Report on the investigation into a

wash wave accident involving

Portsmouth Express

off East Cowes

on 18 July 2002

Marine Accident Investigation Branch
First Floor
Carlton House
Carlton Place
Southampton
United Kingdom
SO15 2DZ

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Extract from

The Merchant Shipping

(Accident Reporting and Investigation)

Regulations 1999

The fundamental purpose of investigating an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 1999 is to determine its circumstances and the causes with the aim of improving the safety of life at sea and the avoidance of accidents in the future. It is not the purpose to apportion liability, nor, except so far as is necessary to achieve the fundamental purpose, to apportion blame.

NOTE

This report is not written with liability in mind and is not intended to be used in court for the purpose of litigation. It endeavours to identify and analyse the relevant safety issues pertaining to the specific accident, and to make recommendations aimed at preventing similar accidents in the future.

CONTENTS

GLOSSARY OF ABBREVIATIONS AND TERMS

Abbreviations

GPS	-	Global positioning system
HSC	-	High speed craft
IMO	-	International Maritime Organization
kW	-	Kilowatts
MW	-	Megawatts
m	-	Metres
QHM	-	Queen's Harbour Master
RAPP	-	Risk Assessment for Passage Plan
rpm	-	Revolutions per minute
s	-	Second
UTC	-	Universal Co-ordinated Time
VDR	-	Voyage data recorder
VHF	-	Very high frequency
VTS	-	Vessel traffic system

Terms

Depth Froude number (Fn_h)

A relationship between vessel speed and depth of water, which can be calculated by using the formula Fn_h = Vs / ã (g x h), where Vs is the vessel speed in m/s, g is the acceleration due to gravity (9.81m/s^2), and h is the depth of water in m.

Critical speed range

The RAPP for *Portsmouth Express* shows the critical speed range as being between a depth Froude number of 0.80 and 1.10. *Portsmouth Express* is operating at sub-critical speed, when the depth Froude number is less than 0.80.

Wash waves

As a vessel proceeds, the motion of the hull(s) and the thrust of the propulsion system disturb the water. The disturbed water is known as wash or wake. The wash from a vessel includes wash waves. The application of high propulsion power usually causes the formation of large wash waves.

SYNOPSIS

On 18 July 2002 at about 1900 UTC, the high speed craft *Portsmouth Express* passed East Cowes, Isle of Wight. Shortly after, large wash waves hit the shore, injuring five members of the public. The MAIB investigation began 4 days later.

Portsmouth Express operates on the ferry route between Portsmouth and Cherbourg in the summer. On 8 July 2002, she was taken to Southampton to have a crankshaft replaced in one of her main engines. At the time of the accident, the vessel was sailing back to Portsmouth after the period of repair. A Southampton pilot was on board.

Portsmouth Express was operating about 0.7 mile offshore; on board, the master, chief officer and pilot were unaware that the vessel was producing a hazardous wash. When the wash arrived onshore, a series of large breaking waves was produced, which rolled up the beach and went right over the sea wall, flooding the road and car park beyond. It was high water at the time and the sea was calm.

The hazardous wash was produced because the speed of *Portsmouth Express* was too high for the depth of water in the channel past East Cowes. It is considered that the master, chief officer and pilot had an insufficient understanding of the wash produced by HSC.

A Risk Assessment for Passage Plan (RAPP) was produced for the normal ferry route. This document contained a detailed study of the wash, and specified the speed profile and track to avoid problems. While such a detailed RAPP was not needed for the infrequent voyages between Southampton and Portsmouth, the passage plan on 18 July 2002 should have included a brief RAPP which assessed the depth of water versus speed for the entire route, and the possibility of producing hazardous wash. The passage plan compiled on the day of the accident did not adequately consider the effects of wash.

Recommendations have been made to operators of HSC and to harbour authorities that employ pilots who undertake HSC movements; the recommendations cover RAPPs and the training of masters and chief officers. Recommendations have been made to the MCA to clearly specify the training required for HSC wash.

Photograph courtesy of P&O European Ferries

Figure 1

Portsmouth Express

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *PORTSMOUTH EXPRESS* AND ACCIDENT

Vessel details

Registered owner	:	Los Cipreses SA
Charterer	:	P&O European Ferries (Portsmouth) Ltd
Port of registry	:	Nassau
Flag	:	Bahamas
Type	:	High speed craft
Built	:	Incat Australia –1998
Classification society	:	Det Norske Veritas
Construction material	:	Aluminium alloy
Length overall	:	91m
Gross tonnage	:	5902
Engine power and type	:	Four Caterpillar diesels driving four steerable waterjets via reduction gearboxes. Total power 28800 kW.
Service speed	:	About 40 knots
Other relevant info	:	Wave piercing catamaran. Ro-ro ferry, 240 cars and 900 passengers.

Accident details

Time and date	:	About 1900 UTC, 18 July 2002
Location of incident	:	East Cowes esplanade, Isle of Wight
Injuries/fatalities	:	Five persons injured at East Cowes point
Damage	:	None to *Portsmouth Express*

A view of *Portsmouth Express* at sea is at **(Figure 1)**.

1.2 BACKGROUND

Portsmouth Express is a 91m long wave-piercing catamaran, designed and built by Incat Australia Pty Ltd of Tasmania in 1998. The hull material is aluminium alloy.

Portsmouth Express was operated by P&O European Ferries (Portsmouth) Ltd in the summer of 2002 on the cross-Channel route to and from Portsmouth and Cherbourg. She normally made two return crossings a day between these ports. During the winter, Buquebus operated the vessel on a ferry route between Argentina and Uruguay. While operating in South America, the vessel was called *Catalonia* and this is currently her registered name. If major repairs or conversion work were necessary during the summer, *Portsmouth Express* was taken to Southampton.

The vessel is powered by four Caterpillar 3618 diesel engines each rated at 7200kW and each driving a transom-mounted Lips LJ145D waterjet, via a Renk ASL60 reduction gearbox, giving an operational speed of about 40 knots. The normal full operating rpm was originally set at 1050, but this had been reduced progressively to 965 rpm to lower the stress on the engines, and to try to avoid some of the problems that had been experienced. The speed was about 35 knots in the fully loaded condition, with all four engines running at 965 rpm. This speed reduced to about 26 knots when only three engines were running at the same rpm and in the same condition. A very small amount of port helm was applied to maintain a straight track when one of the starboard engines was not operating.

1.3 NARRATIVE

All times are UTC.

Portsmouth Express travelled to Southampton docks on 8 July 2002, for repairs. The main item of work was the replacement of the crankshaft in the starboard inner engine. The crankshaft had become damaged after a bearing had seized. As soon as the crankshaft was renewed, the vessel sailed back to Portsmouth so that she could resume her normal service to Cherbourg.

The return journey from Southampton to Portsmouth, on 18 July 2002, was undertaken using three engines. The starboard inner engine could not be operated because various ancillaries needed to be attached. The engine had been stripped down to replace the crankshaft, but the rebuilding was not complete when the vessel returned to service. She was returned to her ferry route as soon as possible, to minimise disruption to advertised sailings. The first voyage from Portsmouth to Cherbourg, after the repair, started at 0600 on 19 July 2002. Work on the fourth engine continued in Portsmouth harbour at night when the vessel was not operating, until the rebuild was complete on 27 July 2002.

Portsmouth Express was due to leave Southampton in the early afternoon, but a problem with a cooling pump delayed her departure. A Southampton pilot was on board in the early afternoon, but left because of the delay. The same pilot boarded at about 1745 and was on board during the voyage to Portsmouth.

Portsmouth Express shared No 3 berth in the Portsmouth Continental Ferry Port with the conventional ferry *Pride of Hampshire*, which was due to arrive from France at 2030. The original plan had been to berth in Portsmouth before the arrival of *Pride of Hampshire*, to refuel, effect a partial crew change, and remove spare gear from the vehicle deck. The problem with the cooling pump reduced the time available to carry out this plan. The aim was to conduct the passage safely, but as quickly as possible.

Before leaving Southampton, the track for the voyage was programmed into the GPS, and the departure checklist was completed. The passage plan did not adequately consider the effects of wash. Electronic and paper charts were displayed for the voyage. The engines were run-up to check that they were working properly. The master confirmed the speed limits in the upper harbour and past Fawley with the pilot. They also discussed the lack of speed limits further on and that good progress could be made once past Fawley. The master and pilot did not discuss the wash of the vessel in relation to the voyage ahead. They considered using the North Channel, but the reduced depth would possibly have meant going at a slower speed. Although using the main channel made the voyage about 2 miles longer, it was decided that they would proceed this way. There were yachts in the North Channel, which was another reason why this route was not chosen.

The master had the conduct of the vessel. The pilot agreed to this, as he was unfamiliar with the controls. The voyage began when *Portsmouth Express* left the flooded dry dock just after 1800. This manoeuvre, and the turn just outside, were conducted with the master, chief officer and pilot on the starboard bridge wing. After this, the master and chief officer sat down at the conning position and the pilot stood behind and between them. The large container ship *Frankfurt Express* was coming into the upper harbour, but they were able to depart King George V dry dock before she arrived. Before the voyage got underway, the pilot told the master that they might have to wait for *Frankfurt Express* to pass before departing. The master did not seem to be too bothered, so the pilot thought there was no great hurry to get to Portsmouth.

Initially, the voyage began at a speed of 4 to 5 knots as they were passing *Frankfurt Express*, which was turning. The pilot had contacted the container ship by radio and agreed the passing arrangement, which was undertaken west of Cracknore buoy. The GPS shows speed over the ground, and this was monitored to ensure that the vessel stayed below 6 knots up to Hythe pier/Weston Shelf buoy. While moving at slow speed, the engineer was able to check that the engines were running satisfactorily. When they were past the 6-

knot speed boundary, the engine revolutions were increased to about 600 rpm, and then up to about 900 rpm per engine. The pilot used the radio to organise passing arrangements with a small dredger and a tanker. On approaching Fawley Oil Terminal, at about 1840, the engine rpm were reduced again to slow down. Fawley was passed at a speed of about 12 knots.

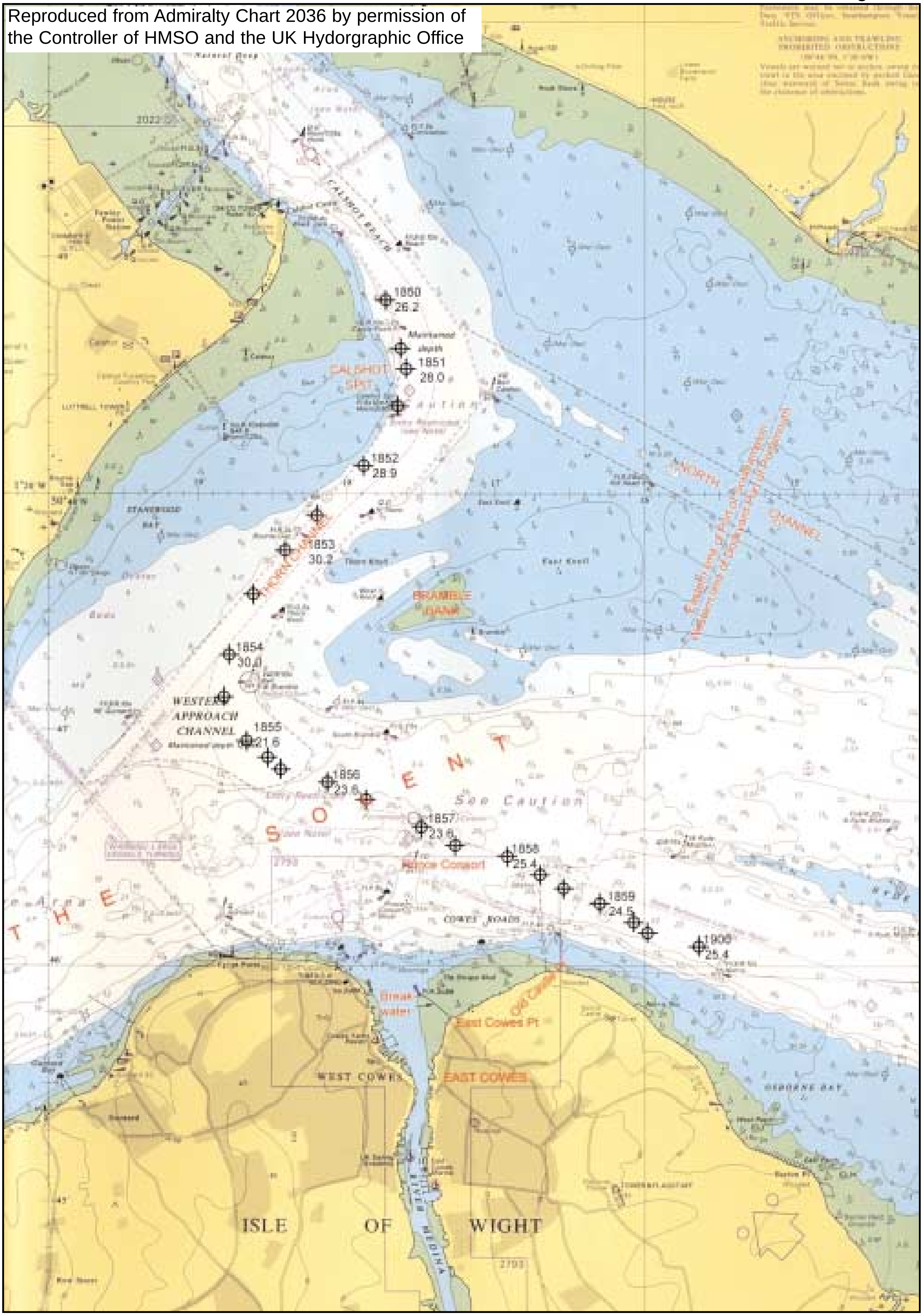
At 1847, once past Fawley, the master and pilot agreed that engine power could be increased. By the time *Portsmouth Express* was in the Thorn Channel, normal full operating power on the three available engines was being used. When the vessel achieved a speed of 30 knots over the ground, the master looked astern to see if excessive wash was being created. This power setting, of 965 rpm per engine, remained during the turn around Bramble Bank and then past Cowes. The speed over the ground was increased by the tidal flow in the Thorn Channel, but was reduced by this effect when passing Cowes. The turn also caused the speed to drop off. The vessel was not fully loaded.

The pilot thought the Bramble turn was negotiated satisfactorily, so he did not interrupt the master. The master was using the electronic chart system to make sure the vessel stayed on track. The pilot looked at the wake on several occasions, but he didn't think it would cause any problems. No comments about the wash were made between members of the bridge team. The master watched the yachts moored off Cowes as they went by; they did not appear to be significantly affected by the wash from *Portsmouth Express*.

At about 1900, as the vessel continued beyond Old Castle Point, and out of sight of East Cowes, a series of large breaking waves came up the beach and at least one of them went right over the sea wall. The master, chief officer and pilot on board *Portsmouth Express* were unaware that the vessel was producing a hazardous wash while passing Cowes.

The pilot called the QHM in Portsmouth on VHF Channel 11 when they reached his area **(Figure 2)**, to pass some details of the voyage, including the Pilot Exemption Certificate number of the master. At the North Sturbridge buoy, the pilot informed the master that he had the pilotage for the approach to Portsmouth. The pilot disembarked to a launch just inside Portsmouth harbour. The vessel arrived at No 3 berth in Portsmouth Continental Ferry Port just before 2000. *Pride of Hampshire* was delayed, so more time was available to unload etc. When *Pride of Hampshire* did arrive, *Portsmouth Express* left No 3 berth, while the conventional ferry discharged and loaded again. *Portsmouth Express* returned to No 3 berth after *Pride of Hampshire* sailed, where she remained, as usual, until her scheduled 0600 sailing the following day.

Apart from *Portsmouth Express,* there were no other shipping movements past Cowes at about 1900 on 18 July 2002.



VDR plots for voyage on 18 July 2002

1.4 EFFECT OF WASH

1.4.1 At East Cowes

Just to the east of the junction between the breakwater **(Figure 3)** and the sea wall, two men, one aged 30 and the other 27, were on the beach with a small inflatable boat. It was high water, so the exposed beach was only about 10m (33 feet) wide. They planned to go rod fishing just offshore. As *Portsmouth Express* went by, one of them thought she was going too fast for that distance offshore.

Figure 3

East Cowes breakwater at low water

Sea wall

Approximate high water mark

While in the process of launching the boat, one of the men noticed that the sea was receding at the edge of the beach. He knew from his experience as a surfer that large waves were coming, so the two of them moved the boat up the beach. As they did this, a large breaking wave knocked them over. They picked themselves up and started to lift the boat over the sea wall. One then scrambled over the wall and pulled the boat, while the other stayed on the beach and pushed. One of them then saw a second wave approaching and he shouted to his companion to jump over the wall. The one on the beach did not seem to realise the danger he was in, and after the second wave struck him, it washed him out to sea, along with his boat, about 50m (160 feet) from the beach. While out there he was hit by a third large wave. He was fully clothed, which made swimming very difficult and his head went under several times before he managed to grab hold of his boat. He stayed in this position until the waves died down. He then boarded his boat and paddled ashore using the oars, which were attached to the sides.

One of the men hurt his neck and back when he was knocked over, and suffered several cuts and bruises as he scrambled over the sea wall. He went to hospital and was kept in overnight. The other sustained several bruises and grazes. They both felt that their lives had been in danger, and were badly shaken by the experience. Some of the equipment they had with them was damaged/lost during the accident.

One of them is a surfer and is used to judging wave heights. He estimated the second wave to be 2.4m (8 feet) in height on the beach, and about 1.1m (3.5 feet) as it went over the sea wall. The second wave was bigger and more powerful than the first. The third was also large, but smaller than the second wave. More waves came, but their heights reduced until the sea surface returned to normal.

A man and his family were at the junction of the breakwater and sea wall at the time of the accident. On 23 July 2002, they were asked to stand in the same positions as when the first wave struck them **(Figure 4)**. The man was on the beach, rod fishing. He was attending to his tackle/bait box, when he was hit from behind by the first wave. It knocked him over and, as he was getting up, the second wave struck, resulting in an impact with the sea wall. He was carried up and down the beach by two or three subsequent waves until he managed to grab hold of a handrail. When the first wave arrived, his wife and daughter only got wet, but the second wave knocked them over and resulted in them impacting their car, which was parked in the road **(Figure 5)**. The second wave was the largest and this went right over the sea wall; subsequent waves reduced in size.

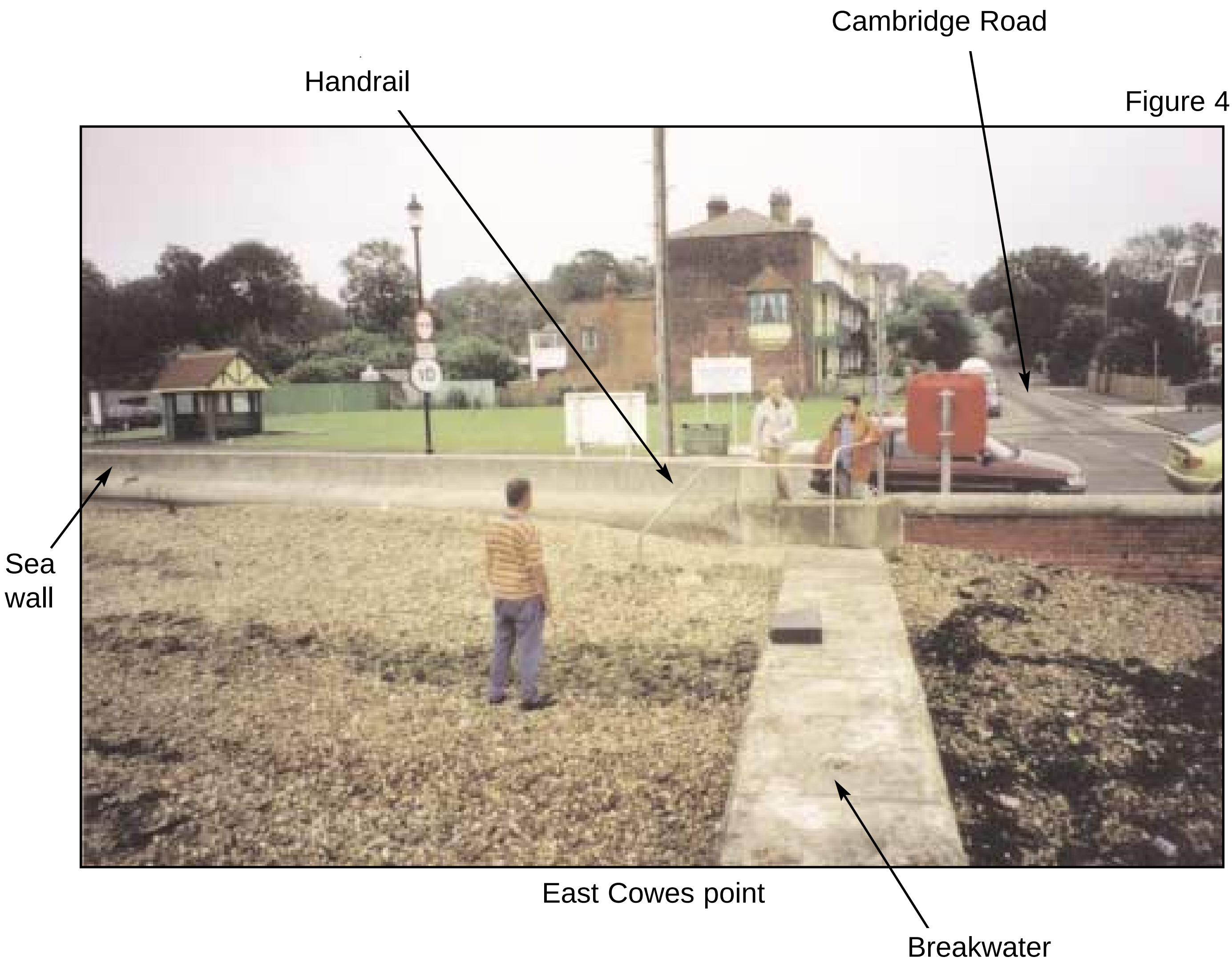
The man injured his back, shoulder and elbow, and his wife and daughter injured their knees. They all received hospital treatment. After the accident, he called the police. Some of his fishing equipment was damaged/lost, and pebbles from the beach made many chip marks in the paintwork of his car.

The police attended the scene at about 1930, and spoke to the five injured people. Several other members of the public got wet, but no one else received injuries. However a lady, who was walking her dog at the extreme eastern end of the esplanade, which is Old Castle Point, was quite badly affected. The first wave came over the sea wall and completely soaked her. The second wave was even larger and knocked her off her feet. She was slightly sore where she fell, but was otherwise uninjured. About 10 minutes after the accident she met the police and the other injured parties, and they exchanged stories.

The road and park at East Cowes esplanade were flooded. The floodwater was still quite deep about half-an-hour after the accident **(Figure 5)**. One of the waves reached as far as the fence on the far side of the park area **(Figure 6)**. Substantial amounts of debris, including seaweed, pebbles and dead fish, were left after the floodwater had drained away. Staff employed by the Isle of Wight Council started clearing this about an hour after the accident.

A witness in a parked car saw *Portsmouth Express* go by and, shortly after, observed the wash running along the breakwater. He believes that the breakwater funnelled the waves to the junction between the breakwater and the sea wall **(Figure 2)**. When the waves arrived at East Cowes Point, they had nowhere to go, apart from over the sea wall. The witness estimates that the plume of spray was as high as a bungalow after the waves hit the junction. The sea wall absorbed most of the force, but the waves still had enough energy to wash over the road and into the car park where this person was located **(Figure 6)**.

Figure 4



East Cowes point

Figure 5

Floodwater on East Cowes esplanade

The family's car

Fence

Figure 6

Road and park at East Cowes

Car Park

1.4.2 In Cowes harbour

The berthing master from the Cowes Harbour Commission was in a boat when the wash from *Portsmouth Express* came into the harbour. He watched yachts and pontoons being moved at Shepards and Thetis wharves as the wash passed through. After this, he made a check of all the yachts, which had crew on board; there was some alarm at the accident, but no injuries were reported.

The 26m-long passenger vessel *Wight Scene* was berthed at Thetis Wharf, just to the north of the chain ferry on the west bank of the River Medina. The skipper received a radio call from another vessel about the wash, so he looked towards the harbour entrance and watched *Portsmouth Express* go by. Shortly after, he saw waves come over the breakwater at East Cowes. When the wash hit *Wight Scene,* the resulting motion parted the stern line. After hauling the parted line out of the water, the skipper went quickly up to the wheelhouse, started the engines and brought the vessel under control. He thought it was fortunate that he was on board, otherwise the vessel could have swung on her forward line and possibly damaged other vessels moored nearby.

1.5 WEATHER AND TIDE

The wind was about 10 knots from the east, there was a slight sea, but no swell, and the visibility was good.

High water at Cowes occurred at 1824. The tidal height was about 3.87m above the chart datum at 1900. The highest high water level at Cowes is 4.2m above chart datum. At about 1900, the tidal flow was with *Portsmouth Express* in the Thorn channel with a speed of about 1 knot, but was against the vessel going past Cowes with a speed of about 2 knots.

1.6 PHYSICS OF HSC WASH AND THE SPEED OF *PORTSMOUTH EXPRESS*

The physics of wash generation and propagation from HSC craft is complex, although a basic understanding of the subject can be obtained without too much difficulty. The main parameter is depth Froude number, which is a relationship between vessel speed and depth of water. To avoid creating hazardous wash, HSC must be operated outside the critical speed range.

1.7 CREW

The master, aged 45, held a class 1 master mariner's certificate issued in June 1986, which was revalidated in June 2001, and pilot exemption certificates for Portsmouth and Cherbourg. For the previous four years he had been working on HSC during the summers, and conventional ferries in the winters. The first summer he was master on the HSC catamaran *Superstar Express*. For the last three summers he commanded *Portsmouth Express*. He had also undertaken delivery voyages on HSC from Argentina and Spain.

The chief officer, aged 34, held a class 2 deck officer certificate, which was issued in July 2001. The chief officer had worked occasionally on *Portsmouth Express* in 2001, and had worked full-time on the vessel for the 2002 summer season.

The pilot, aged 44, held a class 1 master mariner's certificate, and was allowed to pilot vessels up to 170m long, in the Port of Southampton. He had been a Southampton pilot since December 2000, and before this had worked on Isle of Wight ferries for about 12 years.

1.8 TRAINING/EXPERIENCE AND CONSEQUENT ACTIONS

1.8.1 Master and chief officer

The master and chief officer both undertook a familiarisation period of one week on an HSC before taking responsibility in their respective roles on this type of craft. During this period they prepared for their type rating examination, and followed a documented familiarisation regime. One of the subjects on the regime was "Knowledge of the Craft Op. Manual and Route Op. Manual"; the Route Op. Manual contained the RAPP.

The master had read the RAPP for the normal ferry route to and from Portsmouth and Cherbourg. He followed the speed profile and track specified in this document while on this route, as far as other traffic allowed. In four years of operating HSC, he had never been involved in a wash incident.

The RAPP contained general information on HSC wash generation as well as the speed profile and track for the normal ferry route. As he had read this general information, the master had some knowledge of the wash problems of HSC. He understood that vessel speed and depth of water were the main variables. He thought that the water from Southampton to Portsmouth was deep enough not to cause a problem with wash, bearing in mind that the vessel could not reach full speed as one of the engines was not operating. However, when 30 knots was attained in the Thorn Channel, he thought that they might be approaching the critical speed range, so he observed the wash as it reached the shallow water around Calshot Spit, but did not think this gave any cause for concern. The master had undertaken a similar voyage from Southampton to Portsmouth in command of *Portsmouth Express* on 18 May 2001. During this passage, no problems were reported when full power on three engines was applied once past Calshot until approximately the position of the North Sturbridge buoy.

During the playback of the bridge voice recordings, the chief officer was not heard to express any reservations about the speed of *Portsmouth Express*.

The HSC Code, produced by the IMO, contains most of the regulatory requirements for the construction and operation of these craft. *Portsmouth Express* was under the Bahamas flag, but the MCA, which holds authority as port state, checked the operation of the vessel. Both these marine administrations apply the HSC Code.

The requirements for training and qualifications are contained in Chapter 18 of the HSC Code. A type rating certificate should be issued to the master and all officers having an operational role, after an appropriate period of training, in accordance with paragraph 18.3.3 of this code. A brief description of the training required is specified, and item 18.3.3.3 requires training in the "handling characteristics of the craft and the limiting operational conditions". The MCA expected that an understanding of HSC wash would be included in handling characteristics training. However, this expectation was not transmitted to P&O. There is no clear reference to the requirement to undertake training in HSC wash in the HSC Code.

Type rating certificates for the master and chief officer, as well as many other documents for the vessel, were required to obtain a permit to operate. The Bahamas Maritime Authority issued the permit to operate on 15 April 2002, and this was checked by the MCA as the port state. The type rating certificate for the master was issued by P&O on 19 April 2000, and was endorsed by the MCA on 4 May 2000; this certificate was revalidated on 3 April 2002 and endorsed by the MCA on 25 May 2002. The same certificate for the chief officer was issued on 17 July 2001 and endorsed on 19 July 2001. The examination paper, to obtain the type rating certificate, was set and marked by a P&O senior master, but did not include any questions about HSC wash.

1.8.2 Pilot

The voyage during which this accident occurred, was the first time the pilot had undertaken an HSC movement. Before boarding *Portsmouth Express,* he discussed the voyage with one of his pilot colleagues who had worked on HSC. From this conversation, he gained the impression that full power could be used in the Solent. The pilot did not discuss wash with his colleague, but, later, when he heard that the vessel would be operating on three engines, and hence reduced power, he did not think wash would be an issue.

The pilot training, which he had received, did not cover HSC wash, nor did the HSC Code require it. He was not aware of the critical speed range in relation to wash. He assumed the normal speed limits were sufficient to prevent wash problems from this type of craft. The speed limit in the upper harbour of Southampton Port is 6 knots over the ground. The speed limit past Fawley is 7 knots for vessels with a draught of over 6m, which did not include *Portsmouth Express*. However, pilots normally require vessels to slow down there, as was done in this case. The pilot was not aware of any other speed limits on the voyage until the approach to Portsmouth. He was unaware of any previous wash wave incidents at Cowes.

1.9 BRIDGE ARRANGEMENT AND CREW DUTIES

The master sat in the central seat at the forward end of the bridge, as this was the conning position. The chief officer sat on the starboard side of the master, and the engineer was seated to port. An able seaman, who walked around the bridge and kept a lookout, was also present.

On the voyage from Portsmouth to Southampton, the pilot was standing behind and between the master and the chief officer for most of the time. As is usual for this type of vessel, the master steered, controlled the engines and kept a lookout. The chief officer monitored the master's actions, as well as dealing with the radios, looking at the radar screens for collision avoidance, and monitoring the vessel's position on the electronic chart display. The engineer monitored the engine instruments. The master had the conduct of the vessel, the pilot was advising. The pilot handled some of the radio calls concerning the passing of other vessels, and liaison with VTS staff. On the evening of the passage, vessel traffic was quite light in the Port of Southampton area.

1.10 BRIDGE CREW FITNESS

Another master was going to take *Portsmouth Express* to Portsmouth as part of his shift, but, because of the cooling pump problem, it was agreed that the relieving master would undertake the voyage. The relieving master joined *Portsmouth Express* at about 1400; he was well rested and had not taken any alcohol in the previous 24 hours while he was off duty. P&O apply a random breath test policy to their crews. This is taken very seriously by all concerned; generally crew members do not consume any alcohol in the 24 hours before going on duty.

Before the accident, the pilot had been at home on leave for two days. The voyage on *Portsmouth Express* was the first of the day for him. He was well rested and had not taken any alcohol for at least 24 hours.

1.11 RAPP

Since 20 January 2000, the MCA has required the compilation of a RAPP for all HSC ferry routes to and from UK ports. This goes beyond the requirements of the internationally agreed IMO Code. The MCA took action on the issue because HSC wash was foreseen as potentially hazardous. The RAPP contains an analysis of wash, and specifies the speed profile and track to minimise the effects. The measure was found to be necessary after a number of HSC wash wave incidents, most notably the case involving *Purdy*, which occurred off Harwich in 1999. This accident was investigated by the MAIB; *Purdy* was swamped by a large wash wave produced by the HSC *Stena Discovery*, which resulted in the death of one person.

P&O European Ferries (Portsmouth) Ltd employed Seaspeed Technology to produce the RAPP for the ferry route undertaken by *Portsmouth Express*. This report, dated March 2000, identifies the areas of coastline which could be affected by wash, and shows the results of a risk assessment to minimise the problem. The document contains a section on guidance for masters **(Annex 1)**. This section refers to a figure at the back of the report, which clearly shows the relationship between vessel speed and water depth, and the critical speed range to be avoided **(Figure 7)**. The report contains general information on the subject, and, by reading it, it is possible to obtain a basic understanding of the physics of HSC wash.

Figure 7

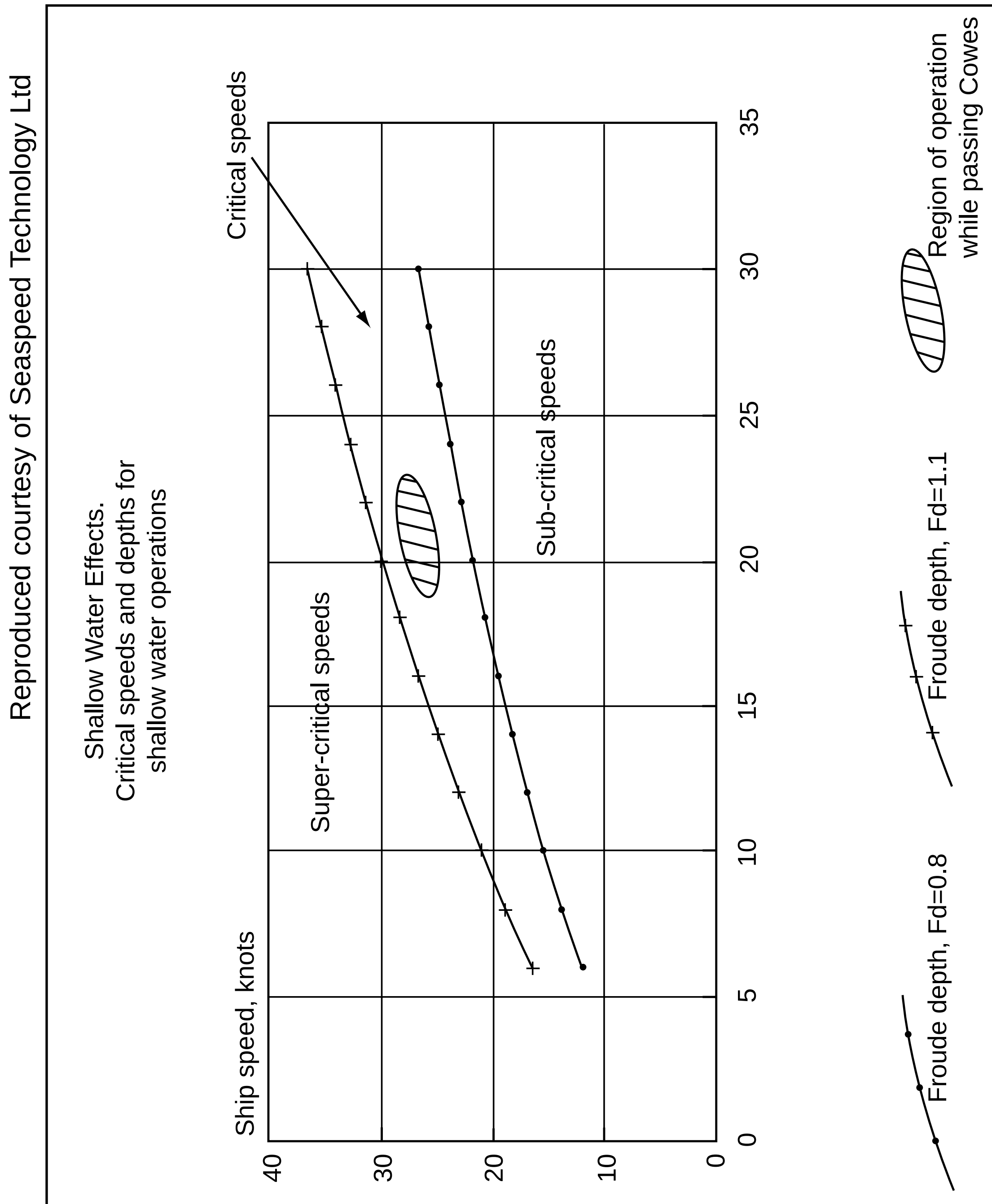


Table B.3. Sub-critical, critical and super-critical speed depth ranges

1.12 PASSAGE PLAN AND DEPARTURE CHECKLIST

The departure checklist, for the voyage from Southampton to Portsmouth on 18 July 2002, was integral with the deck log. The checklist does not include any specific reference to the consideration of wash, as it is intended for the normal route from Portsmouth and Cherbourg. With that ferry route, the effect of wash has been considered in the RAPP and, provided the specified speed profile and track are adhered to, no problems with wash should be experienced. For the voyage on the day of the accident, the passage plan should have considered the effects of wash in some detail, because the RAPP did not directly apply. The passage plan did not adequately cover wash.

The deck log for the day of the accident shows the speed going past the Prince Consort buoy as 23.6 knots. This was speed over the ground; the speed through the water was about 25.6 knots allowing for tidal flow.

P&O's Fleet Regulations state the following, in relation to passage plans:

The master shall designate an officer to review and maintain normal service passage plans appropriate to the latest relevant information. When proceeding to refit/repairs or to a destination outside the normal service ports, the designated officer shall prepare a passage plan for approval by the master. The officer of the watch shall ensure that the passage plan is amended appropriate to any information he receives whilst on watch.

1.13 *ADMIRALTY SAILING DIRECTIONS*

The Admiralty Sailing Directions – Channel Pilot – NP 27 – Fourth Edition 1999, states on page 180 under paragraph 7.26, title "Speed off Cowes" that vessels should "proceed at moderate speed". The Hydrographer of the Navy was unable to establish the exact authority for the caution, but it probably came from the Cowes Harbour Byelaws. In paragraph 12, on page 2 of this document, reference is made to a speed limit of 6 knots in the Harbour and Roads, and it also requires, in the same paragraph on page 3, "reduced speed as necessary in the observance of the normal practice of safe seamanship …… in circumstances which could endanger the safety of other persons vessels boats or properties or cause damage thereto".

At the time of the accident, the master and pilot were not aware of the statement in the *Admiralty Sailing Directions* that vessels should proceed at moderate speed off Cowes.

1.14 VOYAGE DATA RECORDER

Portsmouth Express was fitted with a Broadgate VER 1000A voyage data recorder. This provided recorded positions and speeds, some of which were transposed to the appropriate chart **(Figure 2)**. The track passes about 0.7 mile from East Cowes point and is the normal navigation route for a vessel transiting the Solent to and from Southampton. An approximate track of the whole voyage is shown in **(Figure 8)**.

The VDR also provided an audio recording of the bridge operations.

1.15 PREVIOUS WASH INCIDENTS AT EAST COWES

There is a sign on East Cowes esplanade **(Figure 9)** with the warning “BEWARE OF WASH FROM PASSING SHIPS”. The telephone incorporated into this sign was used to call the police after this incident. The sign was erected in the mid-1980s, following a number of incidents involving container ships. Children paddling on the shore were sometimes taken by surprise when the wash from these ships reached the beach.

There are no known previous HSC wash incidents at East Cowes.

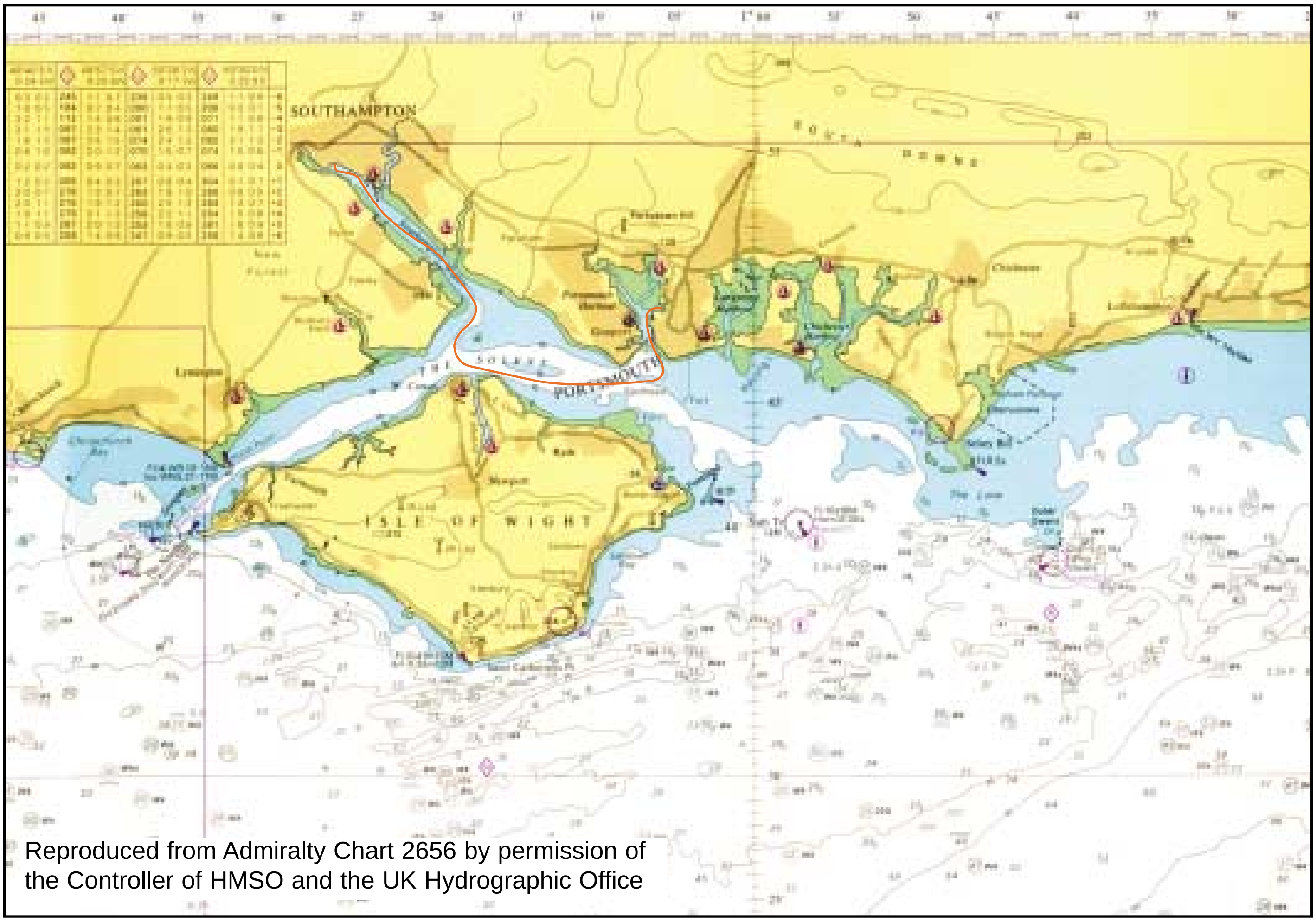
No accurate record of the wash incidents involving container ships in the early 1980s appears to exist. However, within the last few years, a record has been kept of all reported accidents and dangerous occurrences in the Cowes port area in accordance with the Port Marine Safety Code. The accident involving *Portsmouth Express* is included in this record. When significant accidents occur in the Cowes port area, the harbourmasters of Southampton and Portsmouth are informed.

1.16 CORRECTIVE ACTION BY P&O

P&O European Ferries (Portsmouth) Ltd only operates *Portsmouth Express* to and from Portsmouth and Cherbourg in the summer; the service usually starts in March/April.

The company is improving the arrangements for training masters and deck officers assigned to HSC, inasmuch that they will undergo further training in HSC wash propagation before the start of the 2003 operating season. In addition, it has issued a circular reminding masters of the requirements with respect to passage plans, as set out in Fleet Regulations.

Figure 8



Reproduced from Admiralty Chart 2656 by permission of the Controller of HMSO and the UK Hydrographic Office

Approximate track of *Portsmouth Express* on 18 July 2002

Figure 9

Sign at East Cowes point

SECTION 2 - ANALYSIS

2.1 AIM

The purpose of the analysis is to determine the cause and contributory factors of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 HSC WASH WAVE INCIDENTS

The MAIB considers the subject of HSC wash wave generation to be very important, particularly as the number of HSC in service is growing, and also because of the increase in vessel engine power. *Portsmouth Express* has a total power of about 30MW, and *Stena Discovery* has about 70MW. HSC are being designed with a total installed power of about 250MW, which is well over 300,000 horsepower. Putting this amount of power into the sea has the potential for creating huge wash waves. Members of the public who use the coast are entitled to have their safety respected. The effects of HSC wash waves are at their worst when the sea is calm; this is precisely the time when shore users least expect problems, which is the main reason why the issue is of such interest. Small children playing on beaches near the tracks of HSC are a particular concern.

The hazards of operating HSC in relatively shallow water close to shore are exemplified by this case. Realising the importance of getting a safety message out to the marine industry as soon as possible, the MAIB issued *Safety Bulletin 4/2002* **(Annex 2)** in November 2002.

2.3 THE SPEED OF *PORTSMOUTH EXPRESS* PAST COWES

The speed of the vessel past Cowes is shown in **(Figure 2)**. The data comes from her VDR. The speeds shown are over the ground; the speeds through the water were higher by about 2 knots because of the tidal stream. The most relevant data to this accident is the vessel's speed of 23.6 knots north of the Prince Consort buoy at 1857, and the speed of 25.4 knots at 1858. The respective speeds through the water were 25.6 knots and 27.4 knots. The depth Froude number calculation requires speeds to be in m/s, so knots need to be multiplied by 0.514.

It was just after high water at the time of the accident, and the sea level was 3.87m above chart datum. The seabed undulates off East Cowes, but, allowing for the height of tide, the water depth at the time of the accident along the track of *Portsmouth Express*, was about 20m. The two speeds through the water mentioned above, and the depths of water marked on the chart closest to the positions where the speeds were recorded, were fed into the depth Froude number formula. The results of these calculations indicate that *Portsmouth*

Express was travelling in the critical speed range as she passed Cowes **(Figure 7)**. A vessel produces the greatest wash when travelling in the critical speed range. *Portsmouth Express* was using all her available power, so going faster to get out of the critical speed range was not an option; therefore she should have passed Cowes at sub-critical speed. Going faster would, in any case, have been unwise bearing in mind the confined nature of the channel. In summary, the speed of *Portsmouth Express* in the channel past Cowes was too high.

A speed not in excess of 15 knots, while passing Cowes, is considered to be appropriate and in keeping with the moderate speed advised in the *Admiralty Sailing Directions*.

2.4 RUNNING ON THREE ENGINES

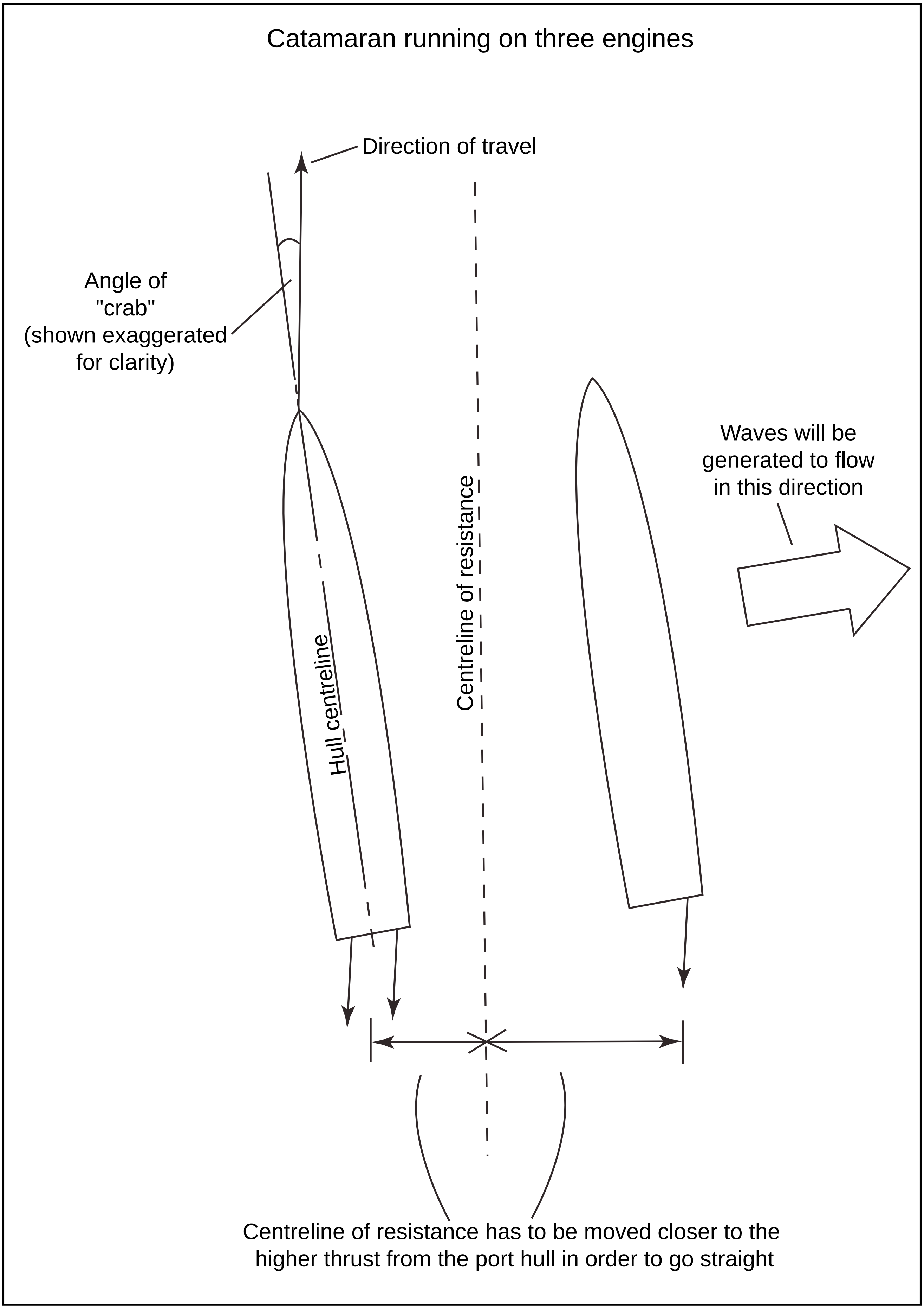
The wash from a catamaran HSC, with two waterjets in each hull, is altered when one of the waterjets is not operating. There is some evidence that the wash is worse when using asymmetric propulsion, as compared to similar speeds when symmetric thrust is applied. The problem is magnified when the spacing between the hulls is relatively large, as was the case with *Portsmouth Express*. The MCA has recently started to compile a record of HSC wash incidents related to running on three engines. If this monitoring exercise indicates that asymmetric propulsion is a significant problem, research into this issue may be undertaken.

It is considered that, as one of the starboard engines on *Portsmouth Express* was not operating, the inclination of the hulls was tending to throw most of the wash out to starboard **(Figure 10)**, towards East Cowes beach.

2.5 PROPAGATION AND PERCEPTION OF WASH

When HSC are running at high speed, the hazardous wash waves produced have long periods. This means that the distance between wave crests is large, and in deep water these waves look quite innocuous. It is only when they arrive in shallow water, such as the approach to a beach that their appearance changes. At this stage, the waves build in height and can break with enormous force. Their insidious nature makes the waves difficult to perceive as the HSC generates them. The problems arise during wave propagation in shallow water, which could be several minutes after the vessel has passed by. For this reason, the observance of a vessel's wash is not sufficient to identify the problem. If high speed is used close to land, the depth Froude number must be ascertained, and the critical speed range avoided.

Long period waves tend to persist in calm conditions. In rough weather they tend to be broken up. Hence, the calm conditions at the time of the accident tended to exacerbate the problem. The high water allowed the waves to wash over the sea wall, which also worsened the accident.


Catamaran running on three engines
Direction of travel
Angle of
"crab"
(shown exaggerated
for clarity)
Hull centreline
Centreline of resistance
Waves will be
generated to flow
in this direction
Centreline of resistance has to be moved closer to the
higher thrust from the port hull in order to go straight

The effect of the breakwater at East Cowes might have been significant. It appears that this sea defence funnelled the waves to the point where the breakwater joined the sea wall, amplifying the wash problem at this section of the seafront. This is where the people were injured. The breakwater also appears to have caused shingle to build up at East Cowes Point **(Figure 11)**. The effective height of the sea wall is reduced in this area. This is another reason why the wash waves were able to rise over the sea wall there.

Figure 11

Beach at East Cowes point

2.6 TRAINING/EXPERIENCE AND CONSEQUENT ACTIONS

2.6.1 Master and chief officer

The master followed the RAPP when operating *Portsmouth Express* on her normal ferry route, and the speed profile and track specified were adhered to. Nevertheless, it is considered that he had insufficient understanding of the effects of wash to be able to operate an HSC safely in shallow water, when the craft was not on her usual route.

The function of the training required to obtain a type rating certificate is for the master and all operational officers to gain an understanding of the special aspects of the HSC they work on. This training is additional to that normally required for masters or mates, and is necessary because HSC are substantially different to conventional ships. An example of this is the wash that HSC produce when running at high speed in shallow water. Type rating certificates were actually issued by P&O, after one of its senior masters delivered training and examination. The certificates were then endorsed by the MCA. None of the examination questions covered the subject of hazardous wash produced by HSC.

The MAIB believes the reason the master applied full power and went too fast when passing Cowes, was that he had insufficient knowledge and training in the effect of HSC wash. During the playback of the bridge voice recordings, the chief officer was not heard to express any reservations about the speed of *Portsmouth Express.* It is, therefore, considered that P&O did not provide sufficient training in this subject.

The item in the RAPP that illustrates the problem most clearly is the graph **(Figure 7)**. The graph is easy to use, and the critical speed range to be avoided is shown. The master had read the RAPP, and he knew that the vessel should not be in the critical speed range near to land. He assumed that the vessel could not reach the critical speed range in the water depths in the Solent, because only three engines were available. However, had he used the graph in conjunction with the charted depths and expected speeds, it would have been apparent that there was a danger of reaching the critical speed range.

Masters have to absorb a great deal of information to be able to command a large complex vessel like *Portsmouth Express*. Nevertheless, they should have had a clear understanding of HSC wash, because of the potential hazards of this problem.

The corrective action, which P&O is implementing, regarding further training in wash for all masters and deck officers of HSC, should be sufficient to prevent a similar accident in the future.

The MCA is currently drafting instructions for the guidance of surveyors for HSC. The document will require MCA surveyors to satisfy themselves that HSC masters and deck officers have adequate knowledge of HSC wash before allowing HSC to operate. This measure will also help to prevent a similar HSC accident in the future.

It is considered that the requirements for the training of HSC masters and chief officers, in the problems of HSC wash, needs to be more clearly specified. Therefore, a recommendation has been made to the MCA to provide guidance on this to HSC operating companies, by publishing a relevant Marine Guidance Note (MGN). In the longer term, the MCA should propose at IMO a more detailed specification for HSC wash training to be included in the next revision of the HSC Code. A recommendation on this has also been made.

2.6.2 Pilot

The pilot had been serving for about 18 months. He had undertaken a comprehensive training programme, but this did not include an appreciation of HSC wash. He did not think hazardous wash would be an issue, given that the vessel was operating on reduced power.

As HSC wash poses a significant danger, mainly to members of the public, pilots who work on them should ensure that a RAPP has been prepared for all HSC movements. As is normally the case with the master/pilot interchange, the pilot should satisfy himself that the passage can be undertaken safely; for HSC, this discussion should cover wash, and the pilot should ensure that the master has adequately covered this aspect of the voyage.

2.6.3 Technical information

Masters and chief officers of HSC should have an understanding of HSC wash. Courses are available, and the following technical papers provide information on the subject:

- The report into the loss of *Purdy,* which can be obtained from the MAIB.
- The Nautical Institute has published guidance on the subject.
- Marine Information Notes MIN 48 (M+F) and MIN 118 (M+F), produced by the MCA and available free of charge, contain some useful research findings.

The MCA commissioned the research reported in MIN 48 (M&F). The MCA is also jointly managing the Ships Wash Impact Management (SWIM) project.

The Permanent International Association of Navigation Conferences (PIANC) is conducting a research programme to establish an international standard for wash wake evaluation of HSC, based on risk assessment.

When the SWIM project and the PIANC work are complete, the output will provide further sources of information on HSC wash.

2.6.4 *Admiralty Sailing Directions*

The master, chief officer and pilot were unaware of the caution in the *Admiralty Sailing Directions* that vessels should proceed at moderate speed past Cowes. The channel past Cowes is part of the Port of Southampton. The master or chief officer should have read the appropriate part of the *Admiralty Sailing Directions* when preparing the passage plan. Southampton pilots are experts in navigation in this area and should have a detailed knowledge of all relevant documents, including the appropriate part of the *Admiralty Sailing Directions*.

2.7 RAPPS

The vessel's passage plan did not adequately consider the effects of wash. Had a RAPP been prepared and adhered to, *Portsmouth Express* would not have produced the hazardous wash.

A RAPP should be prepared for all HSC voyages. A document similar to the RAPP prepared for *Portsmouth Express*, should be compiled for the normal ferry route. However, such a comprehensive piece of work is unnecessary for a one-off voyage, when intending to operate at sub-critical speed. For such a voyage, an acceptable RAPP would be to find the depths of water along the proposed track from charts and tidal information, and then apply this to a graph such as that shown in **(Figure 7)**.

By using the graph, it is possible to find speeds that enable the passage to be undertaken in the sub-critical range. This simple exercise will be sufficient to ensure that a hazardous wash is not produced, provided the derived sub-critical speeds are adhered to.

If no depth Froude number graph is available, the depths can be fed into the formula Fn_h = Vs / ã (g x h) to find sub-critical speeds. In the RAPP for *Portsmouth Express*, when the depth Froude number is less than 0.80, the speed is sub-critical. The use of 0.80 for other HSC is acceptable. These calculations can be easily performed using a pocket calculator. When Fn_h, g and h are known, and Vs has to be determined the formula should be transposed ie Vs = Fn_h x ã (g x h).

SECTION 3 - CONCLUSIONS

3.1 CAUSE

Large wash waves were produced because the speed of *Portsmouth Express* was too high for the depth of water in the channel past Cowes (2.3).

3.2 CONTRIBUTING FACTORS

1. The high tide level allowed the waves to wash over the sea wall, which worsened the accident. (2.5)

2. The beach was built up at East Cowes point; this was another reason why the waves were able to wash over the sea wall there. (2.5)

3. The master and chief officer had inadequate knowledge of HSC wash as they had received insufficient training in the subject. (2.6)

4. The graph of vessel speed versus water depth, from which the crew could have ascertained the critical speed range, was not used. (2.6)

5. The pilot had not received any training in HSC wash. (2.6)

6. The master, chief officer and pilot were unaware of the caution in the *Admiralty Sailing Directions* that vessels should pass Cowes at moderate speed. (2.6)

7. The passage plan did not adequately consider the effects of wash. (2.7)

3.3 OTHER FINDINGS

1. The number of HSC in operation is growing, and they are being fitted with more powerful engines. (2.2)

2. When operating at high speed, visual observation of HSC wash is insufficient to identify hazardous waves, which may be emanating from the vessel. (2.5).

3. The corrective action taken by P&O, regarding further training in HSC wash, should help to prevent similar accidents in the future. (2.6)

4. The requirements for the training of HSC masters and chief officers in the problems of HSC wash needs to be more clearly specified. (2.6)

SECTION 4 - ACTION TAKEN

P&O European Ferries (Portsmouth) Ltd only operates *Portsmouth Express* to and from Portsmouth and Cherbourg in the summer. The company is making arrangements for all masters and deck officers to undergo further training in HSC wash before *Portsmouth Express* begins operating in UK waters in 2003.

The Chief Inspector of Marine Accidents has written to the Harbourmaster, Southampton, regarding the need for pilots to have a detailed knowledge of the *Admiralty Sailing Directions* that cover their pilotage area.

SECTION 5 - RECOMMENDATIONS

Arising from the accident involving *Portsmouth Express*, the MAIB issued Safety Bulletin 4/2002 in November 2002 **(Annex 2)**, which included four interim recommendations. These recommendations have been reviewed; the wording has been altered and the fourth recommendation has been removed. Two additional recommendations have been added. The recommendations are now as follows:

HSC operating companies are recommended to:

1. Prepare a RAPP for all voyages.

2. Ensure all masters and chief officers who operate HSC have sufficient understanding of the problems of wash.

Harbour authorities employing pilots on HSC are recommended to:

3. Ensure a RAPP has been prepared for all HSC movements. The pilot should also ensure that the RAPP is adhered to.

The Maritime and Coastguard Agency is recommended to:

4. Publish a Marine Guidance Note specifying the training in wash generation and its effects required for masters and chief officers of HSC.

5. Propose at IMO, a detailed specification on training in wash generation and its effects for HSC masters and chief officers, to be included in the next revision of the HSC Code.

Marine Accident Investigation Branch
June 2003

ANNEX 1

RAPP Guidance for HSC Masters

3.5. Guidance for HSC Masters

These notes are provided for guidance to HSC Masters with respect to wash.

a. In deep water, wash heights increase with speed up to the primary hull resistance hump speed. For the 91 metre catamaran this speed is between about 27 to 34 knots. At speeds higher that this, the wash heights will reduce slightly but will settle at a constant level after about 38 knots. The wash will consist of divergent and transverse waves. The divergent waves will travel in a direction about 35 degrees either side of the ship's track. The transverse waves will travel in the direction of the ship's track. The period of the waves is proportional to the vessel's speed.

b. The generation of waves is affected significantly by water depth, and as a consequence so is the resistance of the vessel and to a certain extent also its trim. There are three main zones of operation in this context, subcritical, critical and supercritical. In the subcritical zone the vessel is largely unaffected by depth and so the wash is generated as described for deep water. In the supercritical zone the resistance of the vessel is reduced (or speed would be increased for a constant thrust) and the wash characteristics change. The wash will now consist of divergent waves only and their period depends on a range of factors. Their direction depends on the water depth and vessel speed but at 40 knots and 15 to 20 metres depth the direction is about 50 degrees either side of the ship's track. At the critical speeds, very large transverse wash waves are generated which travel in the direction of the ship's track. Full developed critical waves can be very large but in reality the height and extent of these waves depends on the time spent at this speed.

c. For low wash operation of the vessel it is clearly important to avoid certain speeds and certain speed/depth regimes. In particular it is important to avoid operation at critical speeds, particularly in very shallow water, and certainly to avoid operation at the point at which the vessel's hump speed coincides with the critical depth speed. For assistance in this regard a graphical presentation of the three main speed regimes is given in Annex B, Table B.3.

Seaspeed Technology Limited

d. In order to avoid critical speed operation, the operational depth and speed relationship should clearly be kept in mind. However during acceleration and deceleration, running at this speed cannot be avoided entirely. Thus it is important to pass through this speed zone quickly, accelerating or decelerating rapidly. For acceleration an additional benefit can be gained by doing so over a sea bottom ramp. Such a ramp exists just to the east of Warner buoy. Initial acceleration should take place in the 30 metre depth pool reaching the 20 metre contour at about 25 knots whilst still accelerating. This increase of speed during a reduction in depth significantly reduces the time spent at the critical speed.

e. Clearly, when operating in a straight line, the wash propagates equally either side of the vessel. However this changes when a substantial course alteration is made. On the inside of the turn, the wash formed prior to the turn can become superimposed on the wash formed after the turn, thus increasing the observed wash height on this side. This should be taken into consideration when planning a route for high speed operation.

ANNEX 2

MAIB Safety Bulletin 4/2002

Safety
Bulletin

Department for
Transport

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

MAIB SAFETY BULLETIN 4/2002

High Speed Craft (HSC)

Portsmouth Express

Wash Wave Incident

Issued November 2002

MAIB

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MAIB SAFETY BULLETIN 4/2002

This document, containing safety recommendations, has been produced for marine safety purposes only. It is issued on the basis of information available to date.

The Merchant Shipping (Accident Reporting and Investigation) Regulations 1999 provide for the Chief Inspector of Marine Accidents to make recommendations at any time during the course of an investigation if, in his opinion, it is necessary or desirable to do so.

The Marine Accident Investigation Branch (MAIB) is carrying out an investigation into a wash wave incident, involving the high speed craft (HSC) *Portsmouth Express*, which resulted in several members of the public being injured. The MAIB will publish its report on completion of the investigation.

This Safety Bulletin is for the attention of all companies who operate HSC, and all port authorities with pilots who have to deal with HSC movements. The bulletin concerns Passage Plan Risk Assessments and training in relation to the wash produced by HSC.

Stephen Meyer
Chief Inspector of Marine Accidents

Press Enquiries: 020 7944 4691/3387; out of hours: 0207 944 4292
Public Enquiries: 020 7944 3000
Internet address for DfT press notices:
http://www.dft.gov.uk

Background

Since HSC have been operating, a number of incidents have occurred as a result of the wash they have produced. The problems have been minimised by the careful study of the ferry routes involved, the introduction of Operational Criteria to the Permit to Operate HSC and the consequent modification of route and speed profile. The Maritime & Coastguard Agency (MCA) issues or checks the Permit to Operate HSC on routes to and from UK ports. From 20 January 2000, the MCA has required the compilation of a Passage Plan Risk Assessment, which identifies any likely areas of wash, and specifies the speeds/route to reduce it.

The accident

Portsmouth Express was operating close inshore while returning to Portsmouth after a period of repairs at Southampton. On board, the master, mate and pilot were unaware that the vessel was producing a hazardous wash. When the wash arrived onshore, a series of large breaking waves was produced, which rolled up the beach and went right over the sea wall, flooding the road and park beyond. It was high water at the time and the sea was calm.

Several members of the public sustained significant injuries, and one was washed out to sea. Had young children been on the beach, fatalities might well have resulted.

Comments

The physics of wash generation and propagation from HSC is complex, although a basic understanding of the subject can be obtained without too much difficulty. The main parameter is depth Froude number, which is a relationship between vessel speed and depth of water. The worst depth Froude number for producing wash is about 1; the associated speed is known as the critical speed. The vessel involved in this accident was travelling very close to the critical speed[1].

Passage Plan Risk Assessment

To receive a Permit to Operate, the operator must produce a Passage Plan Risk Assessment for the route on which the vessel operates. The purpose of the risk assessment is to ensure that wash does not create any significant problems on shorelines near to the track of the vessel. The vessel involved here was not operating on her normal route at the time of the accident. A Passage Plan Risk Assessment was not produced for this passage. The standard passage plan, which was compiled before the start of the voyage, did not consider the effect of wash.

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[1] [Depth Froude number (Fn_h) can be calculated by using the formula $Fn_h = V_s / \sqrt{(g \times h)}$, where V_s is vessel speed in metres/second, g is the acceleration due to gravity (9.81metres/second^2), and h is the depth of water in metres.]

Training

The master followed the Passage Plan Risk Assessment when operating the craft on her normal route, and the speeds and tracks specified were adhered to. Nevertheless, it is considered that he had insufficient understanding of the effects of wash to be able to operate safely at high speed in shallow water, when the craft was not on her usual route. Also, the competent harbour authority's pilot, who was on board at the time, appeared not to have received any significant training in the effects of wash from HSC.

Solutions

Passage Plan Risk Assessments, which comprise a detailed analysis of wash, should be carried out for all HSC voyages close to land above moderate speed. Had the vessel involved in this particular incident been proceeding at moderate speed, the hazardous wash would not have been produced[2].

Masters, mates and pilots who operate HSC should have an understanding of the wash produced by these vessels. The references below give further information[3].

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[2] If a vessel is operating at a depth Froude number of less than 0.80, it is operating at moderate speed.

[3] Marine Information Notes MIN 48 (M+F) and MIN 118(M+F), produced by the MCA and available free of charge, contain some useful research findings. The report into the accident involving the small vessel *Purdy* and an HSC can be obtained from the MAIB by calling 023 8039 5500. The Nautical Institute has also published guidance on the subject. There is an ongoing research study by PIANC (Permanent International Association of Navigation Congresses) which is endeavouring to establish an international standard for wash evaluation of HSC based on risk assessment.

Safety Recommendations:

To avoid similar problems in the future, the following recommendations are made:

HSC operating companies are recommended to:

1. Compile a Passage Plan Risk Assessment, comprising a detailed analysis of wash, for all voyages close to land and/or in shallow water, unless the HSC is operated at moderate speed.

2. Ensure that all masters and mates who operate HSC have an understanding of the problems of wash. Preferably, this should be obtained by attending an appropriate course but, as a minimum, it should include the reading of some relevant technical papers. They should also study their usual operating route Passage Plan Risk Assessment and apply the guidance on wash to other routes.

Harbour authorities employing pilots on HSC are recommended to:

3. Require a Passage Plan Risk Assessment, comprising a detailed analysis of wash, for all HSC movements. If this document is not available, the pilot should insist the vessel is run at moderate speed.

4. Ensure that all pilots employed on HSC have an understanding of the problems of wash. Preferably, this should be obtained by attending an appropriate course but, as a minimum, it should include the reading of some relevant technical papers.