Report on the investigation of

injury to a passenger on board the RIB

Celtic Pioneer

Bristol Channel

26 August 2008

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

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Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2005 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 13(9) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AINA	-	Association of Inland Navigation Authorities
BMD	-	Bone mass density
EAV	-	Exposure Action Value
ELV	-	Exposure Limit Value
EU	-	European Union
g	-	Acceleration of gravity
GRP	-	Glass reinforced plastic
hp	-	Horsepower
HSG	-	Health and Safety Guidance
ISO	-	International Organization for Standardization
kg	-	kilogram
Knots	-	Nautical miles per hour
kW	-	kilowatt
LACORS	-	Local Authorities Co-ordinators of Regulatory Services
m	-	metre
MCA	-	Maritime and Coastguard Agency
MGN	-	Marine Guidance Note
mph	-	miles per hour
MSN	-	Merchant Shipping Notice
NDP	-	Nominated Departure Point
RCD	-	Recreational Craft Directive
RIB	-	Rigid Inflatable Boat
rms	-	root mean square
rpm	-	revolutions per minute
RYA	-	Royal Yachting Association
SCV	-	Small Commercial Vessel
SI	-	Statutory Instrument

UK	-	United Kingdom
UKFPO	-	United Kingdom Foundation Programme Office
UTC	-	Universal Co-ordinated Time
VHF	-	Very High Frequency
WBV	-	Whole Body Vibration

Times: All times used in this report are UTC + 1 unless otherwise stated

Celtic Pioneer

SYNOPSIS

At approximately 1830 on 26 August 2008, a 55 year old female passenger on board the 9m rigid inflatable boat *Celtic Pioneer* suffered a lower back wedge compression fracture. She was participating in a 1 hour boat trip in the Bristol Channel with 10 colleagues as part of a corporate team building exercise. The injury occurred when the passenger landed heavily on her seat after she was momentarily lifted into the air due to the motion of the craft. She was treated in hospital and fitted with an external spine brace before returning home to begin a 6 month recuperation programme.

Boat trips of varying intensities in small, fast, commercial craft have grown in popularity in recent years. However, these craft are particularly susceptible to relatively high levels of shock and vibration when transiting choppy or disturbed waters when the risk of spinal and other injuries in these craft is increased. The MAIB is aware of 28 accidents that have resulted in lower back compression injuries on board RIBs since 2001, one of which occurred in April 2009. The risk of this type of injury can be reduced by the skill of a boat's coxswain, boat design and procedures such as the exclusion of individuals particularly at risk for medical reasons.

The operation of boats conducting thrill rides and similar activities is not specifically included in the current MCA codes of practice, and there is no industry approved code of practice. Consequently, the standards of safety management among UK operators of these boats vary considerably.

A recommendation has been made to the Passenger Boat and Professional Boatman's Associations to develop an approved code of practice for thrill-type rides in the UK. A recommendation has also been made to the Maritime and Coastguard Agency and the Royal Yachting Association with the aim of raising the qualification requirements for boat coxswains undertaking these activities. A further recommendation, intended to raise awareness of the dangers of shock and vibration in small fast craft, has been made to the Royal Yachting Association. A recommendation has also been made to the Local Authorities Co-ordinators of Regulatory Services and the Institute of Licensing with the aim of encouraging operators to adopt the code of practice when completed.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *CELTIC PIONEER* AND ACCIDENT

Vessel details

Registered owner	:	Bay Island Voyages
Port of registry	:	Cardiff
Flag	:	UK
Type	:	Ribcraft RIB
Built	:	2005
Certifying Authority	:	MECAL Ltd
Construction	:	GRP hull with rubber inflatable tubing
Length overall	:	9m
Engine power and/or type	:	2 x 225hp Mercury outboard motors
Service speed	:	50 knots

Accident details

Time and date	:	1830 on 26 August 2008
Location of incident	:	51 24.1N 003 09.3W, Bristol Channel, Cardiff
Persons on board	:	13 (2 crew + 11 passengers)
Injuries/fatalities	:	One female passenger suffered a lower back *‘wedge’* compression fracture of L2 vertebra
Damage	:	Nil

1.2 NARRATIVE

At about 1745 on 26 August 2008, a group of 11 adults arrived at Mermaid Quay in Cardiff Bay **(Figure 1)**, for a 1 hour boat ride on board the rigid inflatable boat (RIB), *Celtic Pioneer*, operated by Bay Island Voyages. The group had arrived later than expected and were ushered directly onto the pontoon, where each person was issued a lifejacket and a waterproof coat. They were then helped on board and sat on the seats provided **(Figure 2)**; the centre seat on the front row was unoccupied. *Celtic Ranger*, another RIB operated by Bay Island Voyages, which had been booked for a similar 1 hour trip by another group was also moored alongside. Its passengers were already seated and waiting to go.

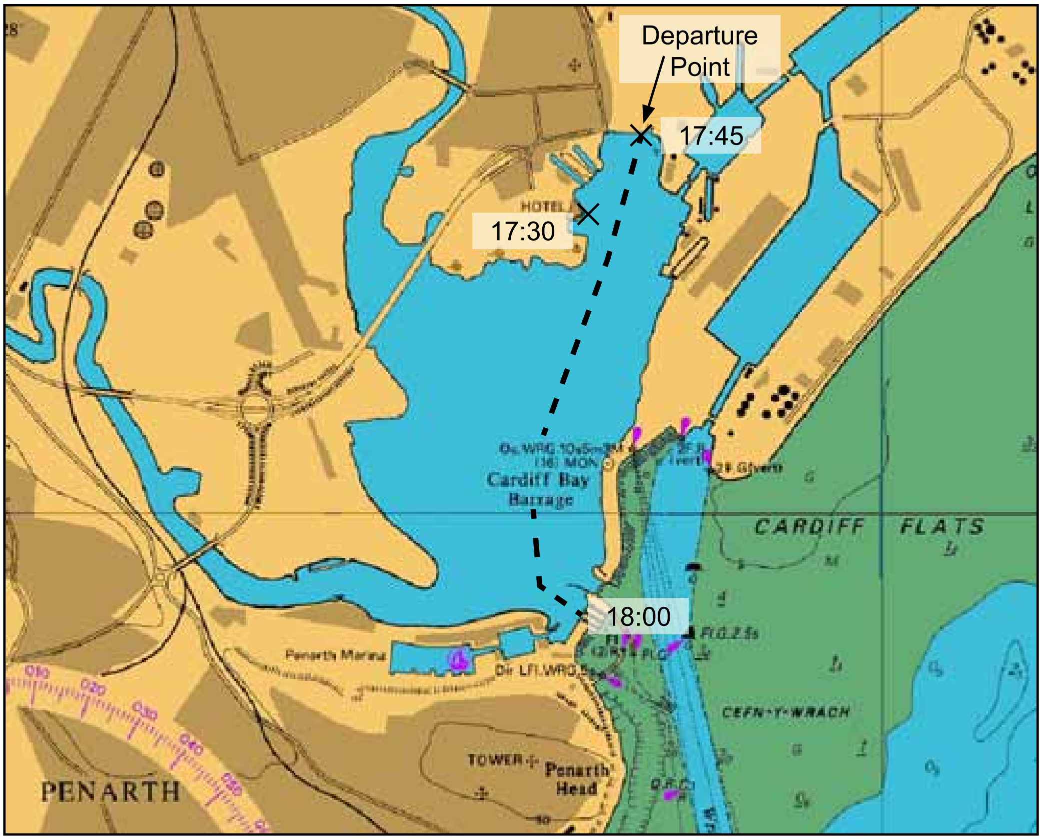
The RIBs set off at a speed of approximately 5 knots towards the Cardiff barrage locks. During the 1 mile transit, the passengers on board *Celtic Pioneer* put on their waterproof coats and lifejackets. The boats entered lock number two **(Figure 3)** at about 1800, where the owner of Bay Island Voyages, who was acting as crewman on board *Celtic Pioneer,* briefed the passengers. He explained how the lifejackets worked, what to expect during the trip and how to sit on the jockey style seats while riding the waves. The passengers were told to hold onto the handrail in front of them, keep their heads up, grip the seat pod between their thighs and use their knees to absorb the shocks in a similar manner to a jockey riding a horse.

At about 1815 the RIBs left the lock and headed into the Bristol Channel **(Figure 4)**. Although both RIBs were working in the same area and were following a similar routine, they were operating independently. The skipper of *Celtic Pioneer* gradually increased speed to between 25 and 30 knots and conducted several helm manoeuvres as the RIB headed south towards the Rannie buoy. However, on several occasions during the transit he slowed down to allow the owner the opportunity to gauge the comfort of the passengers.

After between 5 and 10 minutes the hands of the female passenger seated in the front row on the port side of the boat became wet and cold. Consequently, she found it difficult to maintain her grip and posture and had to steady herself by holding onto the rope attached to the buoyancy tube **(Figure 2)** with her left hand. The owner sensed that she was uncomfortable and instructed the skipper to stop. He then asked the passengers if they were okay and offered them the opportunity to change seats. The majority of passengers responded positively, and one opted to move from his seat at the rear of the boat to the vacant one positioned furthest forward. Several of the passengers did not feel comfortable but did not voice their concerns. The skipper and owner then assessed that everyone was okay, and continued with the trip.

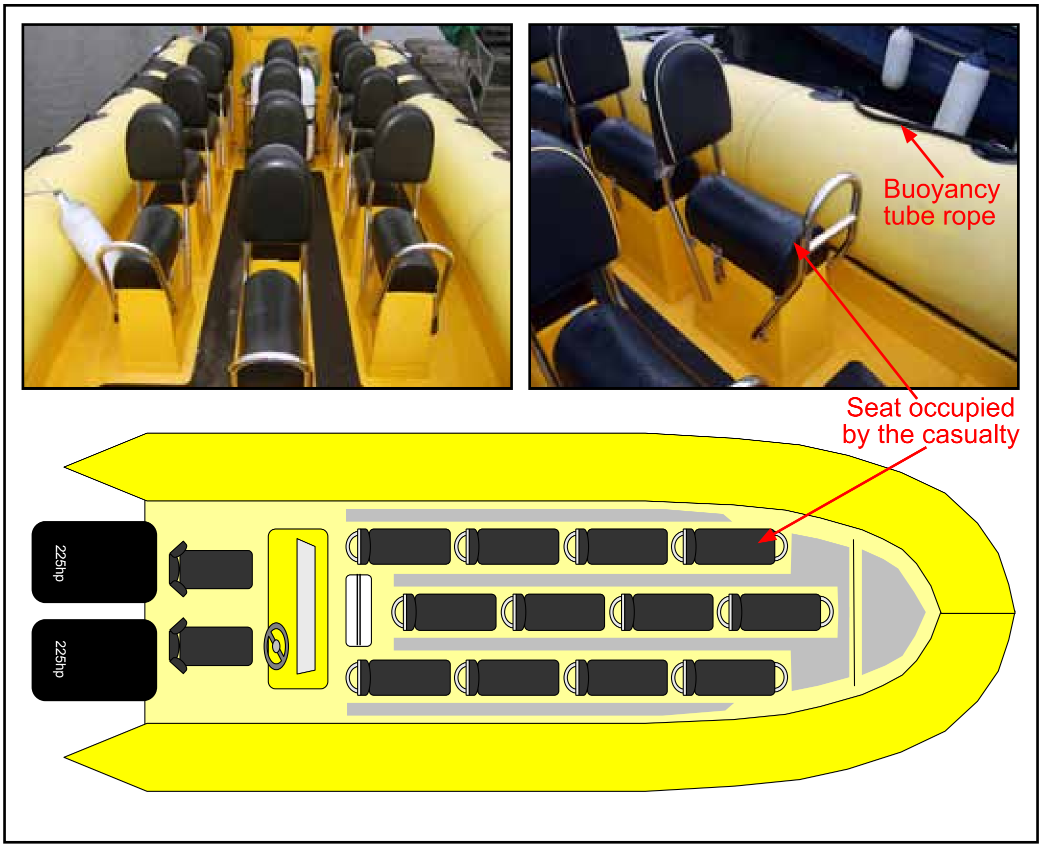
Reproduced from Admiralty Chart BA 1182 by permission of the Controller of HMSO and the UK Hydrographic Office

Figure 1



Extract of chart BA 1182 - Cardiff Bay

Figure 2



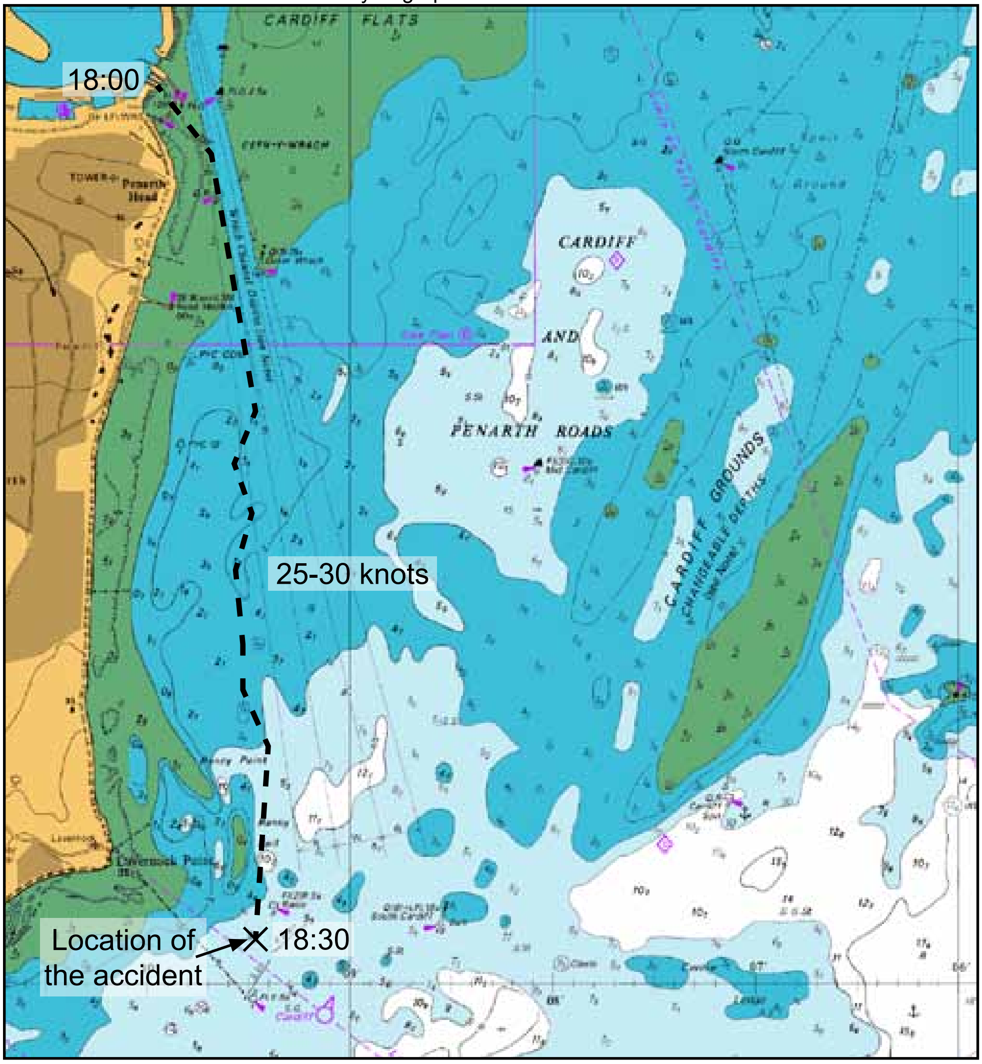
Celtic Pioneer seating positions

Figure 3

Cardiff Bay barrage locks

Reproduced from Admiralty Chart BA 1182 by permission of the Controller of HMSO and the UK Hydrographic Office

Figure 4



Extract of chart BA 1182 - passage and accident location

As *Celtic Pioneer* approached the Rannie buoy the seas became choppy. The skipper slowed to approximately 10 to 12 knots and began to dodge between and over the waves. At approximately 1830, the motion of the boat lifted the female passenger in the front row into the air. She then landed heavily on her seat and screamed due to a sudden intense pain in her lower back. The skipper immediately stopped the boat. The injured passenger moved from her seat towards the bow and lay down. Two passengers, one of whom was a consultant doctor, immediately went to her assistance, quickly followed by the boat's owner. The owner instructed the skipper to turn around and head slowly back towards Cardiff Bay. The casualty was in extreme pain and was wet and cold. She was positioned on her back with her head resting on a fender and her feet elevated onto the RIB's buoyancy tube. The owner used two of the boat's thermal protective aids as blankets to shelter her from the elements.

At 1852 the skipper of *Celtic Pioneer* informed the barrage control that he was running late. He explained that *'a passenger had tweaked her back a little'* and requested to be allowed straight through the locks on arrival. At 1854, the owner, prompted by a concerned passenger, dialled 999 on his mobile phone and requested an ambulance. He informed the emergency services that he intended to berth at Mermaid Quay close to the St Davids Hotel.

Celtic Pioneer entered the lock at about 1900, and once through, the RIB crossed the bay and berthed alongside at approximately 1920. The consultant doctor attended to the casualty and waited with the boat's crew for the ambulance to arrive; the remaining passengers returned to their hotel. Increasingly concerned by the casualty's condition, the doctor again dialled 999 and emphasised the urgency of the situation. The ambulance arrived at 1956 and the casualty was taken to hospital.

1.3 ENVIRONMENTAL CONDITIONS

The accident occurred during daylight hours, in a moderate sea, with good visibility. The air temperature was 17ºC and it was cloudy but dry. The sea temperature was 16ºC. The wind was west-south-westerly at 18 knots. The predicted tidal stream was 2.5 knots in an easterly direction. Localised rip currents are known to occur around the Rannie buoy area.

1.4 *CELTIC PIONEER*

1.4.1 Operation

Celtic Pioneer and *Celtic Ranger* are owned and operated by Bay Island Voyages. The family run business has provided fast RIB rides and tours from Cardiff for 7 years. It employs three people, but hires additional staff on a part-time basis during the summer season.

The company offers half hour, 1 hour and 2 hour trips, the majority of which are booked in advance. The half hour *'fun'* trip is conducted within Cardiff Bay and includes high speed manoeuvres. This accident occurred during a 1 hour trip, which Bay Island Voyages advertises as a *'coastal blast (through the lock gates)'* **(Annex A)**. The 2 hour trip takes the passengers on a 20 nautical mile sightseeing trip in the Bristol Channel around Flat Holm and Steep Holm Islands.

1.4.2 Construction and certification

Celtic Pioneer was manufactured in the UK by Ribcraft Ltd in 2005 and was almost identical in design and layout to *Celtic Ranger,* which was manufactured 3 years earlier. The RIB had a high sheer bow, deep 'v'-shaped hull, inflatable tubes with 7 buoyancy chambers, and 14 jockey style seat pods designed for 2 crew plus 12 passengers. The 12 passenger pods were positioned in front of the helmsman's console and were bonded to the deck in four rows of three. Each pod had a cushioned seat and back rest and a stainless steel handrail **(Figure 2)**. The two crew seats were positioned behind the console at the stern of the boat. The boats had twin 225hp outboard motors and were advertised, by the operator, to be capable of reaching speeds of up to 60mph when fully loaded. However, to reduce fuel costs, the engine revolutions were generally limited to 4,000rpm which equated to speeds between 25 and 30 knots, depending on the sea conditions.

Celtic Pioneer was intended for commercial use and was fitted out and approved in accordance with the requirements of the Maritime and Coastguard Agency's (MCA) Code of Practice for the Safety of Small Commercial Motor Vessels (the *Yellow Code*). The RIB was approved to operate in area category 4[1] and compliance was verified by MECAL Ltd, an approved certifying authority[2] **(Annex B)**. *Celtic Pioneer* was also built to comply with the construction and essential safety requirements laid down in the Recreational Craft Directive (RCD)[3]. It had a maximum power rating of 500hp and was manufactured to meet the standards required for the RCD's design category B[4].

Bay Island Voyages held a licence to operate in Cardiff Bay which was issued by the harbourmaster. The conditions of the licence required the company to comply with the harbour authority bylaws, ensure its boats and operations comply with the relevant small commercial vessel code, and provide £3M limited liability insurance cover.

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1 Area category 4 – Up to 20 miles from a safe haven, in favourable weather and daylight.

2 Certifying Authority – Either the MCA or one of the organisations authorised by the MCA to appoint persons for the purpose of examining vessels and issuing and signing declarations of examinations, and issue certificates.

3 RCD – Directive 94/25/EC on recreational craft as amended by Directive 2003/44/EC.

4 RCD design category B – Designed for offshore voyages where conditions up to, and including, wind force 8 and significant wave heights up to, and including, 4m may be experienced.

1.4.3 Crew and passengers

The skipper of *Celtic Pioneer* was 35 years old and had been employed by Bay Island Voyages on a part-time basis for about 2 years. He held a Royal Yachting Association (RYA) Powerboat Level 2 Certificate with a commercial endorsement. The owner was 51 years old and had many years experience with RIBs. The skipper of *Celtic Ranger,* who was operating without a crewman, was aged 22. He was the owner's son and he held an RYA Powerboat Advanced Certificate with a commercial endorsement. All of the crew were medically fit and held the additional safety, sea survival, first-aid and radio operator qualifications required for this type of operation.

The passengers were employees of, or advisors to, the National Health Service's Cardiff based UK Foundation Programme Office (UKFPO) and were taking part in a 1 day team building seminar based at the St Davids Hotel. The injured passenger was based in Bristol and was one of the UKFPO national advisors. Participation in the trip, which was booked in advance and had been described to the seminar candidates as *'a speed boat ride around the bay'*, was optional.

1.4.4 Operating procedures

Bay Island Voyages had conducted four operational risk assessments **(Annex C)**, one of which was for an injury to passengers during a voyage. The control measures documented included the requirement for the skipper to deliver his safety brief prior to departure and the crewman to observe the passengers at all times while underway. Bay Island Voyages had also developed a set of written operating procedures and emergency contingency plans **(Annex D)**. These included a requirement for a skipper to alert the coastguard by transmitting a 'Pan Pan' or 'Mayday' broadcast on VHF channel 16 and nominated Penarth coastguard slipway as the landing point for a casualty requiring immediate medical attention.

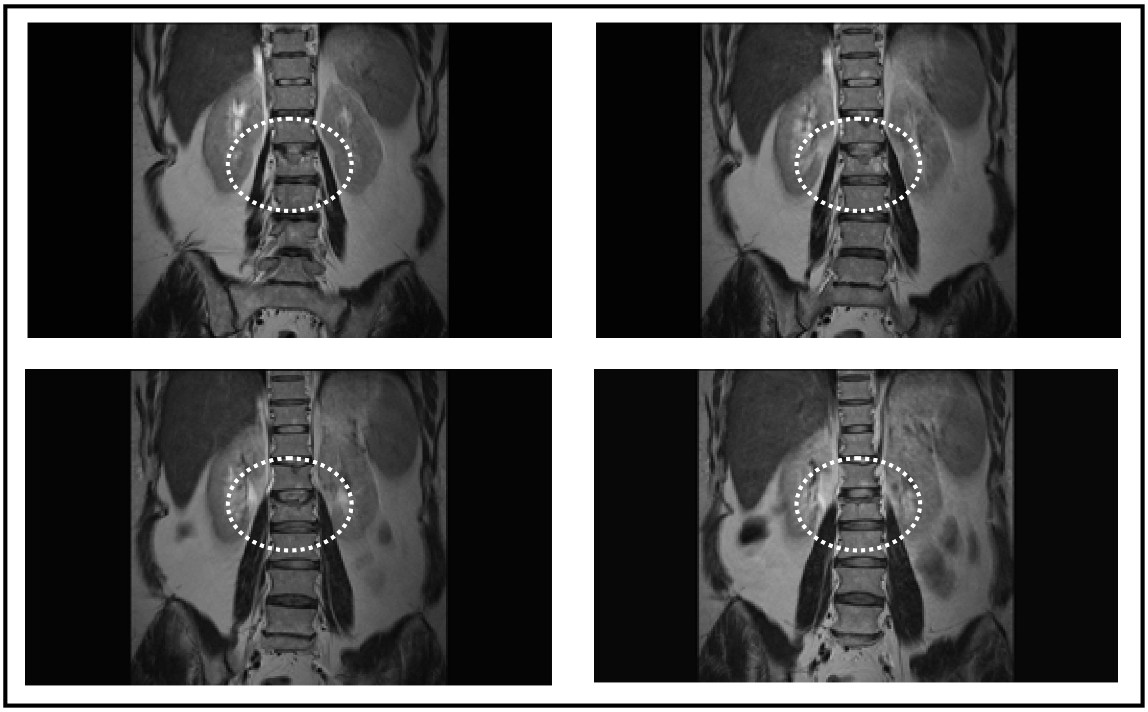
The route followed, and manoeuvres conducted prior to the accident were typical for the standard 1 hour *'coastal blast'*. It was company policy, and normal practice, to issue and fit the passengers' waterproof coats and lifejackets prior to boarding.

1.5 THE INJURY

The injured passenger suffered *'a compression fracture of the second lumbar vertebra (L2) with compression of the superior (upper) end plate'* **(Figure 5)**. The moderately high energy fracture resulted in the separation of a fragment of vertebral body which had the potential to cause neurological damage **(Annex E)**.

The casualty remained in hospital for 10 days and was fitted with an external spine brace before being released home to begin a 6 month recuperation programme. She was aged 55 and was in good health. She had suffered a back injury which had required surgery 15 years earlier, but medical assessment has concluded that this was not contributory to the injury suffered on board *Celtic Pioneer*. Scans conducted after the accident confirmed that the casualty's bone mass density (BMD) was normal.

Figure 5



Scans of injury suffered

1.6 THE MECHANISM OF INJURY

The type of injury suffered typically occurs in the lumbar spine as a result of an axial load[5] being applied with a degree of forward flexion, and is commonly referred to as a *'wedge'* compression fracture. Spinal wedge compression fractures are common among people who have fallen from a height, been involved in a head on car crash, experienced a violent helicopter landing or have ejected from a military aeroplane. The constant pitching and rolling of a boat in a seaway destabilises the upper body, and the resulting shocks due to wave slamming allow this mechanism of injury to be easily mimicked during fast boat rides. Shocks and vibrations resulting from the impacts between a boat's hull and the sea are transmitted through its deck and seats to the passengers and crew. The size of the shocks experienced by people on board a boat are significantly magnified when their bottoms leave the seats and then land as the boat rises up towards them.

The human spine is at its strongest in the standing posture, when it assumes a natural S shape and can readily support the weight of the trunk and head as well as additional loads applied along its axis. An evenly distributed gap is maintained between the vertebrae by its discs, and maximum support is offered by the trunk and abdominal muscles. The spine is weaker in the seated position, when it assumes a slumped posture, and many of the muscles supporting the trunk cannot function effectively. The body's centre of gravity moves forward, increasing the risk of the spine bending forward (forward flexion) during axial

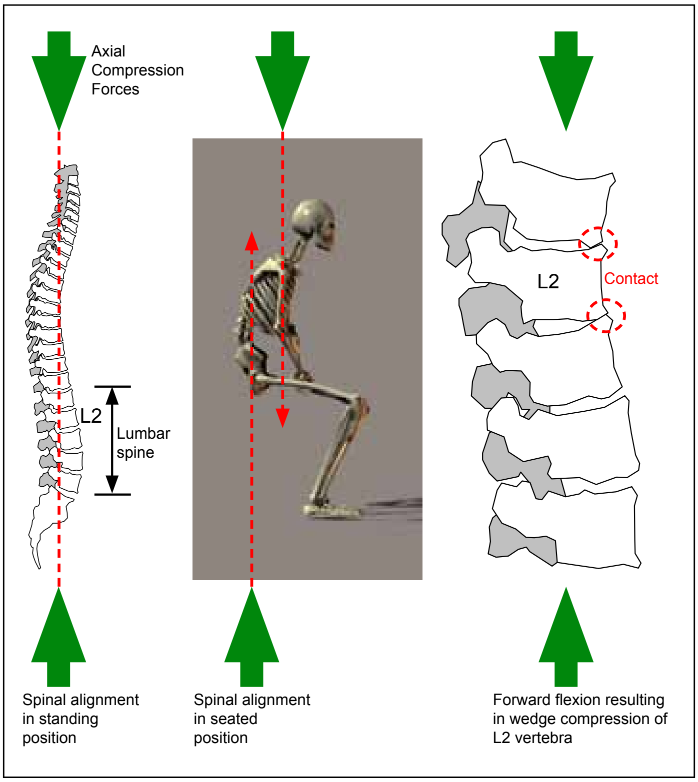
5 Axial load – a load applied compressively through the longitudinal axis of the spine.

loading. It is the combination of the flexion of the spine and the axial forces applied that causes contact between the vertebrae and results in fractures due to the wedging effect **(Figure 6)**. If a twist or bend is introduced to the lower back region the risk of this type of injury is further increased. Research indicates that the introduction of a twist can reduce the mechanical strength of the vertebra/intervertebral disc unit by about one third.

People suffering from osteoporosis, which causes a loss of mineralization and results in a reduction of BMD, are more prone to spinal wedge compression, and other types of fracture. Groups at an increased risk of developing this condition include: the elderly, post menopausal women and women with a strong family history of osteoporosis.

Photograph courtesy of STResearch

Figure 6



Spinal alignment and wedge effect

1.7 SIMILAR ACCIDENTS

The MAIB is aware of 28 accidents that have resulted in lower back compression injuries on board RIBs since 2001. Of these, 21 occurred in the last 3 years, 12 were confirmed as spinal fractures and 16 occurred during thrill-type boat rides.

As in this case, many of these accidents were not reported to the MAIB by the vessel operator, and include an injury to a female passenger in 2007 in the vicinity of the Rannie buoy in a RIB owned by another operator, and two injuries on board a UK coded RIB, operating in Spain in 2008. Several other shock-related injuries during high speed and thrill-type boat rides have been reported to the MAIB, such as leg fractures and facial injuries. Passengers have also been thrown overboard during high speed manoeuvres.

The Maritime Safety Authority of New Zealand conducted an investigation[6] following a spinal fracture suffered by a 57 year old female British tourist during a high speed river rapid ride in 2004. The passenger was later diagnosed with osteoporosis and the report concluded that this possibly contributed to the injury. However, the investigation report identified a number of other contributory factors, including: the boat's skipper had gradually built up speed to increase the thrill level; the casualty was sitting on the front row; the ride had been going for about 20 minutes and, although the casualty had felt uncomfortable throughout, she did not advise the skipper because she did not want to spoil the other passengers' fun; and her bottom left the seat immediately prior to the fracture.

On 14 April 2009, shortly before the publication of this report, five passengers were injured on board a rigid tubed boat of similar characteristics to a RIB, the 10.75m commercially-operated *Ocean Ranger*, during a sightseeing tour around the nature reserve of Ramsey Island off the coast of Wales.

Approximately 30 minutes into the tour, the skipper stopped the vessel at a narrow passage to the south of Ramsey Island, known as Twll-A-Dyllyn (or the Devil's Hole). This passage between islands is regularly used by local boat trip operators when circumnavigating Ramsey Island.

Having assessed that sea conditions were satisfactory, and the crewman having briefed the passengers, the skipper increased speed and commenced his transit through the gap. However, once committed to transiting the passage, a large steep-sided wave appeared, and despite the skipper's best efforts he was unable to stop the vessel slamming heavily as it dropped off the back of the wave. As the vessel dropped off the wave, passengers were briefly suspended above their seats before landing heavily back in them. One passenger suffered a shattered vertebra; another, a fractured sternum. The other passengers suffered less serious back injuries and bruising.

1.8 MAGNITUDE AND FREQUENCY OF SHOCK AND VIBRATION

The UK Ministry of Defence, with the support of the ABCD Working Group on Human Performance at Sea[7], sponsored the production of the High Speed Craft Human Factors Engineering Design Guide. The guide, published in 2008,

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6 Maritime Safety Authority of New Zealand accident report – *Waima, back injury, Fulljames Rapid, Waikato River on 21 November 2004*.

7 ABCD Working Group on Human Performance at Sea is an ad-hoc international group consisting of hydrodynamics and human factors researchers from the US, Australia, UK, Canada and the Netherlands.

explains the type, magnitude and frequency of shocks and vibrations generated during high speed craft transits at sea. It also discusses the effect of repeated shock and whole body vibration (WBV)[8] on people on board, and the methods by which exposure levels can be reduced to as low as is reasonably practicable.

Figure 7, taken from the guide (reproduced on page 18 of this report and included in the summary report at **Annex F)**, shows the magnitude and frequency of repeated shock measured on the deck of an 8.5m long RIB travelling at 40 knots in a sea state of between 1 and 2. It indicates that the passengers and crew can expect to be exposed to constant shocks in the region of 2g, regular shocks of 6g to 10g and occasional shocks of up to 20g. Short term exposure to these repeated shocks can result in micro-muscle fatigue, while long term exposure can lead to chronic musculoskeletal injuries. The occasional high magnitude shocks typically occur when a boat drops off the peak of a wave and hits the face of the next one, or lands in the trough between them. It is these high magnitude impacts that can result in the type of acute injury suffered by the passenger on board *Celtic Pioneer.* The trials also demonstrated that the magnitude of shocks transmitted through the deck of a high speed craft is greater towards the bow.

1.9 THE VIBRATION REGULATIONS

The Merchant Shipping and Fishing Vessels (Control of Vibration at Work) Regulations 2007 (SI 2007/3077), commonly referred to as *The Vibration Regulations,* implement the EU Physical Agents Directive[9] and came into force in February 2008. MGN 353 (M+F)[10] provides guidance on the requirements for the protection of workers from the risks related to the exposure to shock and vibration on board vessels.

The following are the exposure limits for WBV:

- the daily exposure limit value (ELV)[11] standardised to an eight hour reference period is 1.15 m/s^2; and
- the daily exposure action value (EAV)[12] standardised to an eight hour reference period is 0.5 m/s^2.

[8] WBV – means mechanical vibration which is transmitted into the body, when seated or standing, through the supporting surface, during a work activity.

[9] EU 2002/44/EC Directive of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration) (sixteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC).

[10] MGN 353 (M+F) – The Merchant Shipping and Fishing Vessels (Control of Vibration at Work) Regulations 2007.

[11] ELV – means the level of daily exposure for any worker which must not be exceeded.

[12] EAV – means the level of daily exposure for any worker which, if exceeded, requires specified action to be taken to reduce the risk.

MGN 353 (M+F) highlights that WBV presents a particular risk to lower back morbidity and trauma of the spine. It states that the risks are most apparent in smaller, fast craft such as fast rescue boats, RIBs or workboats, particularly when operating in choppy conditions. The regulations place a number of requirements on operators/employers, which include the need to:

- Determine levels of exposure
- Conduct risk assessment
- Eliminate or control the exposure to vibration
- Inform workers of the risks
- Train workers in risk reduction methods
- Apply for exemption from the statutory exposure limits if appropriate
- Conduct health surveillance.

1.10 REGULATIONS AND CODES OF PRACTICE

1.10.1 Vessels operating at sea

Small vessels operating commercially that are United Kingdom (UK) vessels, or other vessels operating from a UK port while in UK waters, must comply with the appropriate Merchant Shipping Regulations or an MCA Small Commercial Vessel Code of Practice. There are currently four Codes for small vessels:

- The Code of Practice for the Safety of Small Commercial Motor Vessels (Yellow Code)
- The Code of Practice for the Safety of Small Commercial Sailing Vessels (Blue Code)
- The Code of Practice for the Safety of Small Workboats and Pilot Boats (Brown Code)
- The Code of Practice for the Safety of Small Vessels in Commercial Use for Sport or Pleasure operating from a Nominated Departure Point (NDP) (Red Code)

The Yellow Code applies to motor vessels of up to 24 metres load line length which are engaged at sea in activities on a commercial basis and which do not carry cargo or more than 12 passengers. The Code sets out the requirements for the construction of the vessel, its machinery, equipment, stability, operation and examination.

In 2004 the MCA drafted The Small Commercial Vessel and Pilot Boat (SCV) Code which rationalised the existing Yellow, Blue, Brown and Red codes and is commonly referred to as the harmonised *SCV Code*. The text of the SCV Code and guidance on its application was published as an annex to MGN 280 (M)[13] in 2004. The harmonised SCV Code was intended to supersede the four coloured codes but is yet to be enabled by the proposed Merchant Shipping (Small Commercial Vessel and Pilot Boats) Regulations.

1.10.2 Vessels operating on inland waterways

The Inland Waters Small Passenger Boat Code is a code of practice for vessels operating in harbour areas, rivers and other inland waters which are in commercial use for sport or pleasure; carry no more than 12 passengers; do not carry cargo; and do not go to sea. It provides guidance on the construction of the vessel, its equipment, stability, operational manning levels and maintenance requirements.

The code was developed by a team of industry experts and was published by the Association of Inland Navigation Authorities (AINA) and the MCA in 2004. It is similar in many ways to the harmonised SCV Code, but compliance is not mandatory. It offers best practice guidelines and safety advice to operators, boat designers, boat builders, and regulators. It was also intended to be a national standard to assist agencies and authorities with powers to license or register vessels and protect public safety.

1.10.3 Safety management

The harmonised SCV Code reminds operators of their obligation to conduct risk assessments for the activities they are engaged in, but it does not prescribe a formal safety management system. The Inland Waterways Small Passenger Boat Code offers similar advice on risk assessment but also provides guidance, based on MGN 158 (M)[14], on how to develop and implement an effective safety management system.

1.10.4 Local authority licensing

Local authorities may require boat operators to be licensed to operate from their land and within their harbour limits. They are also empowered by Section 94 of the Public Health Acts Amendment Act 1907 to grant licences to pleasure boats and pleasure vessels to be let for hire or to be used for carrying passengers for hire, and to the persons in charge of, or navigating such vessels. However, the use of the powers afforded by the Public Health Acts Amendment Act 1907 is optional, and where used they cannot be applied to vessels certified by the MCA or other certifying authorities.

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[13] MGN 280 (M), *'Small vessels in commercial use for sport or pleasure, workboats and pilot boats – alternative construction standards'.*

[14] MGN 158 (M) – Safety Management Code for Domestic Passenger ships of Classes III –VI(A).

1.11 MANNING AND QUALIFICATION REQUIREMENTS

The manning requirements for small commercially operated vessels are dependent on the area of operation and the anticipated environmental conditions. The harmonised SCV Code lists the following seven area categories, which are derived from those given in the four individual coloured codes:

- Area Category 6 – to sea, within 3 miles from a nominated departure point(s) named in the certificate and never more than 3 miles from land, in favourable weather and daylight
- Area Category 5 – to sea, within 20 miles from a nominated departure point named in the certificate in favourable weather and daylight
- Area Category 4 – up to 20 miles from a safe haven, in favourable weather and daylight
- Area Category 3 – up to 20 miles from a safe haven
- Area Category 2 – up to 60 miles from a safe haven
- Area Category 1 – up to 150 miles from a safe haven
- Area Category 0 – unrestricted service

The qualifications and experience required for skippers of small commercial craft are listed in Annex 3 of the harmonised SCV Code. The minimum powerboat qualification for skippers of small commercial vessels is the RYA Powerboat Level 2 Certificate with 12 months relevant experience. This qualification can only be used on vessels operating in area category 6. Area categories 5 and 6 are not included in the Yellow Code and the minimum powerboat qualification for skippers of vessels operating in area category 4 is the RYA Powerboat Advanced Certificate of Competency and 2 years relevant experience.

The requirement to nominate the boat's departure point(s) for area categories 5 and 6 allows the certifying authority to make a proper assessment of the intended use of the boat. The SCV code includes the caveat: *"Area of Operation… Depending on the nature of the vessel and its use, a vessel may be restricted to less than the above specified limits"*. As *Celtic Pioneer* was certified for area category 4, its SCV certificate did not contain any nominated departure points.

It is the responsibility of the owner/operator of the vessel to ensure that sufficient crew are on board, having regard to the type and duration of the voyage/excursion being undertaken. Where a skipper of a vessel carrying passengers is not accompanied by nominated crew he must conduct a safety brief in accordance with **Annex G**. This includes briefing at least one other person on the operation of lifesaving appliances, manoverboard recovery procedures and driving the boat.

The qualification requirements for skippers (masters) of small commercial passenger vessels operating on inland waterways are detailed in The Merchant Shipping (Inland Waterways and Limited Coastal Operations) (Boatmasters' Qualifications and Hours of Work) Regulations 2006 (MSN 1808(M)).

1.12 POWERBOAT QUALIFICATIONS AND COMMERCIAL ENDORSEMENTS

The RYA, as part of its National Powerboat Scheme, has developed a series of powerboat training courses aimed at small open decked boats such as RIBs, sports boats, dories and launches. The courses are provided within the UK via a network of RYA approved training centres and schools, and the qualifications are recognised internationally. They range from the Powerboat Level 1 Certificate for beginners to advanced levels for instructors.

The Powerboat Level 2 Certificate is the recognised minimum standard required for commercial powerboat skippers and is also known as the *National Powerboat Certificate*. Training for this certificate typically takes 2 days to complete and includes practical and theoretical elements. The course is assessed, but there is no formal examination, and the candidates do not require any previous powerboat experience. The syllabus includes high speed manoeuvring, but does not consider the effects of waves or rougher sea conditions **(Annex H)**.

The Powerboat Advanced Course includes high speed boat handling, advanced manoeuvres and manoeuvring in rough weather. The candidates should be competent to the standard of the Intermediate Powerboat Certificate before beginning the course. There are two types of advanced certificate: the Course Completion Certificate and the Certificate of Competency. The Course Completion Certificate is issued by a training centre on successful completion of a 2-day course, while the Certificate of Competency is awarded by the RYA/MCA on successful completion of a practical examination. Prior to attempting the examination, the candidate is required to have 2 years relevant experience.

An RYA powerboat qualification requires a commercial endorsement before it is valid for use on board a commercial craft subject to the MCA codes of practice. The endorsement shows that the holder has relevant experience, is medically fit and has completed basic sea survival training.

None of the RYA powerboat training courses include instruction on the dangers associated with repeated shock and WBV, or methods available to minimise the associated risks.

SECTION 2 - ANALYSIS

2.1 AIM

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

2.2 CAUSE OF THE INJURY

When the female passenger landed on her seat, the resulting force applied along the axis of her spine was of sufficient magnitude to fracture her L2 vertebra. Neither her previous back injury nor BMD levels increased her susceptibility to this type of injury. Therefore, the factors contributing to the fracture were limited to the activity undertaken. These included:

- The speed and movement of the RIB in the sea conditions experienced, which were probably worsened by the wind and tidal streams acting in opposite directions, and the presence of localised rip currents
- The seated posture of the injured passenger
- The location and design of the boats' seats
- A lack of appreciation of the dangers associated with exposure to shock and vibration.

2.3 RISK OF INJURY

2.3.1 Incidence

The introduction of thrill-type boat rides and high speed RIB excursions, similar to those provided by Bay Island Voyages, represents a relatively new and rapidly expanding maritime sector within the UK and across Europe. The intensity of the rides varies considerably, and they are advertised by operators using phrases such as 'thrill' or 'white knuckle' rides, sea safaris, exhilarating ocean voyages, coastal blasts and eco tours. The statistics in **paragraph 1.7** clearly demonstrate that the risk of spinal fractures and other impact injuries during this type of fast boat ride is significant.

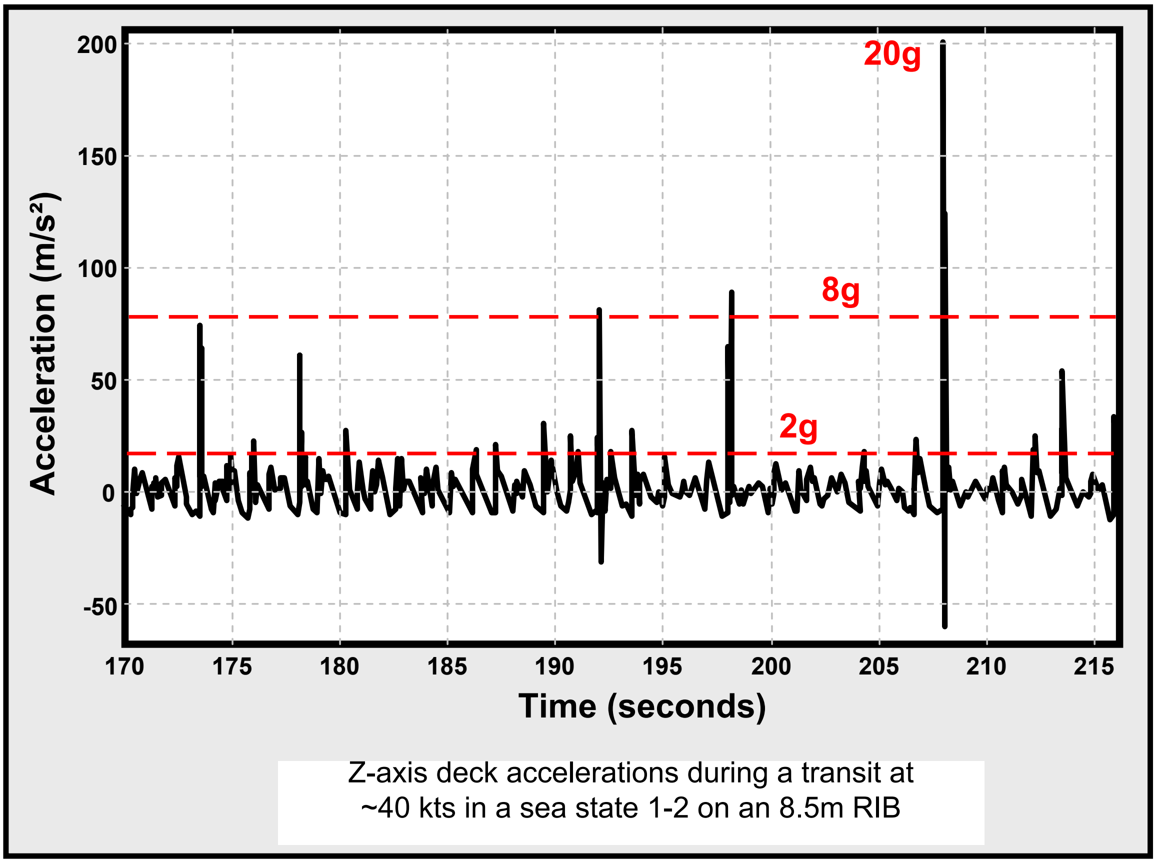
2.3.2 Exposure

The research conducted and documented by the ABCD working group has attempted to accurately quantify the levels of shock and vibration transmitted through the hull of high speed craft while travelling at speed in a seaway. Although much of its work has been sponsored by the military and the trials discussed in **paragraph 1.8** and **Annex F** were conducted on board a military craft, there is no reason why the results obtained would be dissimilar for RIBs used in the commercial and leisure sectors, particularly during thrill-type rides.

Not only did the trials demonstrate that the repeated shocks expected during high speed operations can occasionally be of sufficient magnitude to cause impact injuries, but they also clearly justify the requirement for fast boat operators to conduct a shock and WBV risk assessment and take the appropriate steps listed in the Vibration Regulations to reduce the risk of chronic and acute injuries to employees to as low as reasonably practicable. A person exposed to the shock and vibration levels shown in **Figure 7** exceeds the 8 hour WBV EAV within 15 minutes. **Figure 8** illustrates that after 1 hour, the level of exposure is up to 7.5 times the EAV and 3 times the ELV allowed maxima.

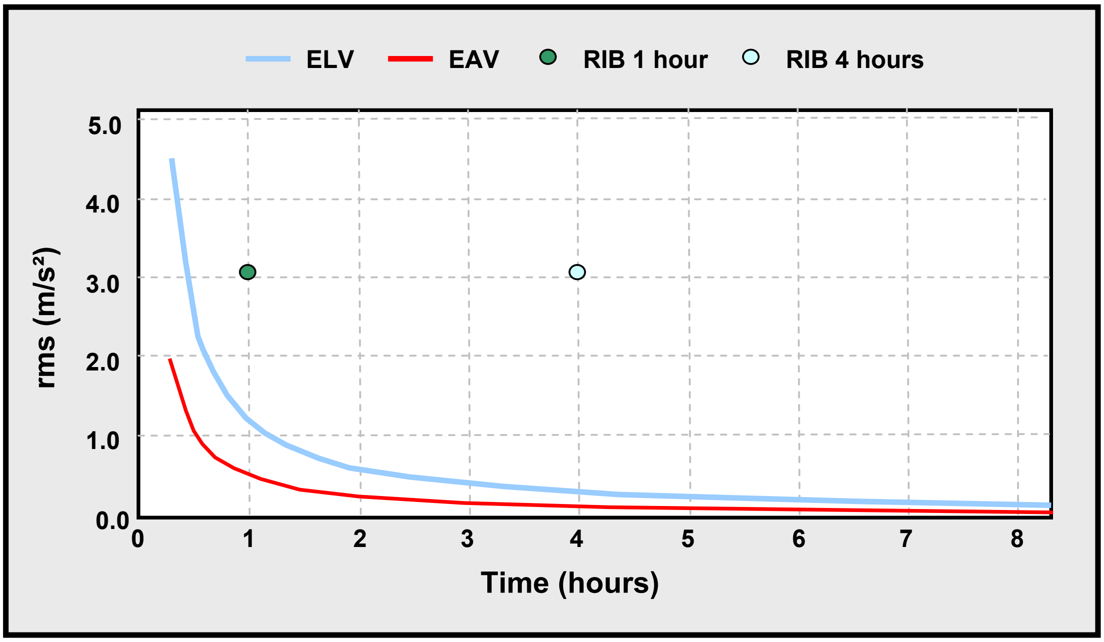
It is important to note that although these trials were conducted at high speed, in calm conditions, this accident indicates that shocks of sufficient magnitude to cause impact injury can also occur at lower speeds when large waves or wakes are encountered.

Figure 7



Magnitude and frequency measurements for shock recorded on board an 8.5m RIB

Figure 8



An example of how a RIB travelling at ~40 kts in a sea state 2
will exceed the EU WBV Exposure Action and Limit Values

2.3.3 Awareness

It is highly likely the majority of powerboat manufacturers, owners, skippers, crew and racers are aware of the practical hazards associated with driving small craft at speed in a seaway and the physical effects of wave slamming. However, an understanding of the mechanism of spinal wedge compression fractures, the requirements of the Vibration Regulations, and knowledge of shock and vibration mitigation methods is less widespread. Consequently, it is inevitable that thrill ride operators manage the risk of injury to passengers to varying standards. The need to raise industry awareness in these areas is compelling.

2.3.4 Mitigation

There are three key areas to be considered when attempting to reduce the risks associated with shock and vibration on board high speed craft: boat handling ability; human factors engineering and design; and operating procedures.

2.4 BOAT HANDLING

Boat handling skills, including the ability to judge and anticipate the effects of the prevailing sea conditions is the most significant factor when managing the risks associated with high speed powerboat operations. *“The principal mechanism influencing craft performance and therefore shock exposure is throttle response i.e. reducing power before reaching the top of a wave”* **(Annex F)**. The skills required to drive a boat safely at speed in a seaway or choppy conditions are developed through training, experience and gaining knowledge of local conditions.

The manning requirements in the MCA codes are based on operating areas which take into account the distance from shore and environmental conditions. Little distinction is made between passenger carrying boats and other small commercial craft. Additionally, the operating speed of a vessel is not considered. *Celtic Pioneer* and *Celtic Ranger* were certified under the Yellow Code to operate up to 20 miles from a safe haven, which requires a minimum qualification equivalent to the RYA Powerboat Advanced Certificate of Competency. The skipper on board *Celtic Pioneer* only held the RYA Powerboat Level 2 Certificate. As the 1 hour *'coastal blast'* took place within 3 miles of the Cardiff Bay barrage, this could be considered to fall within area category 6 of the SCV Code, in which the Powerboat Level 2 is an acceptable standard providing a departure point has been nominated. As no departure point was nominated, and as the skipper only held a Powerboat level 2 qualification, this trip did not meet the requirements laid down in either Code.

Fast passenger boat operations and thrill ride activities do not sit comfortably within the scope of the codes, particularly if a skipper is seeking disturbed waters rather than attempting to avoid unfavourable weather. The RYA Powerboat Level 2 Course might be an appropriate qualification to operate craft at relatively slow speed in sheltered waters. However, its suitability as a qualification to operate high speed, passenger carrying boats in open waters, where the conditions are inevitably more challenging and the skill of the coxswain is paramount in the prevention of injury through shock, is questionable.

2.5 HUMAN FACTORS ENGINEERING, AND DESIGN

2.5.1 General

Careful consideration of human factors engineering issues during the design stage for high speed craft can significantly reduce the levels and effect of shock and vibration. Bay Island Voyages had invested in new, well built RIBs from an established manufacturer, which were designed specifically for this type of activity. However, a number of design features have been identified that adversely affected the casualty's ability to sustain the required posture and therefore increased the likelihood of her suffering a spinal compression fracture.

2.5.2 Hull design

Generally, flat bottomed boats such as dories are particularly prone to wave slamming, whereas deeper 'v'-shaped hulls tend to cut through waves. Inflatable buoyancy tubes make RIBs particularly stable in choppy seas, but ensure they climb over waves rather than cut through them. *Celtic Pioneer'*s deep 'v'-shaped hull design would have helped reduce the transmission of repeated shock while skimming over small waves, but the buoyancy tubes would have increased the likelihood of wave slamming when encountering larger waves.

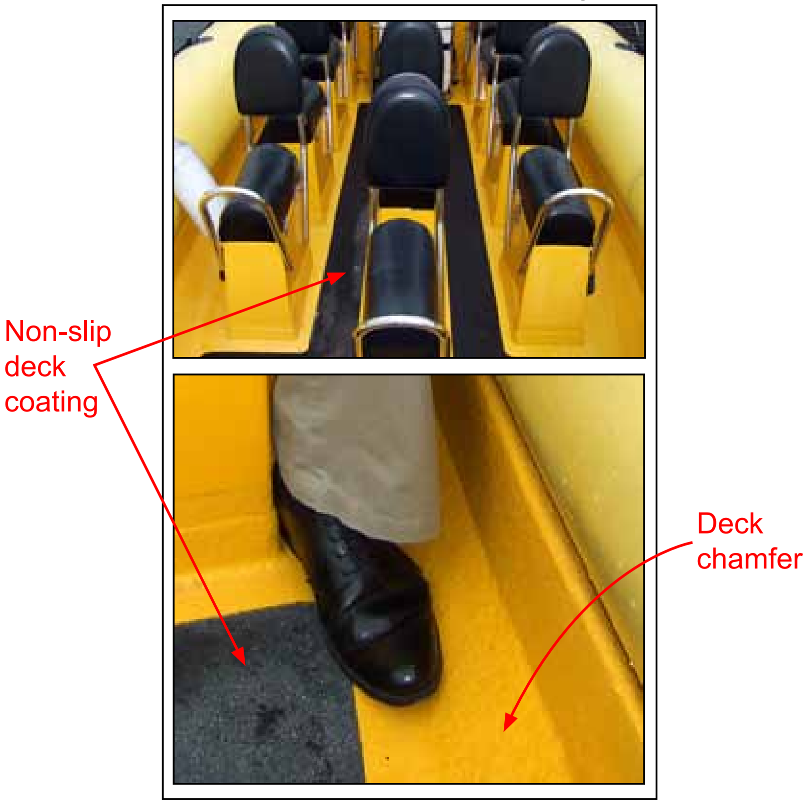
2.5.3 Deck design

Deck design and layout, in particular the positioning of seats, are important factors when considering exposure to shock and vibration. The casualty was seated in the front row towards the bow of the RIB, where the magnitude of shock would have been at its greatest, while the skipper was positioned at the stern. Positioning the passengers' seats towards the stern would significantly reduce their exposure for given speeds and sea states. However, the positioning of a helmsman in a RIB requires careful consideration. Although a more forward position would increase sensitivity to the prevailing conditions, it also inevitably increases a helmsman's exposure to shock and vibration over the longer term, and also impedes his or her ability to monitor passengers.

Deck coating materials are available which are designed to dampen the transmission of shock, and features such as non-slip deck coatings and the provision of toe holds or foot stirrups improve a passenger's ability to anchor themselves while underway, thereby making it easier to maintain an appropriate posture. In this case, however, the injured passenger's foot grip was not ideal because the front row of seats on board *Celtic Pioneer* were positioned at the narrowing part of the vessel where there was insufficient room to apply the non-slip deck covering to the outboard side of the port and starboard seats. Additionally, due to the chamfer on the deck, the anchor point for the passenger's outboard foot was not flat **(Figure 9)**.

In the longer term, technological advances are likely to lead to the development and use of deck suspension systems in high speed craft.

Figure 9



Celtic Pioneer deck design factors

2.5.4 Seating design

Most high speed passenger boat and thrill ride operators in the UK fit either rigid pod-type jockey seats, similar to those fitted on *Celtic Pioneer*, or bench seats. In general, jockey seats are preferred when operating in more extreme conditions, although a degree of skill, strength and agility is required to maintain the desired posture. Bench seats offer little opportunity for passengers to use their legs to absorb shocks while underway, but are simple to use and are generally better suited for RIB rides and excursions on smoother waters.

Seats are available for use on high speed craft, which are designed to dampen the transmission of shock and vibration and improve the occupant's posture and spinal alignment. Some of the most commonly adopted designs include shock absorption systems, restraint harnesses, and adjustable features to allow for people of differing sizes **(Figure 10)**.

Figure 10

Examples of seats used on board high speed craft

Shock absorption is not simply a case of adding extra padding to a seat. Although this might increase the comfort of its occupant when the boat is at rest, it will not necessarily provide a reduction in the magnitude of vibrations felt while underway. Indeed, the use of certain cushioning materials can lead to an increase in shock and vibration magnitude **(Annex F)**. However, there are several suspension seats available which significantly dampen out the magnitude of repeated shocks and reduce exposure to WBV. Restraint harnesses help ensure an occupant stays in contact with the seat while underway, and offer additional support and a sense of security as the boat is manoeuvred at speed or in choppy seas, but they present other hazards that need to be carefully considered. Adjustable seats will help passengers of varying sizes assume the designed optimum posture.

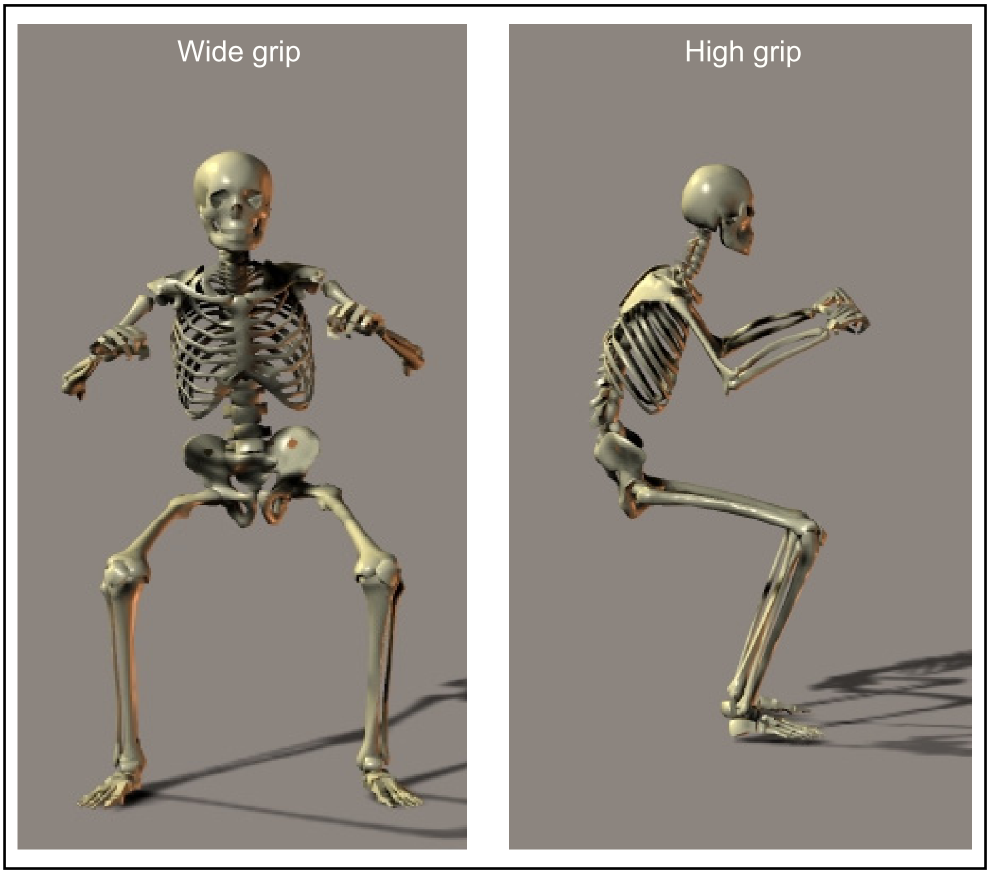
At present there is no standard for the design, manufacture and securing of seats fitted to high speed craft such as RIBs. Indeed, some passengers do not have a dedicated seat as several thrill-type rides use RIBs which have not been specifically designed for the activity and have been approved to carry a greater number of people than there are seats on board. Consequently, some passengers have to sit on the buoyancy tubes, or even stand. Sitting on buoyancy tubes will inevitably lead to the introduction of a twist in the lower back and therefore increase the risk of injury. It also increases the risk of falling overboard.

2.5.5 Handrails and handgrips

Handrails or handgrips, particularly when affording a high and wide grip, allow passengers to support themselves against impacts during high speed manoeuvring or while dodging waves **(Figure 11)**. The position of the handrail on the front row of seats on board *Celtic Pioneer* was lower than those provided on the seats behind. The reduced height of this rail would have made it difficult for the injured passenger to stop herself being thrown forward on impact with the sea. It would also have caused her to assume a more stooped posture while underway **(Figure 12)**. Furthermore, the relatively narrow handrail is likely to have offered the injured passenger limited lateral support against impacts with the water during a turn. The handrails on the front row of seats were also open to the elements, exposing the hands of the occupants to the effects of wind chill and sea spray. It was probably a combination of these factors which contributed to the injured passenger's decision to hold onto the buoyancy tube rope with her left hand. Bay Island Voyages' advertising leaflet **(Annex A)** shows a passenger, occupying the corresponding seat on board *Celtic Ranger*, taking similar action. The resulting posture is likely to have introduced a degree of bending and twisting to the casualty's lower back as *Celtic Pioneer* dodged the waves. This would have significantly increased the risk of her suffering a wedge compression fracture **(Figure 13)**.

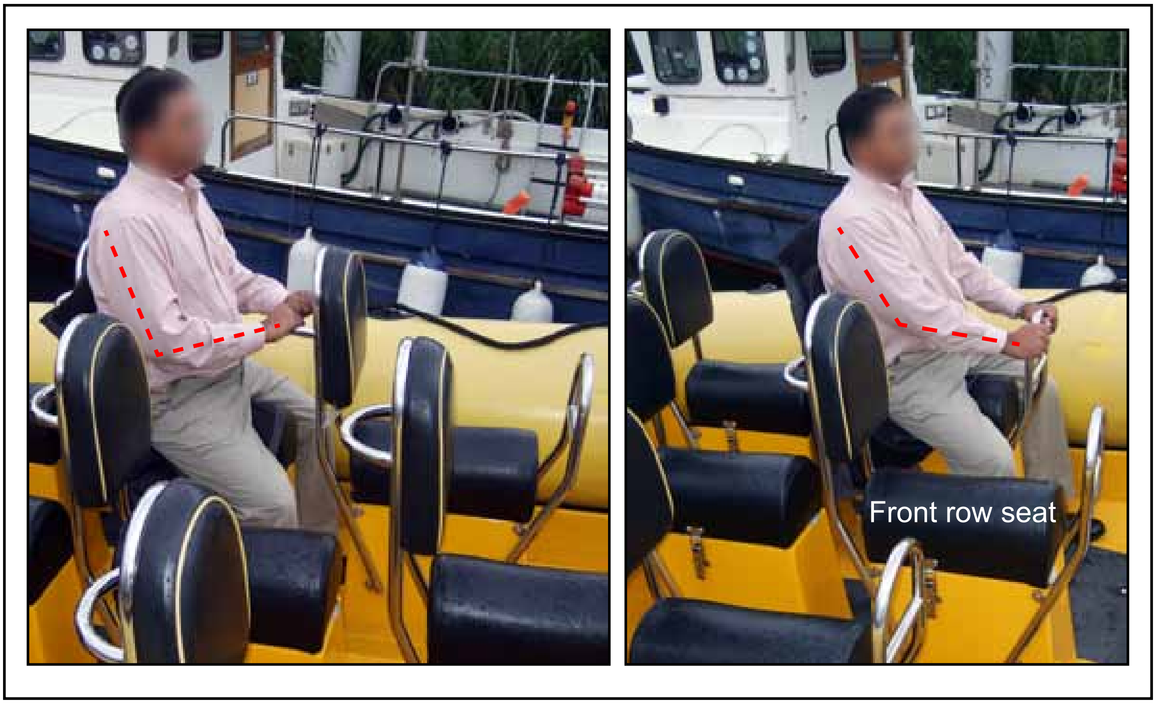
Images courtesy of STResearch

Figure 11



The effects of handgrip or handrail design
on passenger posture and stability

Figure 12



Posture factors associated with the casualty's seat

Figure 13

Image courtesy of STResearch

Illustration of the probable spinal alignment of the casualty at the time of the accident

2.6 PROCEDURAL CONTROL MEASURES

2.6.1 General

Although the risk of injury caused by shock and vibration can be reduced by the skill of the coxswain, and by boat design, the performance of individuals cannot be guaranteed and engineering solutions in some cases are financially prohibitive. Furthermore, the benefits gained through engineered solutions can be lost if the improvements are seen purely as an opportunity to operate at greater speeds or in choppier conditions. Therefore, it is important that procedural measures are also adopted to try and prevent injury through shock.

2.6.2 Company procedures

There were several departures from the measures identified in Bay Island Voyages' risk assessments, including:

- Lifejackets were not issued until the passengers were on the pontoon
- A safety brief was not given until after departure
- No action was taken when the injured passenger held on to the rope on the RIB's buoyancy tube instead of the handrail
- The coastguard was not alerted
- The injured passenger was landed at Mermaid Quay rather than Penarth slipway.

The consequences of the injured passenger's posture through holding on to the rope on the buoyancy tube have been discussed in detail at **paragraph 2.5.5**. The decision not to alert the coastguard limited the immediate support available to the injured passenger and possibly contributed to a delay in her evacuation to hospital. Had the coastguard been alerted, an immediate medical link between *Celtic Pioneer* and the shore could have been established, the option to task a search and rescue helicopter or the Penarth lifeboat would have been considered, and a land-based coastguard mobile team would have been despatched to the casualty landing point. Although the initial delay in raising the alarm was possibly influenced by the crew's appreciation of the injury and the assumption that the medical experts on board had the situation under control, the decisions to request an ambulance using a mobile phone and to not fully apprise the barrage control of the situation possibly indicates a reluctance to publicise the emergency.

Procedures are generally developed from experience and risk assessment, and are designed to reduce risk and ensure prompt and effective action in emergencies. However, to be effective, such procedures must be followed regardless of any potential local or commercial embarrassment.

2.6.3 Risk reduction

The risk of injury can be reduced by the identification and exclusion of individuals with a history of, or existing, medical conditions such as osteoporosis, musculoskeletal injury, physical disability which prevents a person from sitting in the seats provided and/or assuming and sustaining the desired posture, and pregnancy. This action is required by thrill ride operators ashore in the Health and Safety Executive's HSG 175 *'Fairgrounds and amusement parks guidance on safe practice'*[15].

Many thrill ride operators include health warnings on their websites and in their advertising literature, some even place warning notices at the embarkation point. Many also repeat the warning during the pre-departure safety brief. Bay Island Voyages did not provide such warnings and, with the information available to the casualty prior to departure, it is highly probable that she thought she was about to enjoy a high speed trip within the smooth waters of Cardiff Bay. It is likely, taking into account her previous back injury, that had she been fully aware of the extent of the proposed ride she would have declined to participate. Although boat operators and skippers cannot be expected to accurately diagnose the effect a fast or turbulent boat ride will have on every passenger, as a minimum they should ensure that all passengers are made fully aware of the risks prior to departure.

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[15] HSG 175 paragraph 240 – Take reasonably practicable measures to identify and exclude any individuals who cannot ride safely if, for example: they are too small to be safely contained; they are too large to be safely contained; they have a disability or condition, e.g. back or neck injury, heart condition, or they are pregnant; they are behaving inappropriately.

Bay Island Voyages relied predominantly on the experience of the skipper and the feedback received from the passengers to govern the intensity of the ride provided. However, although the majority of passengers on board *Celtic Pioneer* were enjoying the thrill of the ride up to the time of the accident, the casualty and other passengers opted not to voice their concerns. This behaviour, which was also identified as a factor in the similar accident in New Zealand noted in **paragraph 1.7**, is understandable given perceived peer pressure, personal pride and/or a desire not to spoil the fun enjoyed by the majority. Therefore, passenger feedback cannot be relied upon to accurately gauge any discomfort or unease.

2.6.4 Manning

The crew on board *Celtic Pioneer* were quick to identify the passenger was in difficulty after sustaining her injury, and responded by stopping the boat and offering assistance. Had the accident occurred on board *Celtic Ranger*, however, the ability of her skipper to respond as effectively would have been severely compromised by the lack of assistance available from other trained crew.

The Yellow and harmonised SCV Codes allow boats to be chartered for this type of activity, without additional crew if a skipper nominates at least one of his passengers to assist him in an emergency. Nonetheless, it is impractical to expect a skipper to nominate and brief a member of the public on how to launch a liferaft, operate flares, drive the boat, recover a man overboard or use a VHF radio, prior to every 1 hour excursion. Therefore, in determining levels of manning, it is essential that, in addition to the regulatory requirements, operators must take into account the need to maintain the safety of the passengers and to effectively deal with all emergency situations.

2.7 SAFE OPERATION

Thrill-type and fast boat rides are not specifically covered in the Yellow, Brown, Blue and Red Codes of Practice, or the harmonised SCV Code. Although these codes do specify some operational requirements for all vessels, it is difficult, if not impossible, to regulate every type of operation or water-based activity. The responsibility of ensuring that the risks to passengers and employees are effectively managed rests firmly with boat owners and operators.

A brief review of several operators' risk assessments and safety management systems during this investigation identified that passenger safety was being managed to widely varying standards. It was also apparent that some companies operating on the inland waterways were applying more stringent control measures than those operating at sea. This possibly reflects the positive influence of the Inland Waters Small Passenger Boat Code.

The information and guidance available to manufacturers, operators, insurers, local authorities and certifying authorities to help manage the risk associated with high speed passenger boat rides is limited. It is recognised that a growing number of people enjoy and participate in this type of activity, which is frequently exciting and exhilarating. However, given the risks associated with these activities, the need for a more uniform approach to operating and safety standards is compelling. This will probably be best achieved through the introduction of an approved code of practice, which could be used as a benchmark for licensing and certifying authorities, and insurers.

SECTION 3 - CONCLUSIONS

3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT WHICH HAVE RESULTED IN RECOMMENDATIONS

1. *Celtic Pioneer* was manoeuvred at speeds and/or in sea conditions such that the injured passenger was unable to maintain her intended posture when seated. [2.2]

2. The risk of spinal fracture and other impact related injuries from the repeated shocks experienced during thrill-type boat rides, and when encountering large waves and wakes, is significant. [2.3.1] [2.3.2]

3. Operators and skippers of thrill-type boat rides are not generally aware of all the dangers associated with shock and vibration in their craft. [2.3.3]

4. A number of *Celtic Pioneer'*s features, including her hull and deck design, seating and handgrip arrangements, increased the likelihood of shock or impact related injury. [2.5]

5. There were several departures from the measures identified in the operator's risk assessment. In particular, no action was taken when the injured passenger held on to the rope on the RIB's buoyancy tube instead of the handrail. [2.6.2]

6. The injured passenger was not fully aware of the nature of the boat trip. [2.6.3]

3.2 OTHER SAFETY ISSUES IDENTIFIED DURING THE INVESTIGATION ALSO LEADING TO RECOMMENDATIONS

1. The suitability of the RYA Powerboat Level 2 Certificate to operate high speed commercial passenger carrying boats in open waters is questionable. [2.4]

2. When operating fast boat rides, it is important that there are sufficient crew to monitor the welfare of the passengers and deal with all onboard emergencies. [2.6.4]

3. The lack of regulation or guidance regarding the operation of thrill-type and fast boat rides has resulted in varying standards of safety management within the sector. [2.7]

SECTION 4 - ACTIONS TAKEN

The **Passenger Boat Association** and the **Professional Boatman's Association** have:

- Initiated the development of an industry code of practice for operators of thrill-type boat rides based on the safety issues identified during this investigation.

Mecal Ltd has:

- Issued an instruction notice to its examiners advising them of the issues highlighted during this investigation, and offering additional guidance for the certifying of high speed commercial passenger vessels.

SECTION 5 - RECOMMENDATIONS

The **Passenger Boat Association** and **Professional Boatman's Association** are recommended to:

2009/125 In consultation with the MCA, continue to work towards the production of an industry approved code of practice for thrill-type boat ride operators, taking into account the safety issues raised in this report and the requirements laid down in the Vibration Regulations.

The **Maritime and Coastguard Agency** and **Royal Yachting Association** are recommended to:

2009/126 Review and revise the deck manning and qualification requirements of the harmonised SCV Code taking into account the speed of craft and the type of activity intended in addition to the distance from shore and environmental conditions.

The **Royal Yachting Association** is also recommended to:

2009/127 Raise the awareness of the dangers of shock and vibration in small high-speed craft through its powerboat training syllabi.

The **Local Authorities Co-ordinators of Regulatory Services (LACORS)** and the **Institute of Licensing** are recommended to:

2009/128 When available, promulgate the approved code of practice for thrill-type boat operators, and strongly encourage local authorities within the United Kingdom to require operators to adhere to the code as a condition of licensing.

Bay Island Voyages is recommended to:

2009/129 Review its risk assessments and operating procedures taking into consideration the safety issues identified in this report, and ensure that all such procedures are followed.

May 2009
Marine Accident Investigation Branch

Safety recommendations shall in no case create a presumption of blame or liability