owners and operators

The vessel was purchased in 2009 by the current owner, Dive Victoria Group Pty Ltd, Queenscliff (Dive Victoria), and leased to Game and Recreational Fishing Charters (Gamerec Charters) who modified and used the vessel for fishing charter operations until the incident. Gamerec Charters operated the vessel as The Ultimate.

2.2 Personnel

2.2.1 Overview

The vessel's total complement consisted of the master, two deckhands and nine passengers.

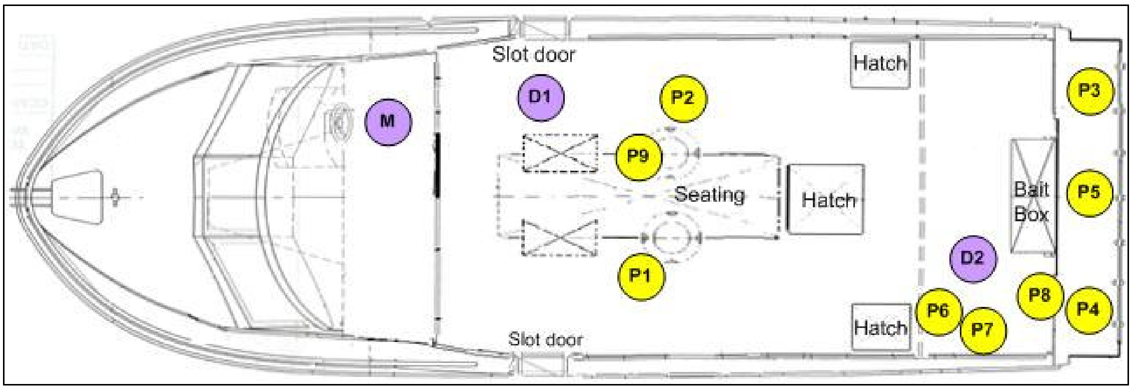

Figure 6 - Approximate positions of crew and passengers prior to capsize

2.2.2 The master

The master of the vessel held a current and valid Certificate of Competency (CoC) as Coxswain issued on 18 November 2003. His CoC was revalidated on 3 December 2008 and was valid until 18 November 2013.

The master informed the investigation that he had started working as a deckhand in Queensland in 1994 before moving to Victoria in August 2000. Once he was certified as a Coxswain he worked as the master on mussel boats for about 15 months and was employed by Gamerec Charters from November 2007. He stated that he initially worked alternatively as a deckhand and master and after a period of about 12 months worked solely as the master on two vessels owned by Gamerec Charters.

The master stated that he started work at about 0500 on the day of the incident. The first charter of the day commenced at about 0600 with 12 passengers and two other crew members. He said that he fished north of Swan Island to get some protection from the wind that had picked up to about 28 knots from the west-southwest. He stated that due to the adverse weather conditions the charter was reduced from eight to five hours and they returned to Queenscliff at about 1155.

The master stated that the afternoon charter was scheduled from 1400 to 1900 and he intended fishing north of Swan Island and also trawl for salmon off Point Nepean. He said that at about 1420 nine male passengers and the two other crew members boarded The Ultimate and that he conducted the standard safety procedures that involved briefing the passengers on the location of Personal Flotation Devices (PFD) and demonstrated the proper donning of these devices. He also said that he briefed the passengers about the first aid kit, radio communication, flares, EPIRBs and fire extinguishers, and conducted a man-overboard exercise.

With respect to the location of passengers on the vessel, the master explained that the deckhands ensured that the passengers were evenly distributed on the vessel.

The master stated that he checked the weather forecast at about 1300 and the bay conditions were mild with an 8 to 10 knot wind from the southwest. He stated that they arrived at Point Nepean at about 1445 and that he was comfortable with the conditions and, as there was no groundswell, he felt that they were totally safe. He stated that he observed the deckhand assisting the passengers to don the PFDs, although that is not his normal practice when trawling for salmon at Point Nepean.

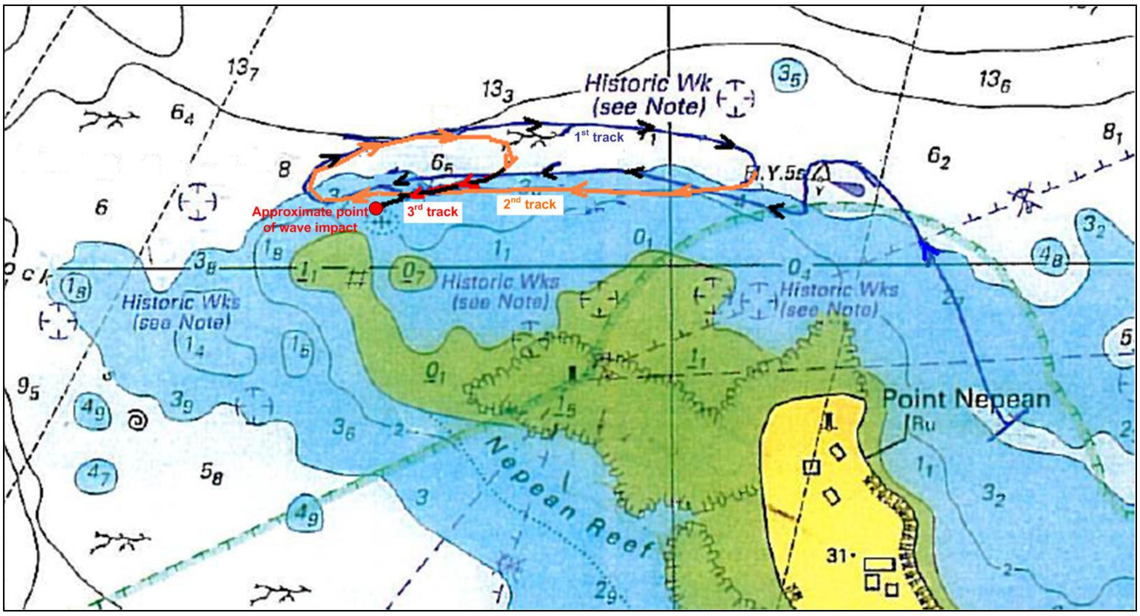

Figure 7 - Approximate track of The Ultimate as indicated by vessel master

The master said that he started tracking east along the Marine Park Line over three ledges that are common fish holds. He recalled that he did two passes and caught salmon on the second pass. He said that on the third pass he decided to cut his track short and follow his previous track where he caught the salmon, about 100 metres away from Big Rock. He said the vessel was travelling at about 3.5 to 4 knots and the engines were running at about 300 revolutions per minute when he noticed a full rolling ground swell of about 6 foot (1.8 metres) about 25 to 30 metres off his bow, which was not going to face up or form a breaking wave.. He said that he increased the engine speed to about 500 revolutions and the vessel was travelling at about 5.5 knots. He stated that he was preparing to manoeuvre the vessel over the swell when he noticed another smaller swell of about 4 to 5 foot (1.2–1.5 metres) coming from the beam of the vessel's port side. He said that he then noticed that the swell on his starboard bow had risen to about 10 to 12 feet (3.0–3.6 metres) and he put both motors to full throttle to punch through or go over the wave. He stated that a wave that was higher than the roof of the vessel, about 2.5 to 2.8 metres high and was still forming, hit the vessel. He said that he steered slightly to the port side before the wave from the port side hit the vessel and the combination of the waves turned the vessel onto its port side. He said that the vessel travelled about 30 metres on its port beam until eventually the wave engulfed the vessel and completely rolled it over. He stated that he tried maximum throttle to outrun the waves, but was not successful as he could not get enough power as the propellers were cavitating[1].

The master stated that during the rollover he was in the helm chair and was not wearing a PFD. He recalled the deckhands calling out to the passengers to deploy their PFDs. He said that he observed water rush along the port side and wheelhouse, three people get thrown onto the roof in the back deck, and two or three people try to jump or get taken by the water as it came over the deck. He stated that when the boat came to rest he released his brace from the helm chair and fell onto the roof as the vessel was now upturned. He said that he then attempted to make a VHF call to the vessel Kyena and 'mayday' for assistance, but could not get the calls out due to the flooding in the wheelhouse.

He stated that once the cabin was completely flooded, he was stuck in an air pocket. After disentangling a rope around his right leg, he said that he managed to extricate himself through the starboard window. He stated that when he surfaced he saw that the propellers were still rotating and also noted that two passengers were missing. He said that he looked for the liferafts and, realising that they had not automatically released, found the static lines and activated them. He said that he then attempted to locate the missing persons.

The master stated that it took about 10 minutes to get everyone into the liferafts and counted seven passengers and the two other crew members. He said that he was physically spent and was not able get back under the hull to attempt to find the missing passengers.

The master stated that about 15 minutes after the incident the dive vessel Sea Dragon arrived at the scene, and soon after the Oceanic Diver and the Nemo also arrived. He said that he advised the Sea Dragon that two persons were missing and the vessel headed towards The Ultimate, which was being washed onto the Point Nepean shoreline. He said that after about 10 minutes of navigating around The Ultimate, the Sea Dragon came back to the liferaft and took on the passengers and crew and then continued to look for the missing persons until about 1615. It then departed for

[1] Bubble formation at the surface of the propeller blades as a result of low pressure. Cavitation will normally lead to a reduction in propulsive performance.

Queenscliff harbour where the waiting ambulance crews attended to the passengers and crew.

The master stated that The Ultimate was in good condition and he did not experience any mechanical or steering problems. Also, that the sea conditions were favourable for fishing and that “there is nothing in his decision making that he would change”.

The vessel operator Gamerec Charters estimated that the incident vessel’s master had approximately 3000 hours total experience as a master with them, including about 1300 hours experience on The Ultimate. The operator was unable to state with certainty the master’s fishing experience in the waters around Point Nepean, but estimated that about 200 to 500 hours may have been spent in the area of the incident.

2.2.3 Deckhand 1

This crew member stated that he holds a Coxswains CoC issued in 2006 and had been employed by Gamerec Charters as a deckhand for about three weeks. He said that his duties were to assist in the berthing and unberthing of the vessel, assist the passengers and prepare the vessel’s fishing gear.

The crew member stated that on the day of the incident, he was the deckhand on the morning charter that started from Queenscliff at about 0700 and returned at about noon. After this charter, he washed down the vessel and prepared the vessel for the afternoon charter. He stated that after the master’s safety briefing, they left Queenscliff at about 1430 and the weather conditions were considerably better that the morning with about a 15 knot westerly wind. He said that the vessel got to Point Nepean in about 10 minutes and took up a position a couple of hundred metres offshore, just outside the Marine Park.

The crew member stated that they ran three lines and made a few runs east to west and then reversed the course. He opined that on about the third run they were travelling west and were north of Corsair Rock when the master “must have seen a wave standing up and started feeding power with a view to getting out of its way”. He said that the master called out for everyone to hold on, so he grabbed onto the rail above his head when the wave picked the vessel up and capsized it. He said that the vessel was facing southwest at the time the wave hit and he felt the bow twitch to port before rolling over onto its port side. He said that he managed to get out through the slot door that had come out and managed to latch onto a life-ring or some other item. He then noticed the liferaft inflating and made his way towards it. He said that he hung onto the side of the liferaft and assisted passengers onto the liferaft before getting into it himself.

The crew member stated that the dive boats started arriving and the persons in the liferaft were taken aboard one vessel. He said that there were at least three other vessels carrying out a search of the area and he also saw the rescue helicopter arrive. He stated that the passengers and the crew were then taken to Queenscliff where they received medical attention.

2.2.4 Deckhand 2

The second crew member stated that he had about 20 years experience on commercial fishing vessels. He stated that he had attended the Coxswains course but had not obtained his CoC. He said that he had been employed as a deckhand by Gamerec Charters for about two years and his role was to prepare the boat for a charter and keep an eye on the passengers.

On the day of the incident the crew member stated that they completed a morning charter at about noon with about 12 passengers. He stated that the afternoon charter started shortly after a safety briefing by the master at about 1430. He said that they headed to Point Nepean and started trawling for salmon around Point Nepean Bank, where they caught three salmon. He stated that they turned around the first yellow marker and headed out to the Nepean Bank with the intention of going out through the heads. He stated that the passengers had their PFDs on as on the second pass they were going through the Heads.

The crew member stated that they were trawling towards the heads when he heard the engines “rev up”. He said that he then saw a wave slightly forward of the starboard beam approaching the vessel and told the customers to hold on. When the wave was about 15 feet (4.5 metres) away, it was about 8 to 10 foot high (2.4–3.0 metres) and was higher than the boat. He said that he then shouted to the passengers to get off the duck board and get back into the rear deck area and hold on. He said the wave then impacted the vessel, coming through the back of the boat around head height and “grabbed the boat and just threw it over”. He said that he came up from under the water and shouted to the passengers to pull the chords on their PFDs.

The crew member stated that he then saw the inflated liferaft and after assisting a passenger onto the liferaft he also got on. He stated that he assisted more passengers onto the liferaft and when he did a headcount, he realised that two persons were missing and advised the dive boat crew, which had arrived at the scene. The dive boat then carried out a search but due to the swell could not get close to the capsized vessel. The dive boat then towed the liferaft clear of the shore and took the passengers and crew on board. He stated that he observed the rescue helicopter winch one person out of the water before the dive boat headed back to Queenscliff.

2.2.5 Passengers

The general opinion of the passengers was that the vessel appeared to be in very good condition. One passenger stated that the plastic zip-out windows on either side of the vessel had been removed to allow fishing access.

All the passengers stated that prior to departing Queenscliff, the vessel’s master carried out a safety briefing, in which he advised them of the location of the safety and first aid equipment, the requirements to wear lifejackets under certain conditions and passenger movement and weight distribution with respect to vessel stability. Some passengers stated that the master did not carry out a demonstration of the wearing of the jackets or how to inflate them. Some also stated that there was no briefing as to the procedure to follow in the case of an emergency.

With respect to the weather conditions when heading towards Point Nepean, the passengers described the conditions as mild, with light to medium winds and a small swell without any white caps or spray. Once at Point Nepean the passengers stated that they observed a slight swell coming across the entrance and a moderate sea with no whitecaps. Some passengers stated that they observed breakers on the rocks at Point Nepean and the vessel operated in an area where there was some swell that caused the boat to pitch and although the waves had increased in size, it was still comfortable and the boat was handling the seas well.

With respect to the vessel capsize, passenger comments of significance are detailed below.

Passenger 1

Just prior to capsize, a passenger who was standing mid-ships on the port side stated that he saw a massive wall of water closing in rapidly from the right of the boat. He said that before the wave broke he yelled out to his son to "look out" and remembered seeing a couple of the passengers heading from the rear of the boat to the canopy area. He stated that the first part of the wave hit the back of the boat and splashed into the boat and was as high as the canopy. He recalled that the majority of people were at the back of the boat. He stated that the wave seemed to come in at an angle and that he ran to the port forward area of the boat to avoid getting wet. He said that the boat then started to list and he initially thought that it would right itself, but it heeled to about 75 degrees, and seemed to pause for a split second before flipping over.

He stated that he then surfaced in an air space inside the upturned boat and hung onto the railing. He said that he observed the opening to the wheelhouse and that he could see debris but no other persons. He recalled seeing light to his right where the slot door had come out, but due to the fishing line that was wrapped around his right leg he decided not to swim out. He said that the wheelhouse storage space hatch cover had come off and he dragged himself into this space and most of his body was then out of the water. He stated that he attempted to remove the fishing line from his leg, and was able to do so only after removing his shoe.

The passenger stated that he decided to stay in the air space as it appeared to be safe but he kept banging on the hull and yelling out to try and attract attention. He said that after a while he heard a voice outside the boat asking if he was alright and he responded that he was. The person outside asked him to swim out and go to the right and when the swell reduced he went under the water and kept going until he approached the person outside the vessel who assisted him to the surface. He said that he was then winched up into the rescue helicopter and put on the Point Nepean beach where a short time later he was attended to by a paramedic.

Passenger 2

Another passenger who was standing on the starboard side of the vessel just prior to capsize, stated that when they were heading towards the rip he heard a crew member yell out “hold on we got some swell coming” and felt the boat speed up. He stated that he held onto the rail at the top of the canopy and looked to the right and saw a wave that looked higher than the boat. He then heard his father shout to him to watch out. He stated that the wave looked smooth and he didn’t think it would be a problem, but then it washed through the boat at about waist height and he saw water gushing across the back of the boat. He said that the boat then tilted onto its side close to 90 degrees and he thought that it would right itself. The passenger stated that he and another passenger were on the high side of the vessel and then the boat capsized and he was under water. He stated that he tried to swim to the surface but could not do so due to the life jacket snagging onto some object and he had to remove the jacket in order to swim to the surface. The passenger said that after he surfaced he swam towards the inflated liferaft and was helped onto it.

The passenger stated that he remembered thinking that there were only two persons including him on the starboard side and that there were three persons at the stern, so the remainder could have been on the other side of the boat that was away from the wave.

Passenger 3

This passenger was on the starboard side of the fishing platform at the time of the incident. He stated that he suddenly noticed that the boat was accelerating hard. He was of the opinion that at the time the vessel was heading south and was about three hundred metres northeast of land. He said that he looked to the starboard side and saw a large wall of water approaching the boat. He stated that the wave was so large that he was unable to see Point Lonsdale behind it and could only see the sky over the top of it. He estimated that the wave was close to a metre higher than the boat and about fifty metres from the boat. He stated that the boat was accelerating parallel to the wave and the wave kept getting closer and was far taller than the boat. He said that he thought he was going to get wet and attempted to step off the platform and head under the canopy, when he heard someone shout to get away from the edge. He said that as he stepped back the wave broke over the top of him and he felt the deck of the boat tilt with the wave to a steep angle. He stated that when he realised the boat was going to capsize he held onto the railing and went right over with the vessel. He said that he found himself submerged under the water, but as the boat was close to him, he managed to pull himself to the surface and then swam to the liferaft and was assisted onto the liferaft by a crew member.

Passenger 4

Another passenger, who was standing on the port side of the fishing platform, stated that he heard a loud voice and glanced to his left and saw an enormous amount of breaking and rising white water, and was then engulfed by it. He stated that the boat started to roll over and he dived out the back of the boat and into the water. He was of the opinion that the wave was about 8 foot (2.4 metres) high and hit the starboard side. He said that he was under the water for a few seconds and when he surfaced he observed the boat had overturned and the propellers were still rotating. He said that he attempted to inflate his life jacket but was unable to do so as he could not locate the ring-pull. The passenger stated that he was swamped a few times by numerous waves. He saw the inflated liferaft about 20 metres away and started swimming towards it. When he got close to the liferaft, another person surfaced and assisted him to inflate his lifejacket before they both climbed into the liferaft.

Passenger 5

A passenger who was standing in the middle of the fishing platform at the time of capsize stated that he recalled a crew member shouting "hold on" and he looked to his left and saw a "wave right in my face". He said that it was at least 6 foot (1.8 metres) high and broke as it went over his head. He stated that he grabbed the cutting board and wrapped his leg around the stern rail. He said that the boat was still upright after being swamped by this wave. He stated that when he wiped his face and opened his eyes he saw another wave of about 11 to 12 feet (3.5 metres) bearing down on the vessel. He said that he grabbed the rail and felt the boat ride up onto its side as the wave went through the boat. He stated that the boat stayed suspended on its side for a second or two before capsizing.

Passenger 6

This passenger, who was standing on the portside just forward of the fishing platform, stated that he thought the vessel was turning to port to head back to the area where his friend and another person had caught fish when the waves came side-on to the vessel. He said he was talking to his friend about the fish when he saw a wave of about 12 foot high (3.6 metres) and about 5 foot (1.5 metres) higher than the canopy coming from his right and heard the master shout "hold on" and another crew member say that they were going to get wet. He said that he held onto a bar attached to the roof canopy and the wave hit the boat and a wall of water washed over him. He said that he found himself under the water and became very disorientated and then realised that the boat was upside down.

The passenger stated that he was stuck under the boat for a short while before he pulled himself down and under the rail, then swam to the surface. He said that when he got to the surface he tried to inflate his PFD but could not locate the inflation cord. He said that he then saw the liferaft and swam towards it and was helped onto the liferaft.

2.3 Search and rescue

2.3.1 Communication

All commercial vessels are required to be fitted with radio communication equipment appropriate to their class and area of operation. The Ultimate was fitted with a Very High Frequency (VHF) radio that met the requirement. The vessel's 406 MHz emergency position indicating radio beacon (EPIRB) was automatically activated when the vessel capsized.

The Victoria Police Search and Rescue centre received a call at about 1535 from the master of the Sea Dragon and they requested the Australian Volunteer Coast Guard (AVCG) to attend. The Queenscliff AVCG vessel CG 09 attended the incident site at approximately 1548. The AVCG advised that when they got to the incident site a diver was already in the water near the capsized vessel, attempting to locate the missing persons. They also advised that when they got to the site they observed the Victoria Police rescue helicopter carrying out a search of the area. They stated that after a short while a person was located, hoisted onto the helicopter and taken ashore.

2.3.2 Master - Sea Dragon

The master of the Sea Dragon stated that they had concluded a dive inside Port Phillip Bay and were heading back to Portsea when he looked across to Corsair Rock and noticed a capsized vessel. He said that he manoeuvred his vessel closer to the capsized vessel and realised that it was The Ultimate. He said that he immediately called the Dive Victoria shop in Portsea and advised them of the incident.

He stated that as he approached The Ultimate he observed a liferaft with people on board. They advised him that two people were missing and he commenced a sweep of the area. He stated that he did not get too close to the overturned vessel due to the shallow water and the surf. When his attempts to locate the missing persons were unsuccessful, he went back to the liferaft and took the occupants on board. He stated that he then discharged the crew and passengers at Queenscliff.

2.3.3 Dive Instructor – Dive Victoria

A dive instructor employed by Dive Victoria, advised the investigation that at about 1530 on the day of the incident, the owner of the shop told him that The Ultimate had capsized and they needed to get to the vessel. Soon after, the vessel's owner, the operator and the dive instructor boarded the vessel Oceanic and headed out to the incident site. He stated that while underway, the master of the Sea Dragon advised them that his vessel had picked up 10 persons including the crew of The Ultimate, but two persons were still missing.

The drive instructor said that when they arrived on site, there were multiple vessels searching the area and as he was a strong swimmer, he volunteered to get into the water near the upturned vessel to search for the missing persons. He stated that the sea conditions where quite calm with a slight swell.

The diver stated that, on reaching the capsized vessel, he found a male person floating face down in the water. The person's legs, up to his knees, were still inside the vessel through the starboard slot door and his torso was outside the vessel. He stated that he noted that his body was wrapped up in monofilament line and that his legs were entangled in rope. The diver stated that he attempted to free him but was unable to do so.

The diver said that he shouted into the capsized vessel and heard banging from inside the vessel. He said that after finding out that the person was not injured, he instructed him to swim out of the wheelhouse and to the right towards him. When he swam out, he pulled him free of the vessel and towed him towards the shallow water. He then assisted the rescue helicopter officer to attach a harness to the passenger, and after advising the officer that there was another person trapped in the capsized vessel, swam back to the Oceanic.

2.3.4 Vessel recovery

Victoria Police advised that two officers swam to the capsized vessel and after removing a combination of ropes that the deceased was entangled in, transferred him to the Victoria Police vessel.

The police advised that on the following morning they conducted a recovery operation of the capsized vessel. They said that the vessel was lying on its roof and there were no signs of major damage to the hull, above or below the water. The capsized vessel was righted with the assistance of a tug boat, but during this process the roof section was torn away and the cabin was damaged. They commented that the vessel was buoyant and was towed to Queenscliff.

2.4 Vessel regulation and certification

2.4.1 Regulatory framework

At the time of commissioning of the vessel the applicable legislation was the *Marine Act 1988* and Marine Regulations 1999 and at the time of the incident the applicable legislation was the *Transport Integration Act 2010, Transport (Miscellaneous & Compliance) Act 1983*, *Marine Act 1988* and the Marine Regulations 2009.

Both the 1999 and 2009 Marine Regulations refers to the Uniform Shipping Laws Code (USL Code). This code was originally adopted in 1979 to facilitate uniform survey, manning and operation of commercial vessels in Australia.

The National Maritime Safety Committee (NMSC) was established in 1997 and tasked with developing an updated national standard (Combined USL/NSCV[2]) in consultation with national, state and territory maritime regulators.

The *Transport Integration Act 2010* establishes the position of the Director, Transport Safety (the Director) and Transport Safety Victoria (TSV) exists to support the Director to achieve his/her statutory functions. For marine regulation, the predecessor to TSV was Marine Safety Victoria (MSV).

2.4.2 General requirements for certification

For a vessel to be initially deemed seaworthy, vessel plans are assessed by the regulator to ensure compliance with approved standards. Thereafter compliance inspections are carried out during construction of the vessel. Once the construction is completed the vessel's stability is assessed to the stipulated standards and on completing satisfactory sea trials the vessel is issued a Certificate of Survey (CoS), allowing the vessel to operate in designated areas of Victorian waters.

The renewal of a CoS requires a periodic survey of a vessel to ensure ongoing compliance. The standards define a periodic survey as examinations, verifications, tests and trials to verify, within the scope and depth of the inspections, the vessel's continued compliance with the applicable legislation and applicable standards, subject to any program for the rectification of deficiencies.

2.4.3 Certification of The Ultimate

The Ultimate was originally built and surveyed in 2000 as a dive charter vessel, the Ultimate Diver, and approved to operate as a Class 1C[3] and 1D[4] vessel. When operating as a Class 1C vessel, it was required to have two crew members and was approved to carry 18 passengers. When operating as a Class 1D vessel, it was required to have two crew members and was approved to carry 26 passengers.

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[2] USL/NSCV2008, USL/NSCV2009 and USL/NSCV2010 are referenced NMSC standards.
[3] A passenger vessel carrying over 12 passengers and allowed to operate in restricted offshore waters.
[4] A passenger vessel carrying over 12 passengers and allowed to operate in partially smooth waters.

The investigation was unable to verify the procedures that were followed during the commissioning and construction of the vessel (approval of design drawings) or subsequent survey information (inspections, repairs, modifications) pertaining to the vessel as the regulator was unable to locate the original file for the vessel. A new file had been created in 2008.

Records show that the last inspection of the vessel before the incident was carried out on 14 April 2010. On completion of the inspection the surveyor issued a survey requirements report to the owner listing a number of deficiencies. The investigation was advised that these deficiencies were rectified by the owner and a CoS was issued by MSV[5] on 31 May 2010, expiring on 30 May 2011.

The CoS allowed the vessel to operate as a class 1C and 1D vessel. The vessel was required to be skippered by a master holding a coxswain certificate of competency [6]. As a 1C vessel, the CoS limited its operation to within 15 nautical miles of the Victorian coast, within 30 nautical miles of a safe haven, and within 20 nautical miles of an MSV accepted VHF Station. As a 1D vessel, the CoS limited its operation to the Port of Western Port and Port Phillip Bay.

2.5 Vessel modifications

With respect to alterations to vessels, the NMSC guidelines issued in 2008 and 2010 require that operators notify the authority of alterations or modifications in order to determine if risks have been increased by the changes, and to then invoke standards to manage those risks and record the alterations for future survey purposes.

The investigation was informed that at various stages of the vessel's life it underwent changes to suit its operations. More recent modifications involved the removal of overhead lockers, dive gear storage cabinets, a diesel Genset, air compressor units and air bottles, and the addition of a bait box and table and a stern frame with fishing rod holders. There is conflicting reports from previous vessel owners and operators with respect to the weights of the items removed and installed on the vessel during its lifetime. The investigation was unable to verify the details of these modifications as the original vessel file was not available. The present owner advised the investigation that modifications carried out in 2009 when the vessel was converted from a dive vessel to a fishing charter vessel, were brought to the notice of the authority's surveyors. There was no documentation with respect to these modifications in the newly created vessel file.

With regards to the modifications carried out on the vessel prior to the April 2010 survey, the regulator advised the investigation that the surveyors recalled discussing guardrails and wires around the stern of the vessel and the fitting of a bait board. They further advised that the changes were considered negligible and the content of such general discussion would not normally appear in any documentation unless the surveyor considered the changes to be significant, in that they could affect operational safety and fitness for purpose.

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[5] Marine Safety Victoria was amalgamated into Transport Safety Victoria in July 2010.
[6] Allows a person to operate a vessel of maximum length of 12 metres up to 15 nautical miles off shore.

2.6 Operating procedures

2.6.1 National Standard for Commercial Vessels (NSCV) Operational Practices

The NSCV Operational Practices standard (Part E) specifies operational requirements and other essential elements required in a safety management system (SMS) of a commercial vessel. This section recognises that the responsibility for ensuring that a vessel is safely operated is a shared responsibility between the vessels owners/operators, masters, crew and the appropriate regulator.

The standard requires that an SMS provides for safe practices in vessel operation and establishes means of identifying hazards and then eliminating or reducing risk to an acceptable level. Procedures are required to be developed for operations that present the greatest risk to the crew, passengers, the vessel and the environment.

The Marine Regulations 2009 (Vic) required that all trading and fishing vessels comply with the NSCV Part E from 1 July 2011. At the time of the incident the regulator did not require any commercial vessels to have an SMS.

The regulator advised the investigation that Part E is being implemented for all vessels within Victoria and that high risk vessels will be the focus of initial audits. They further advised that passenger operations in hazardous areas will receive considerable attention when the implementation of the *Marine Safety Act (Vic) 2010* is considered in more detail.

2.6.2 Operating procedures for MT Ultimate

Gamerec Charter’s operating procedures specified the duties and responsibilities of masters and deckhands. With respect to the master’s duties, the procedures specified that the master was responsible for ensuring that he adheres to the laws of the waterways and will be held accountable for any prosecution due to breaking those laws. The procedures required the master to go through the safety procedures with the crew at least twice a season and the vessel was to be operated at a safe and comfortable speed. With regard to crew responsibilities and duties, the procedures required the crew to carry out a safety drill on every fishing charter trip.

The operating procedures did not include any instructions to masters with respect to operating in adverse weather or sea conditions or identify any hazards in the operation of its vessels.

2.7 Vessel stability

2.7.1 Overview

A vessel's stability is its ability to resist overturning moments and to return to an upright position after being disturbed by external forces. This righting ability is determined by the righting moment (RM), which is developed between the vessel's weight (W) acting through the vessel's centre of gravity (G) and its buoyancy acting through the vessel's centre of buoyancy as it moves (B to B_1) when a vessel is heeled (see Figure 8). Stability therefore becomes a function of the vertical position of G, a characteristic of the vessel's fixed and variable weights, and the movement of the centre of buoyancy as a vessel is inclined, a characteristic of hull dimensions and form.

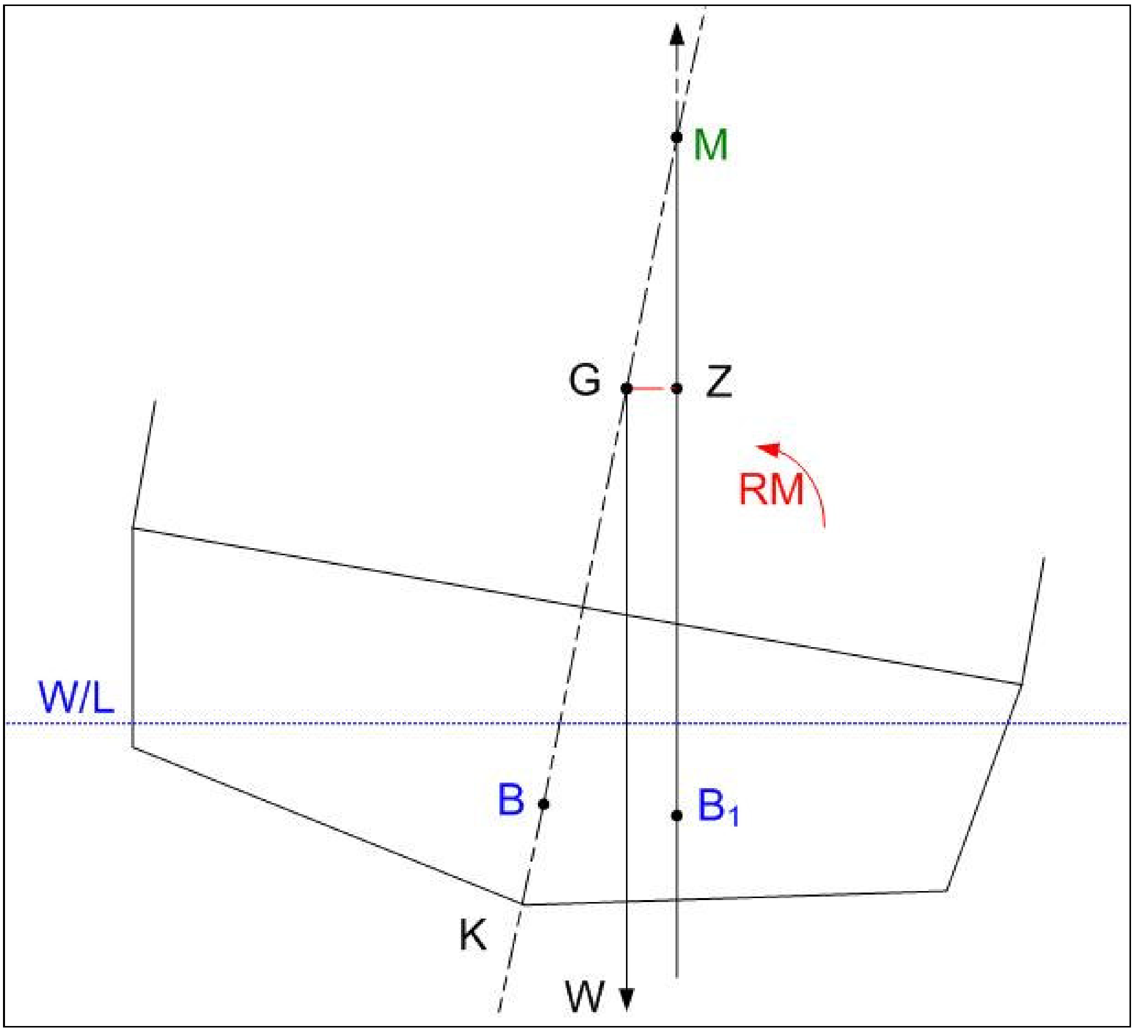

Figure 8 - The righting moment developed by an inclined vessel and its righting arm GZ

The righting moment is the mathematical product of the vessel's weight (a constant for any particular vessel loading condition) and the righting arm (GZ). The value of GZ can be plotted against the angle of vessel inclination to produce a GZ-curve (Figure 9) and provides a picture of statical stability over the range of vessel heel angles. For a conventional form monohull, GZ is zero when the vessel is upright (no righting moment), increases with increasing angles of heel before reaching a peak and then diminishes at higher angles of heel. At the angle of heel that the GZ returns to zero and then becomes negative (sometimes referred to as the point of vanishing stability), there is no longer a positive righting moment and the vessel will capsize.

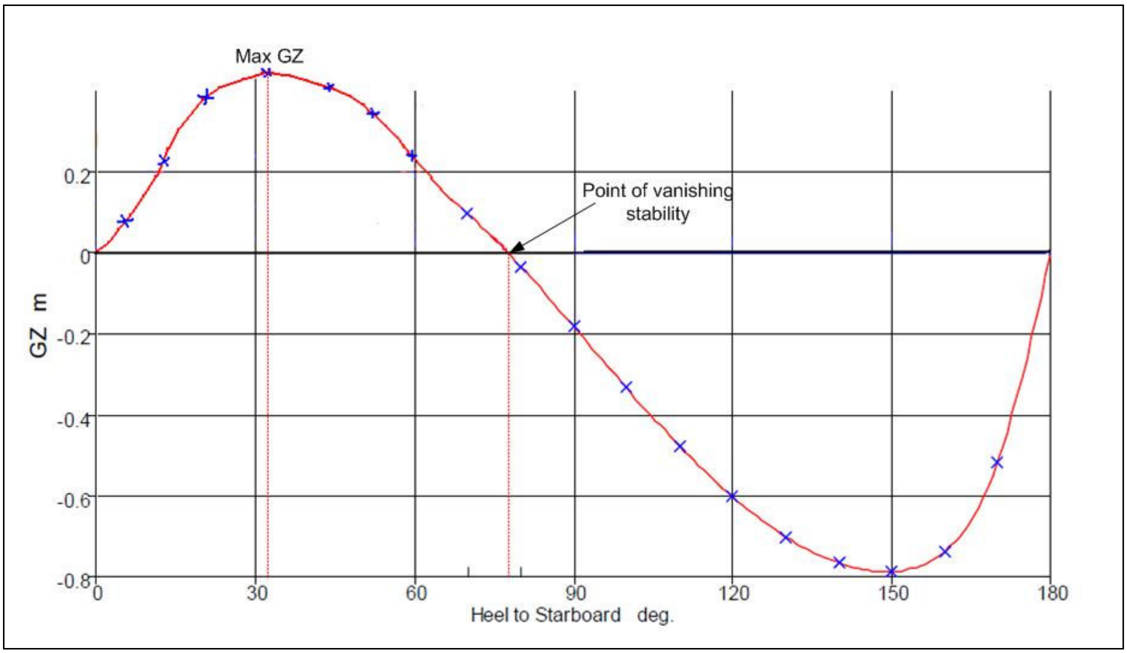

Figure 9 - Generic GZ-curve

For small angles of heel, the righting moment and GZ are proportional to the vessel's metacentric height (GM), which is the distance between the vessel's centre of gravity and the vessel's transverse metacentre (M), the point through which a vertical line from the vessel's centre of buoyancy intersects the vessel centreline as the vessel is heeled to small angles. The position of M and therefore GM can be assumed to be constant for small angles of vessel heel, typically up to around eight degrees unless there is an abrupt change in vessel shape in the vicinity of the waterline.

For larger angles of heel or if there are abrupt changes in vessel shape (such as a chine) in the vicinity of the waterline, the simplified relationship between GZ and the GM no longer holds. The GZ-curve provides greater insight into a vessel's stability over the range of vessel heel angles. Characteristics of the curve of particular interest include the magnitude and behaviour of the righting arm, the angle of maximum righting arm, the area under the GZ-curve to various angles and the range of stability.

2.7.2 Stability assessment

A vessel's stability is required to be assessed prior to a vessel being certified to operate commercially and a documented assessment is submitted to the relevant authority for approval. At the time of the construction and commissioning of the Ultimate Diver, the applicable standard was the USL Code. In recent years the standards have been updated and at the time of the incident the applicable document was referred to as USL/NSCV2010[7].

For certain areas and types of operation, a simplified form of stability assessment is permitted. At the time of vessel commissioning the USL Code simplified stability criteria were Category T for sheltered waters and Category S for restricted offshore waters. Assessments are based on a vessel's small angle stability, as reflected in the

[7] This title reflects the transition of standards underway since 2006. NSCV refers to the National Standard for Commercial Vessels which for a time was the title used for the updated standards.

vessel's GM and assume a level of ongoing stability performance through larger angles of heel. The standards set criteria for the response of the vessel to a number of scenarios including heeling due to passenger crowding, beam winds and turning.

Should a vessel not comply with the simplified criteria for a particular area of operation, there is provision to prove compliance by examining the stability over a greater range of inclination angles. Various acceptance criteria are applied to the GZ-curve and heeling moments due to passenger crowding, beam winds and vessel turning are again considered.

2.7.3 The original Trim and Stability Booklet

The stability for the as-built vessel, the Ultimate Diver, was carried out by the vessel builder and the vessel's Trim and Stability Booklet (May 2000) was approved by the regulator (then the Marine Board of Victoria) on 17 October 2000.

A vessel's Trim and Stability Booklet is a presentation of stability critical vessel data and calculations. The booklet for the Ultimate Diver indicated that the vessel stability met the Category T criteria for 'sheltered waters' operations (including partially smooth waters) carrying two crew members and 26 passengers, and the Category S criteria for restricted offshore operations carrying two crew members and 18 passengers. For each of these operational areas, the booklet included assessments of vessel stability in vessel 'departure' and 'arrival' conditions with full passenger and crew loads. Departure is the condition when the vessel leaves port with full fuel and other consumable loads; the arrival condition simulates the state of the vessel when returning to port after using most of its fuel and other consumables.

A review of the booklet indicated that methodology followed normal naval architectural practices but that the load cases examined did not encompass the worst case condition. Reworking of the stability calculations using the original vessel data but with varied load conditions, found that the vessel would continue to meet the requirements for sheltered waters (including partially smooth waters) but did not meet the requirements for restricted offshore operations for all loading conditions. In its arrival condition but with a lesser passenger load, the vessel in its original configuration would not have met the simplified stability criteria for restricted offshore operations due to emergence of the vessel chine when subject to wind heeling. The investigation also found that compliance with the criteria for restricted offshore operations was sensitive to vessel trim as might be affected by passenger fore-and-aft positioning. It was also noted that the assumed vertical centre of gravity for passengers and crew was not the most unfavourable likely to occur in service.

2.7.4 Assessment of vessel in incident condition using USL/NSCV2010

The investigation engaged a naval architect to review the condition of the vessel at the time of the incident and to assess its stability. The vessel was re-measured to ascertain its hull form characteristics and an inclining experiment undertaken to assess vessel weight particulars. When compared with the data within the original Trim and Stability Booklet, the results of the inclining experiment indicated a small rise of about 30 mm in vessel centre of gravity and an increase in weight of about 350 kg. Because the full history of the vessel's through-life changes was not available, it could not be determined to what extent the differences in the inclining results were due to configuration changes or measurement variations.

The stability assessments were carried out using the comprehensive method (USL/NSCV 2010) that examines the GZ-curve over a full range of heel angles. Assessments were made using the certified maximum personnel load for each operational area and the incident loading of three crew and nine passengers. All assessments were done for the arrival condition.

Operations in partially smooth water

For operations in partially smooth waters, the assessments found that the vessel did not comply with the stability criteria for either the certified maximum personnel load condition or the incident load condition.

In the maximum personnel load condition, a number of criteria related to the GZ-curve are not satisfied, including the required area under the GZ-curve up to the point of maximum GZ, the value of the maximum GZ at 30 degrees inclination, and the area under the GZ-curve at greater angles when truncated by the downflooding angle. Criteria related to heeling as a result of beam winds, passenger crowding and vessel turning are met.

In the incident load condition, the only criterion not satisfied was the area under the GZ-curve between 30 and 40 degrees heel due to the truncation of the GZ-curve (and therefore truncation of the under-curve area) at 32.9 degrees, the assumed point of downflooding. In the incident condition, this criterion and therefore all stability criteria would be met if the angle of downflooding was greater than 40 degrees.

Figure 10 shows the vessel's GZ-curve for the incident condition and the flattening of the curve after about 20 degrees inclination.

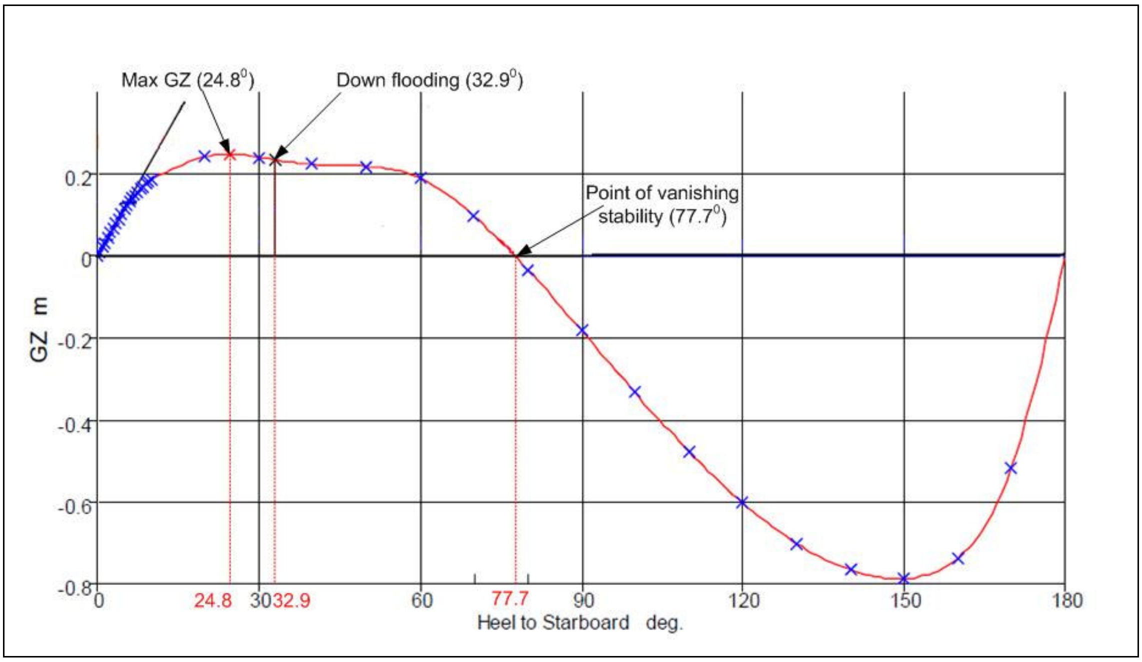

Figure 10 - Curve of statical stability (GZ curve) for arrival condition with 3 crew and 9 passengers

Operations in restricted offshore waters

For operations in restricted offshore waters, the assessments found that the vessel did not comply with the stability criteria for either the maximum personnel load condition or the incident load condition.

In the maximum personnel load condition, two criteria related to the GZ-curve areas are not satisfied, both the result of truncation of the GZ-curve at the angle of downflooding. All criteria related to heeling as a result of beam winds, passenger crowding and vessel turning are met.

In the incident load condition, the only criterion not satisfied was the area under the GZ-curve between 30 and 40 degrees heel due to the truncation of the GZ-curve (and therefore truncation of the under-curve area) at 32.6 degrees, the assumed point of downflooding. In the incident condition, this criterion and therefore all criteria would be met if the angle of downflooding was greater than 40 degrees.

Angle of downflooding

The investigation sought clarification on the point of downflooding used in the stability assessments against the analysis and were advised that the stability was truncated at the point at which water was able to be on the deck through the opening (in the bulwark) at the transom.

2.7.5 Assessment of vessel in incident condition using USL Code

The vessel in its incident configuration and condition and loaded with three crew and nine passengers was also assessed against the simplified USL Code criteria as applicable at the time of vessel commissioning in 2000. The investigation found that with the vessel in this condition it would have complied with the Category T (sheltered waters) criteria but would not have met the Category S (restricted offshore waters) criteria.

2.8 Compliance with vessel construction standards

In order to be surveyed and certified as a class 1C vessel by the then authority, The Ultimate was required to be designed and constructed to comply with the USL code. The USL code requires that the sill height for the wheelhouse opening of this length and class of vessel is a minimum of 300 mm, unless the openings are shielded from the full force of the sea and if so the sill height may be reduced but not be less than 150 mm. The wheelhouse sill height of The Ultimate was 235 mm. Although protected by side bulwarks, the stern of the vessel is open to the sea and therefore is open to interpretation whether the wheelhouse sill is exposed to the full force of the sea.

2.9 Physical/Operating environment

2.9.1 Port Phillip Bay

Port Phillip Bay covers approximately 1,930 square kilometres and is located in the southern part of the state of Victoria. The shore line extends approximately 264 kilometres and opens to the Bass Strait at its southern end, the Port Phillip Heads.

Port Phillip Heads (see Figure 1) is characterised by two relatively shallow banks, one extending from Point Nepean on the eastern side and called Nepean Bank, and the other extending from Point Lonsdale on the western side and called Rip Bank. Water depths on these banks are generally less than 15 metres with the exception of the Great Ship Channel which has recently been dredged to a depth of 17.3 metres. Separating the two banks and curving around the western end of Nepean Bank is the Entrance Deep, a canyon with very steep sides and water depths of up to 100 metres.

Extending west-northwest from Point Nepean are rock platforms which dry at low tide and include some outcrops that are above the surface at all tides.

2.9.2 Wind

Wind records were obtained from the Bureau of Meteorology for stations at South Channel Island, 13 km east of Point Nepean; Point Wilson, 25 km northwest of Point Nepean; and Fawkner Beacon, 45 km north-northeast of Point Nepean. These stations are all located so as to record the wind over the water speeds. Analysis of the three records for the incident date indicated that no significant events or changes occurred. On 12 December 2010, the wind speed between 1400 and 1600 was averaging about 14 knots from the southwest, while wind gusts of approximately 25 knots were observed at about 1430.

2.9.3 Waves

The height of the waves depends on the wind strength, how long the wind has been blowing, the fetch[8] and the currents. The waves affecting Port Phillip Heads predominantly come from Bass Strait. There are some occasions when strong winds from the northeast generate waves from this direction; however, the resulting waves are not large compared with those from Bass Strait.

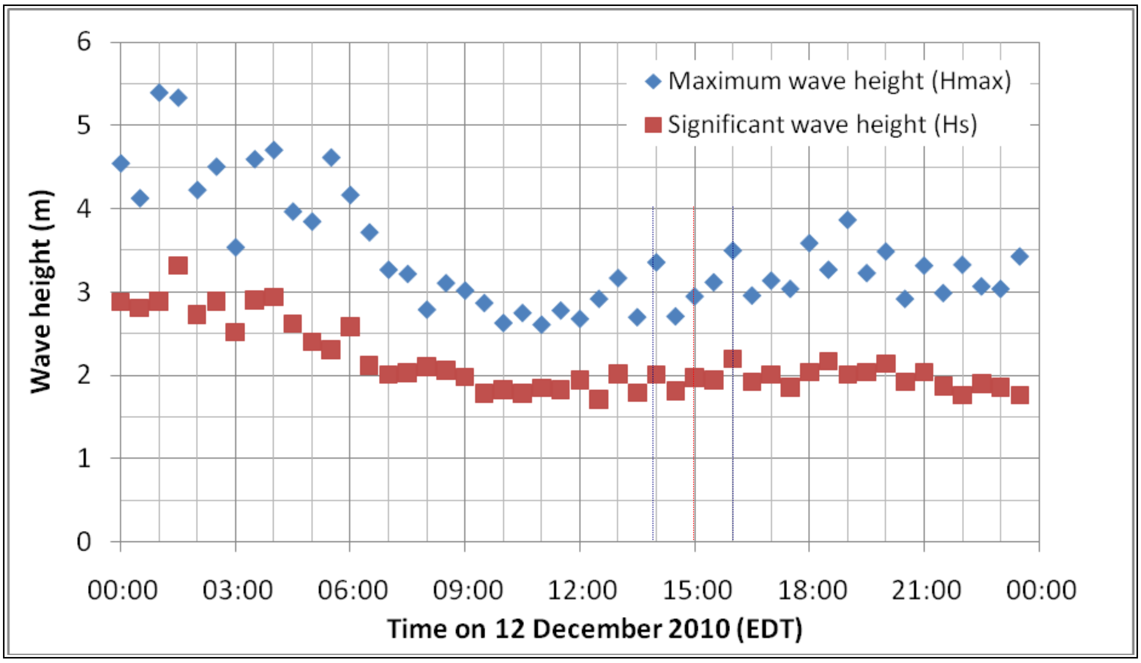

Figure 11 - Wave heights recorded by PoMC Wave buoy on 12 December 2010

The significant wave height[9] recorded on 12 December 2010 from 1400 to 1600 was about 2.0 metres. The spectral peak wave period[10] was approximately 12 seconds and wave direction was about 208 degrees.

[8] The distance over water that winds of a constant speed and direction can generate waves.
[9] The significant wave height (H_s) is defined as $H_s=4\sqrt{m0}$ where m0 is the variance of the wave spectrum or the "zero order moment". For practical purposes, the significant wave height is close to the average wave height reported by an experienced observer, such as an experienced mariner.
[10] The period of the largest waves with maximum energy.

2.9.4 Rogue waves

In open ocean conditions, based on statistical distribution, the maximum individual wave height in a wave record (1000 waves) will be 1.9 times the significant wave height. However, there are circumstances such as refractive focussing, either by bathymetry or currents which contribute to larger waves termed 'rogue waves'.

These waves are waves that are larger than expected and Dysthe et al (2008)[11], in a review of oceanic rogue waves, provides an operational definition that a rogue wave is one whose height (trough to crest) is at least twice the significant wave height at the time.

2.9.5 Historical wave height data

The waves in Bass Strait are recorded by Port of Melbourne Corporation (PoMC) wave buoys moored about seven kilometres southeast of Point Nepean and data has been collected over a seven year period from 2003 to 2010. This data provides a record of the waves approaching Port Phillip Heads from Bass Strait. An analysis[12] carried out on this data shows that the average significant wave height at the buoy location is 1.7 metres. Spectral peak wave periods vary from about 6 to 20 seconds, with 54 per cent of the wave periods being between 10 and 14 seconds and a further 28 per cent between 14 and 16 seconds. The wave directions are predominantly from the southwest and south-southwest directions. This data indicates that the dominant wave energy comes from swell generated in the Southern Ocean and arriving at Port Phillip Heads through the gap between Cape Otway and King Island at the western end of Bass Strait. In addition, waves generated by local wind conditions can also become a major component of wave energy.

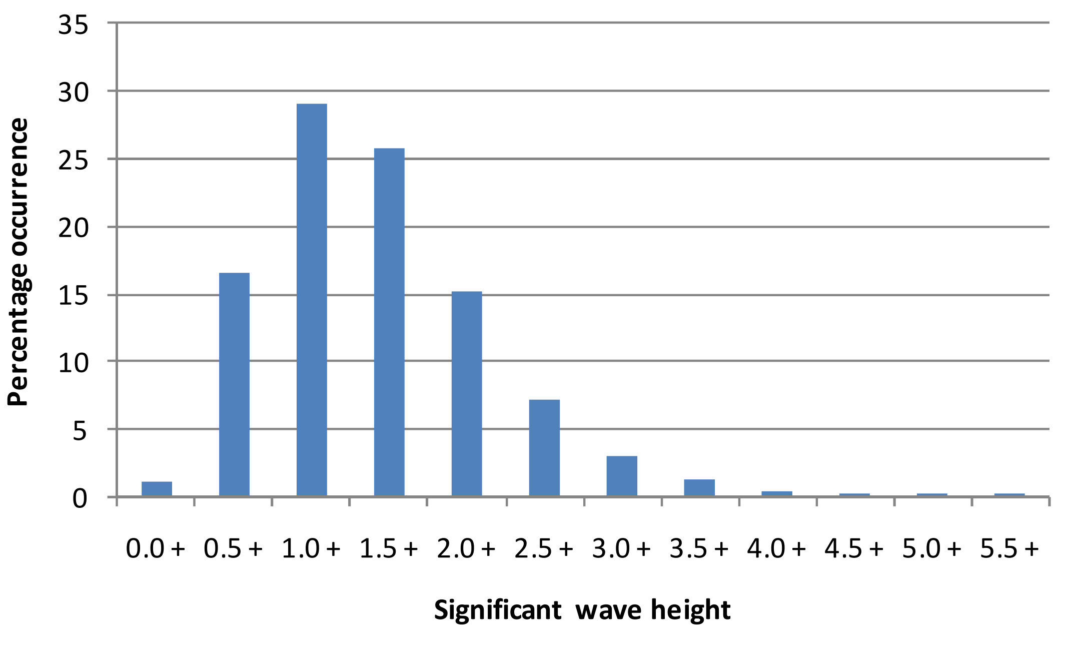

Figure 12 - Percentage occurrence of significant wave height, 2003-2010, from the wave buoys 7 km south east of Point Nepean.

[11] Dysthe, K., Krogstad, H.E., Müller, P. 2008, *Oceanic Rogue Waves*. Annu. Rev. Fluid Mech. 40:287-310.
[12] Cardno Lawson Treloar, 2008, *Wave Data in the Entrance to Port Phillip*. Report prepared for Port of Melbourne Corporation Channel Deepening Project by Cardno Lawson Treloar Pty Ltd, report RM2126/LJ5450_2 DRAFT Ver.0.2.

2.9.6 Tides and tidal streams

A tide is a periodic rise and fall of the ocean surface principally due to the gravitational interactions between the earth, moon and the sun. Due to the regular pattern of the relative position of the earth, moon and the sun and consistency of these forces, the periodic rises and falls of the tides also follow a regular pattern and hence the height of the tide of a particular area of water can be predicted with a reasonable degree of accuracy. There are about two tidal cycles in each 24-hour period in the Port Phillip Heads.

Associated with the changes in water level due to tides, are horizontal movements called tidal streams or tidal currents. Tidal streams flow into Port Phillip Bay (flood tide) or out of the bay (ebb tide) depending on the difference in water level between the Bay and Bass Strait. Port Phillip Heads is subject to very strong tidal streams, in excess of 3.5 metres per second (7 knots) at times. The strongest flows correspond with the times of high and low water in Bass Strait.

2.10 Research and modelling of sea conditions at incident site

In order to estimate the sea conditions that may have existed at the incident site at the approximate time of the incident, wave data recorded by the PoMC wave buoys, wind records obtained from the BoM, tide data and the bathymetry[13] of the area around the incident site were utilised in a computer program to model the conditions. As the significant wave heights recorded by the wave buoys around the time of the incident was about 2.0 metres, this value was used for the modelling exercise.

2.10.1 Modelled conditions for the incident area

Model results for the wave conditions adjacent to Point Nepean at about 1500 on 12 December 2010 are shown in Figure 13.

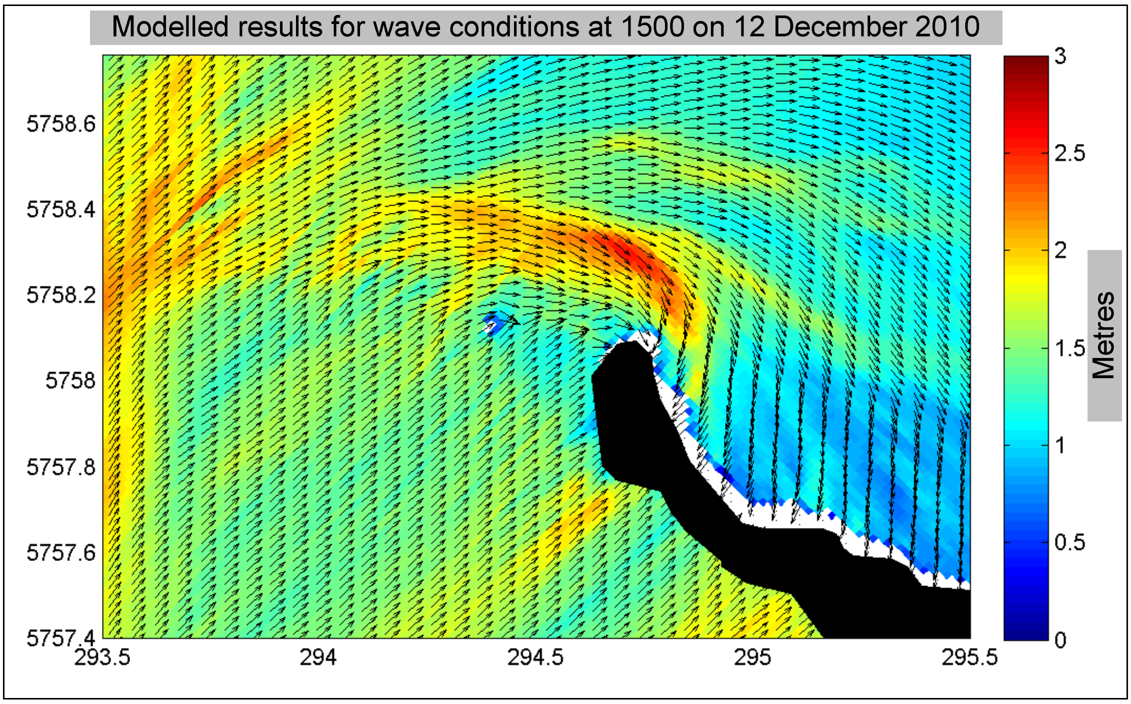

Figure 13 - Model results for the wave conditions adjacent to Pt Nepean at approximately 1500 on 12 December 2010

[13] The study of the ocean floor.

Modelling indicates that incoming waves refract towards Point Nepean. The modelled significant wave heights in the assumed area of operation indicate that waves of between 2.0 metres and 2.5 metres may be generated in this area. These are average wave conditions and are the result of a combination of the incoming wave conditions, the seabed topography, and the tidal conditions, both elevation and tidal current.

Assumptions were made with respect to energy losses due to bottom friction and wave breaking in the area of the incident as this data is unavailable. However, the magnitude of the significant wave heights projected by the modelling has been found to be quite close to the actual wave heights in previous modelling exercises and hence in this case assumed to be quite accurate.

As the tidal conditions change, it is likely that changes in the wave conditions may occur relatively quickly. Thus, the area of greater significant wave heights indicated in the vessel's area of operation may develop and vary in position very quickly.

Utilising the measured sea levels, tidal conditions around the incident site was modelled and at the time of capsize a flood tidal stream speed encountered by the vessel was estimated to be about two knots[14] from a southerly direction.

2.11 Designation of waters

2.11.1 Overview

The USL code requires that vessels are classified as sheltered water or seagoing vessels. Commercial vessels are surveyed and certified by the regulator and are restricted to operating in the designated classified areas to ensure occupant and vessel safety. Criteria such as vessel construction, size and stability are taken into consideration in the classification of vessels. Through formal determinations, certain Victorian waters have been declared by the regulator as sheltered waters. Sheltered waters are further categorised into smooth waters and partially smooth waters. The USL code states that partially smooth waters are where the wave height, under normal conditions, does not exceed 1.5 metres from trough to crest.

2.11.2 Sheltered waters

Sheltered waters are defined in Marine Determination No. 1.1 *Designation of those State Waters that are Sheltered* Waters issued on 16 September 2005. In this determination all Victorian inland waters and in Port Phillip, all waters north of an imaginary line drawn between Breakwater Pier Light and St Kilda Pier Light are designated smooth waters. Further, waters landward (north) of an imaginary line drawn between Point Lonsdale and Point Nepean and not otherwise designated as smooth waters are designated as partially smooth waters. The determination states that the designation of these waters is in accordance with the guidelines set out in the USL code.

The investigation was advised by TSV that this determination was originally made in 1979 and there was no available documentation with respect to any assessments that may have been made in determining that these waters complied with the USL code guidelines. TSV further advised that the 2005 determination was based on the 1979 determination and no amendments were made to it.

[14] One knot is one nautical mile per hour or 1.852 kilometres per hour.

2.11.3 Port Phillip Heads

The bathymetry, narrow entrance, strong winds for long periods of time in one direction and strong tidal flows can make Port Phillip Heads an extremely hazardous area for all vessels. The Marine Regulations 1999 specifically defines and demarcates the area of Port Phillip Heads. The regulations require vessels carrying passengers in and through the heads to follow additional safety precautions. Further, masters of vessels carrying passengers in or through Port Phillip Heads are required to have their certificates of competency endorsed for Port Phillip Heads (heads endorsement), after completing specified training requirements.

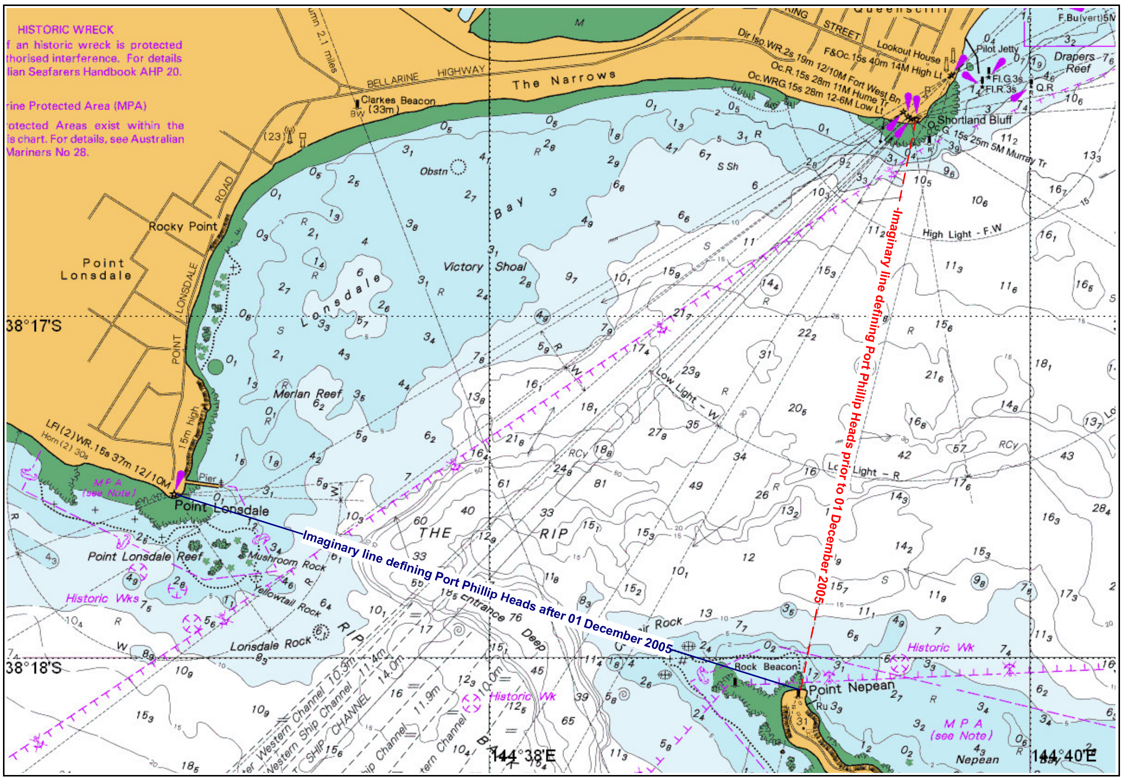

Figure 14 - Chart indicating definition of 'Port Phillip Heads' before and after 1 December 2005

Prior to 1 December 2005, the inner limit of Port Phillip Heads was defined as the waters between an imaginary line drawn between Shortland Bluff and Point Nepean. On 1 December 2005 an amendment to the regulations changed the definition to an imaginary line drawn between Point Lonsdale and Point Nepean. This amendment allowed masters to operate vessels in an extended area of water without the training for the heads endorsement and the additional vessel operating safety requirements. Although the investigation was unable to ascertain with certainty the reason for this regulatory change, the available documentation implies that the change was in order to remove an anomaly in the definitions of sheltered waters and Port Phillip Heads.

2.12 Certification of crew

2.12.1 General

Marine Regulations 1999 specify the certification requirements for the master and crew of commercial vessels. In accordance with these requirements the master of The Ultimate was issued with a Coxswain certificate of competency on 18 November 2003.

2.12.2 Requirements for carrying passengers in or through Port Phillip Heads

In order for a certificate of competency to be endorsed to carry passengers in or through Port Phillip Heads a training course is required to be completed by a certificate holder. Schedule 6 of the Regulations specify the course requirements, which includes local knowledge including lights, charted depths, channels, local dangers, tidal flows, navigation leads, beacons and topmarks; VHF radio communication procedures; passenger briefing and control; person overboard response procedures; occupational health and safety; and boat operation and handling techniques specific to Port Phillip Heads.

2.13 Vessel handling

The investigation consulted both Marine Safety Queensland's *Small Ship Training and Operational Manual* and the Royal New Zealand Coastguard's *Coastguard Rescue Vessel Training Manual.* Both manuals addressed the methods of handling small ships and the information contained in this section is drawn from these manuals.

Handling a small vessel in heavy seas requires the utmost accuracy of judgement and knowledge of the vessel's characteristics in responding to helm and engine movements. When faced with a heavy sea, the vessel must be turned towards the wave and power applied judiciously in order to meet and ride the wave. Having the experience to judge the gradient of a wave is also critical, as steeper the gradient the more likely it is to break and swamp a vessel. The gradient of the wave also affects the ability of the vessel to safely ride up or down the wave without loss of control.

If the helmsman is unable to avoid a breaking wave, the most appropriate action would be to maintain a heading such that its bow is into the wave (approximately 0–10 degrees off head on). If a helmsman is unable to keep the head into the sea, there is a distinct possibility of the vessel slewing in such a way that the wave will hit the vessel broadside, resulting in it capsizing.

When turning a vessel, it is critical to ensure that the vessel's beam is exposed to the sea only during a calmer period and the turn is executed rapidly with full power before the larger waves build up.

2.14 Incident history of area

The investigation was provided with vessel incident data for Port Phillip Bay from 2005 to 2010 by TSV. The information indicates that 69 vessels capsized during this period. Thirty-four of these were mechanically powered vessels and 35 were sailing vessels. Further, 287 vessels were reported as swamped during this period and of these, 198 were mechanically powered and 89 were sailing vessels. Of the swamped vessels, 32 of these were Victorian registered commercial vessels and 25 were foreign going vessels.

With respect to incidents in the area bounded by an imaginary line between Shortland Bluff and Point Nepean and an imaginary line between Point Lonsdale and Point Nepean (Figure 14), there are no reported commercial vessel capsizes and only one recreational vessel (mechanically powered) capsize during the above period.

3. ANALYSIS

3.1 The Incident

On 12 December 2010, the significant wave height off Point Nepean was relatively constant at about two metres. Based on the oceanographic modelling and witness accounts it is most probable that a steep wave of at least 2.5 metres height impacted the vessel on its starboard bow/beam region resulting in its capsize. The time of the incident is not know with certainty but probably occurred between 1500 and 1515.

The large wave acted upon the starboard bow of the vessel probably slewing the vessel further to port and so exposing its beam to the full force of the breaking or near-breaking wave. It is also possible that the wind from the south-southwest acting on the heeled vessel and a passenger loading bias to the port side may have assisted capsize.

There is some inconsistency in the eye witness evidence as to the dynamics of capsize. However, the balance of evidence suggests capsize was the result of a single wave and that the vessel rolled-over in a single motion with the impact and passage of the wave, possibly hesitating at a high angle of heel for a short time. There are indications that during the capsize water may have come across the vessel, suggesting impact by a steep wave and the potential for water to have entered the deck area during capsize.

Prior to being impacted by the wave, the vessel was heading in a southwesterly direction and was in the process of turning to port in order to head back in an easterly direction. A local tidal stream of about two knots acting on the port bow of the vessel may have impeded the vessel's headway and a planned manoeuvre to port.

3.2 Vessel handling

The master was experienced in the type of operation being conducted and the area of operation. However, he may never have positioned his vessel against a wave of this nature before and therefore not have experienced the characteristics of the wave that capsized his vessel. His comment that he observed a "full rolling ground swell about six foot, which was not going to face up or form a breaking wave" is testimony to either a lack of experience or complacency with the conditions. Regardless, the master did not follow the correct course of action when confronted by the approaching wave and turn his vessel into it.

3.3 Vessel stability

3.3.1 The commissioning Trim and Stability Booklet

A review of the vessel's Trim and Stability Booklet indicated that, had the worst case loading condition been considered as part of the initial stability assessment, the vessel would not have met the simplified stability criteria for operations in restricted offshore waters.

This error was not detected by the regulator during the initial approval of the vessel. The investigation was unable to explore the possible reasons for this oversight due to the loss of documentation supporting the approval process. However, the regulator advised the investigation that the processes for approving stability submissions have been considered over time and new improved processes have been implemented.

3.3.2 Stability assessment in vessel incident condition

To gain a better understanding of the vessel's stability, the investigation commissioned an independent assessment of vessel stability using comprehensive modelling and methods. The assessment indicated that the vessel did not comply with stability criteria specified in USL/NSCV 2010 for operations in either partially smooth waters or restricted offshore waters. Criteria associated with wind heeling, passenger crowding and turning were met, reflecting adequate levels of initial (small angle) stability. However, criteria associated with righting arm curve (GZ-curve) at greater angles were, in some instances, not met.

The reduced area under the GZ-curve relates to the flattening of the curve at higher angles of heel, as reflected in Figure 10. The flattening is the result of hull form characteristics at higher angles of heel. The non-compliance with some GZ-curve area criteria was also the result of truncation of the GZ-curve, limiting the 'usable' area for the stability assessment. In the case of the full load arrival condition in partially smooth waters, an area criterion was not met when the curve was truncated at the point of maximum GZ. Other non-compliances, in this condition and other assessed scenarios, were the result of truncation of the GZ-curve at the assumed angle of downflooding, as required by the stability standard.

The point of downflooding is normally the point at which water floods into the buoyant hull space through an opening such as unsealed doorway or vent. In this instance, the assumed point of downflooding was the point at which the water enters the deck area via the open bulwark at the stern. This assumption may be justified in that once on the deck, the mechanism for the subsequent release of the water overboard is unclear given the lack of freeing ports forward and the possibility of trim by the head[15], leading to progressive downflooding through the wheelhouse door, if open.

3.3.3 Vessel stability in this incident

Stability criteria are based on the statical stability characteristics of a vessel, and assessing vessel adequacy in a dynamic capsize like this event is less definitive.

The investigation examined the results of assessments for the vessel in incident condition and for operations in restricted offshore waters, which would potentially allow the vessel to operate 30 nautical miles off the coast. The vessel meets small-angle stability requirements, but due to the flattening of the GZ-curve has less stability at higher angles of heel than one might expect from the small-angle data. However, even given this flattening, the failure of the stability criteria for restricted offshore conditions specifically relates to truncation of the GZ-curve at the assumed point of downflooding. If the downflooding point was taken as the more traditional opening in the buoyant space, the stability criteria would be met.

In this incident, the vessel appears to have capsized in an almost single motion, perhaps hesitating near the point of vanishing stability for a small time. While it is probable that water entered the deck area in the process of capsize, there is no evidence of progressive downflooding into the wheelhouse prior to capsize. Had there been some downflooding, it is unlikely that an increase in wheelhouse sill height would have made a difference due to the dynamic nature of capsize. It is likewise unclear to

[15] When the bow of the vessel trims down.

what extent water was trapped on the deck or whether freeing ports would have assisted in releasing water from the deck given the apparent speed of the capsize.

The investigation has concluded that with the vessel loaded as it was on the day of the incident and given the circumstances and probable nature of the capsize, the statical stability of the vessel was probably not a factor in its capsize. In this instance, the vessel was in an area of shallowing waters with the potential for large and breaking waves. It is probable that other vessels of similar size and type would also have had difficulty if struck beam-on with such a wave as occurred in this instance.

3.3.4 Vessel configuration control

The vessel's original documentation file could not be located. Maintaining historical information of a vessel, such as approved original drawings and alterations to the vessel through its life, is critical in order to assess ongoing compliance with survey requirements. Although a new file was created in 2008 there was no apparent attempt to restore or document the vessel history and there was no documentation with respect to modifications carried out in 2009. Good survey practice would dictate that all modifications are reviewed and documented as the compounding of incremental changes to a vessel's configuration may eventually result in non-compliance with survey standards, in particular stability requirements.

3.4 Operating environment

3.4.1 Conditions on the day of the incident

Witness reports from the day of the incident suggest that from the time of their arrival in the area at 1440 to the capsize of the vessel about 20 to 30 minutes later, conditions were moderate and that swell and wave conditions were not perceived by crew or passengers as being hazardous. This may have encouraged the master to operate in the area in the belief that the conditions would remain unchanged.

Oceanographic evidence indicates that conditions in the area, predominately the product of ocean swells, are changeable and that individual waves of greater height than the average can occur. It is probable that around the time of the incident, a more significant set of waves than had been experienced in the preceding 20 minutes approached the area and the wave that capsized the vessel may have been one of the larger of that afternoon.

3.4.2 Designation of waters of Port Phillip Bay

The original determination of the waters of Port Phillip Bay as smooth waters and partially smooth waters was made in 1978 and was probably based on the guidelines specified in the USL code. The oceanographic data and modelling indicates that wave heights in the incident area often exceed the USL code guidelines and on occasion can be significantly higher.

Even though incident records for the five years prior to this incident indicate that there have not been any commercial vessel capsizes in this area, in view of the oceanographic data, it would be appropriate to review the designation of the waters in those areas inside Port Phillip Bay affected by ocean swells.

3.4.3 Port Phillip Heads

It is apparent that Port Phillip Heads is a hazardous area of water, especially for smaller vessels. Although the master of the vessel appears to have a significant amount of experience in the area, it is open to question whether he had an awareness of the unpredictable and inconsistent sea conditions that may be experienced around Port Phillip Heads. Had this area been defined as Port Phillip Heads, as it was prior to 2005, the master would have been required to complete the heads endorsement training course, which may have made him aware of the hazardous conditions that can exist in this area. In view of the above, it would be appropriate to carry out a review of current regulations with respect to the demarcation of the area of Port Phillip Heads.

3.5 Operating procedures

Although the standard for vessel operational practices was developed by the NMSC and applicable to high risk commercial vessels, it was not mandated in Victoria at the time of the incident. Despite the fact that there was no requirement for a SMS, the vessel operator should have assessed the hazards associated with their operations and provided guidance to crews.

4. CONCLUSIONS

4.1 Findings

The Master

1. The master of the vessel was appropriately qualified to operate the vessel.

The Ultimate

2. There was no evidence to suggest that there was a mechanical defect with the vessel just prior to the incident.

3. Although the original Trim and Stability Booklet showed that the vessel complied with stability requirement for offshore operations, had the worst case loading condition been considered, the vessel would not have complied with this requirement.

4. The vessel did not comply with the comprehensive stability criteria specified by the USL/NSCV standard when assessed for the conditions of loading at the time of the incident.

Sea conditions

5. The vessel was capsized by a wave probably in excess of 2.5 metres in height.

Designation of waters

6. The oceanographic evidence suggests that the waters that the vessel was operating in do not meet the Uniform Shipping Laws code guidelines for the designation of partially smooth waters.

4.2 Contributing factors

1. The vessel was operated in an area that was subject to larger and steeper waves.

2. The sea conditions were not adequately monitored by the vessel's crew.

3. By not turning into the approaching wave, the master did not follow conventional boat handling procedures.

5. SAFETY ACTIONS

5.1 Recommended Safety Actions

Issue 1

The oceanographic evidence suggests that the waters that the vessel was operating in are hazardous to small vessel operations.

RSA 2012014

That Transport Safety Victoria carries out a review of commercial operations in the incident area.

Issue 2

The vessel operator had not adequately assessed the hazards associated with their operations and did not provide guidance to crew on areas of operation.

RSA 2012015

That Gamerec Charters conducts a risk assessment of its operations and amends operating procedures accordingly.

Issue 3

The ongoing modification status of the vessel was not adequately recorded in the regulator's files. Considering weight changes in particular, there is the potential for a vessel's stability to become non-compliant with specified criteria.

RSA 2012016

That Transport Safety Victoria reviews its processes for maintaining the modification status of vessels.