

Report on the investigation into the
unintended movement of the ro-ro passenger vessel

Ben-My-Chree

during loading operations at Heysham

26 March 2010

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Extract from
The United Kingdom Merchant Shipping
(Accident Reporting and Investigation)
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NOTE

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

| | | |
|---------|---|--|
| AB | - | Able bodied seaman |
| ABB | - | Asea Brown Boveri |
| BPA | - | British Ports Association |
| BS | - | British Standard |
| CIRA | - | Construction Industry Research and Information Association |
| CPP | - | Controllable pitch propeller |
| CSM | - | Continuous Survey of Machinery |
| ECR | - | Engine control room |
| Global | - | Global Switchgear Services Ltd |
| HSE | - | Health and Safety Executive |
| IOM | - | Isle of Man |
| IOM-SPC | - | Isle of Man Steam Packet Company |
| ISM | - | International Safety Management |
| kg | - | kilogramme |
| kN | - | kilonewton |
| kts | - | Knots |
| kW | - | kilowatt |
| LR | - | Lloyd's Register EMEA (Europe, Middle East & Africa) |
| MBL | - | Maximum breaking load |
| MCA | - | Maritime and Coastguard Agency |
| MCB | - | Main circuit breaker |
| MGN | - | Marine Guidance Note |
| MSC | - | Maritime Safety Committee |
| OCIMF | - | Oil Companies International Marine Forum |

| | | |
|-------|---|---|
| PMSC | - | Port Marine Safety Code |
| PSA | - | Passenger Shipping Association |
| PSMS | - | Port safety management system |
| ro-ro | - | roll on roll off (ferry) |
| rpm | - | revolutions per minute |
| SMS | - | Safety management system |
| SOLAS | - | International Convention for the Safety of Life at Sea |
| STCW | - | International Convention on Standards of Training, Certification and Watchkeeping for Seafarers |
| UKMPG | - | UK Major Ports Group |
| UTC | - | Universal Co-ordinated Time |
| 2/E | - | Second Engineer |
| 3/E | - | Third Engineer |

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

Photograph courtesy of Isle of Man Steam Packet Company



Ben-My-Chree

SYNOPSIS



On 26 March 2010, while embarking passengers and loading vehicles at Heysham, England, the ro-ro passenger ferry *Ben-My-Chree* moved approximately 8m along the quayside, causing serious damage to the passenger access structure. The foot-passenger walkway detached at both ends and collapsed onto the quayside, and the gangway detached from the vessel's side shell door and was left hanging on a single rope. Fortunately, there were no injuries. Eight passengers were trapped in the gangway compartment of the shore structure and were later rescued by the local fire service.

A number of weaknesses were evident in the passenger access structure, including:

- The quay on which the structure was built had suffered considerable settlement over the years;
- The walkway was secured to the rest of the structure with only two small bolts at either end, and;
- There were no records of inspections or maintenance work carried out on the structure.

Ben-My-Chree had just completed an extended period of repairs in a dry dock but still had electrical faults on the main circuit breakers connecting the main engine driven shaft generators to the bow thrusters. When *Ben-My-Chree* called at Heysham, shore electricians rectified the faults, and in order to provide electrical power to test the bow thruster, the starboard main engine was started with its controllable pitch propeller (CPP) set to zero pitch.

The accident was caused when the chief officer, intending to carry out pre-departure control tests, set the pitch lever of both main propulsion engine CPPs to the 100% ahead position. Expecting both shafts to be stationary, he had not noticed that the starboard engine and shaft were running at sea speed with its CPP set on zero pitch. The engineer who passed control of the engines to the bridge was not fully aware of which machinery was running, and had not informed the chief officer that the starboard shaft was turning. Running the main engines in port during passenger and vehicle operations was a normal activity on board this vessel, carried out once every 3 days to facilitate water-washing of the turbochargers on the main engines.

As all the mooring lines which could have restrained the vessel were set on autotension winches, the vessel surged forward as soon as the propeller thrust overcame the preset tension on the winches.

The Isle of Man Steam Packet Company (IOM-SPC) has since implemented a policy allowing its vessels a minimum of 24 hours after finishing any extended maintenance period to test systems and rectify defects before resuming passenger service.

The UK Major Ports Group (UKMPG) and British Ports Association (BPA) have been recommended to: review the risks of vessels running main engines while embarking/ disembarking passengers and vehicles; and, inspect the passenger access structures in their ports, following the best practices and guidelines available on the subject from the civil engineering industry.

The MAIB has published a safety flyer regarding the hazards of operating propulsion systems while embarking passengers and vehicles; the appropriate use of autotension winches; and the safety of passenger access structures.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *BEN-MY-CHREE* AND ACCIDENT

Vessel details

| | | |
|------------------------|---|--|
| Registered owner | : | Isle of Man Steam Packet Company, Douglas |
| Manager(s) | : | Isle of Man Steam Packet Company, Douglas |
| Port of registry | : | Douglas |
| Flag | : | Isle of Man (IOM) |
| Type | : | Passenger ro-ro |
| Built | : | 1998 at Van der Giessen-de Noord B.V. |
| Classification society | : | Lloyd's Register |
| IMO Number | : | 9170705 |
| Construction | : | Steel |
| Length overall | : | 125.2m |
| Gross tonnage | : | 12,504 |
| Engine power and type | : | 8640kW (2 x MAK M32) |
| Engine/shaft speed | : | Constant speed 600/160rpm |
| Service speed | : | 19kts |
| Shaft generators | : | LEROY SOMER, 2 x 1160kW @1500rpm |
| Bow thrusters | : | LIPS, 2 x forward tunnel thrusters with four blade variable pitch propellers; 900kW motors |

Accident details

| | | |
|----------------------|---|---|
| Time and date | : | 1357 on 26 March 2010 |
| Location of incident | : | Heysham Port |
| Persons on board | : | Approximately half of the 148 passengers had boarded; 41 crew members |
| Injuries/fatalities | : | Nil |
| Damage | : | Ship's shell door frame buckled and shore side passenger access structure collapsed |

1.2 BACKGROUND

1.2.1 Dry dock period

Ben-My-Chree was in dry dock at Cammell Laird Ship repairers & Shipbuilders Ltd, Birkenhead (UK), from 5 March to 25 March 2010. During this period eight main circuit breakers (MCB) on the main switchboard were overhauled and secondary current injection¹ tests carried out by an electrical company, Global Switchgear Services Ltd (Global). Subsequently, the MCBs were subjected to a periodic survey by a surveyor for Lloyd's Register EMEA (LR), the vessel's classification society. Work was also carried out on the controllable pitch propeller (CPP) control system by the equipment manufacturer.

The vessel was expected to leave Birkenhead on the morning tide of 25 March in order to resume her regular service from Douglas, Isle of Man, on the morning of 26 March; but the departure was delayed by 12 hours because of problems experienced in inserting a tailshaft. Passenger and freight reservation for the 26 March sailing had started approximately a week before the expected undocking date.

1.2.2 Weather and environmental conditions

The weather at Heysham on 26 March 2010 was calm, with light airs. Low water occurred at 1444. The mean Spring tide range at Heysham is around 8m, and the tidal range approaches 10m on occasions. On the day, the predicted tidal range was 6m.

1.3 NARRATIVE

1.3.1 Post-docking – Birkenhead to Douglas

Ben-My-Chree undocked at approximately 1845 on 25 March. Soon afterwards, the engineers discovered that the MCBs for both the aft bow thruster and the starboard shaft generator were indicating that they had “tripped”. The MCBs could not be reset and consequently neither the forward nor the aft bow thruster could be used. Cammell Laird yard did not have a layby berth and once clear of the Mersey River the engineers changed over MCBs from the forward to the aft bow thruster so that the aft bow thruster could be powered from the port shaft generator. The master decided to continue on to Douglas with one operational bow thruster and then proceed to Heysham, where the vessel was due to arrive at midday on 26 March. The chief engineer informed Global of the MCB defects, and Global agreed to send technicians to meet the vessel at Heysham.

Ben-My-Chree arrived at Douglas at 2330 on 25 March. At 0500 she had to vacate the berth for 2 hours to allow another vessel to use it, and she returned to the berth shortly after 0700 to prepare for loading.

¹ Secondary current injection is a technique to test circuit breakers with solid state trip systems.

1.3.2 Douglas to Heysham

At 0905 on 26 March, 20 minutes later than the scheduled departure time, *Ben-My-Chree* sailed from Douglas with her cargo of passengers and freight. A number of defects were identified during the passage to Heysham, including: the pitch response on both CPPs was observed to be slower than normal (rectified on board approximately one month later); the public address system located at the ship's passenger reception area was defective; and, an intermittent fault on the temperature sensor of the starboard aft mooring winch motor was detected. The latter two defects were rectified as the vessel approached Heysham.

Ben-My-Chree arrived at Heysham at 1244 (**Figure 1**). Bunkering operations were normally carried out during the night, but as the vessel had emptied her tanks prior to dry dock she needed to bunker on arrival at Heysham. A fuel lorry embarked shortly after arrival, and the third engineer (3/E) took charge of bunkering, assisted by a motorman. The 3/E monitored the remote tank gauges in the engine control room (ECR) while the motorman stood by at the bunker point. Two technicians from Global arrived on board as soon as the vessel was secured and, observed by the chief engineer, they commenced repairs on the MCBs.

1.3.3 MCBs repair and test

The starboard shaft generator provided power to the forward bow thruster, and at 1337 the chief engineer asked the master for permission to start the starboard main engine in order to test the MCB for the forward bow thruster.

Photograph courtesy of Peel Ports Group

Figure 1



Heysham Port

The master agreed, and he notified the second officer, the designated loading officer for the day, who was positioned at the stern ramp. The chief officer, who was on deck nearby at the time, overheard this conversation. At 1338 the starboard engine was started. No cautionary notices were displayed on the bridge or in the ECR to warn that the starboard engine was running and the shaft was turning. The chief officer went up to the bridge after the engine was started and remained there during the bow thruster tests which followed.

The bow thruster was tested twice by the master on the request of the second engineer (2/E), but without success. One of the technicians then identified that the mechanism that activated the breaker trip indication had been assembled incorrectly, and he promptly rectified the defect.

During the attempts to diagnose the MCB faults a fuse from an MCB charging spring motor fell out of its holder; but no one noticed it fall. The technicians then discovered that they could only engage the MCB manually by physically winding up the charging spring motor using its handle (**Figure 2**). They requested a third test and, at 1342, the 2/E asked the master to switch on the bow thruster again. This time the master observed the bow thruster motor start up as normal, and 2 minutes later he received a call from the 2/E who informed him that the tests were completed. At about 1350, the chief officer and master left the bridge and the 2/E left the ECR to prepare the port engine for departure. The starboard engine, still in engine room control, was left running.

Figure 2



Main circuit breaker

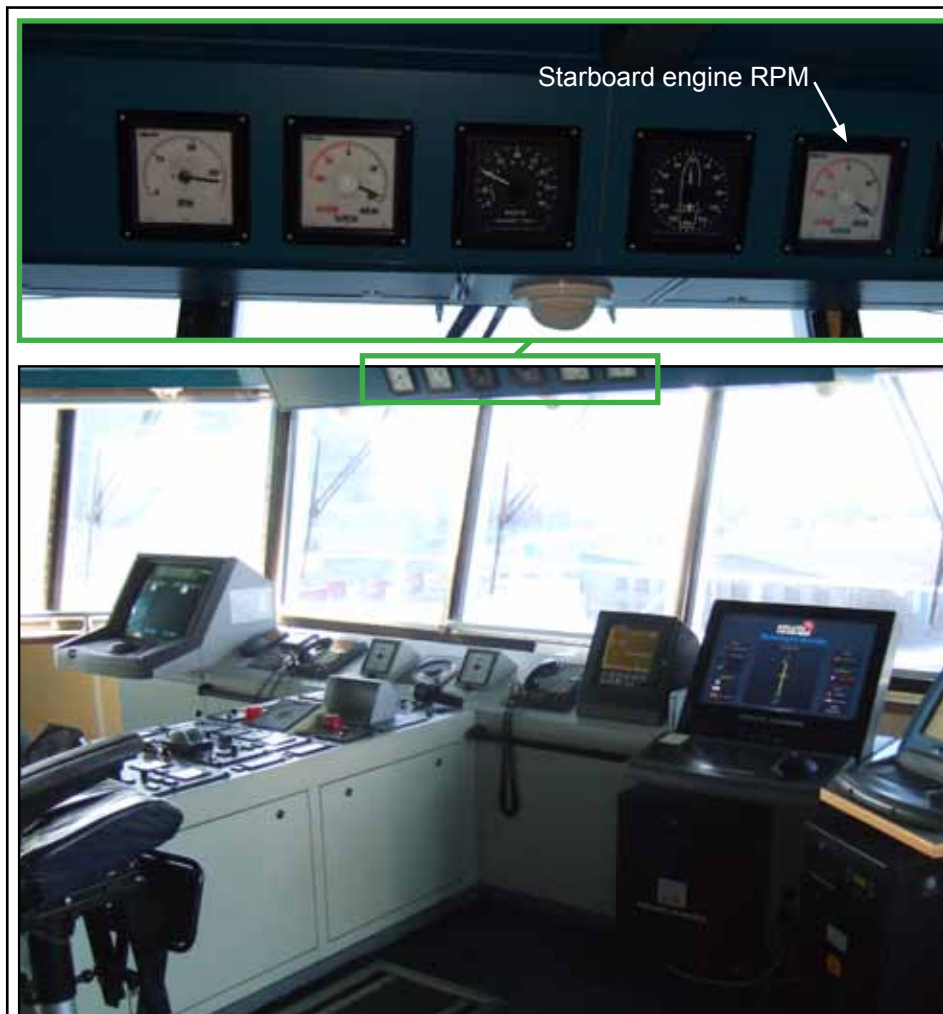
Shortly afterwards, one of the technicians found the missing fuse from the MCB charging spring motor circuit lying just under its holder, and he put it back in place. The spring motor was then observed to wind up under electric power. The technicians asked the chief engineer if operation of the forward bow thruster motor could be tried once again, but the chief engineer did not immediately relay this request to the master.

1.3.4 Pre-departure checks at Heysham

At approximately 1355, the master returned to the bridge and stood near the port wing controls. The chief officer arrived on the bridge just before 1357 and used the bridge telephone at the chart table to call the engine room to arrange for the testing of controls prior to departure. The 3/E answered the call, agreed to the request to test controls, and switched both main engines to bridge control.

The chief officer approached the centre console from its side (**Figure 3**) and at 1357:22 moved the pitch control levers on both engines to the 100% ahead position. He also put both rudders hard to starboard. The rudder angle attained was 18.5 degrees on both rudders. He then asked the master if he could test

Figure 3



Central control station on bridge.
Insert - deck head repeaters above bridge windows

the bow thrusters. The master in turn called the engine room and asked the 3/E if the bow thrusters could be tested. The 3/E replied that, as work was still being carried out on the MCBs, the bow thrusters could not be started.

1.3.5 Collapse of passenger access structure and gangway

By 1357:50, the starboard shaft CPP had achieved 60% pitch ahead. The chief officer then observed the vessel moving forward along the quay and he pulled the pitch control levers to full astern. By that time the ship was moving ahead at 0.5 knot and had travelled approximately 8m forward.

Two or three passengers, who were on the gangway and about to embark, ran inside the vessel. Some others, who were stepping on to the gangway from its shore compartment, were told by the gangway watchman to remain in the compartment of the shore structure, and they retreated quickly. The watchman then tried to disconnect the gangway from the vessel. He unlash the forward securing line and, while he was trying to unlash the aft line the gangway pulled clear of the vessel and hung, suspended by its aft line (**Figure 4**).

Figure 4



Gangway collapse

Meanwhile, the walkway connecting the passenger terminal to the gangway compartment detached at both ends and fell about 2m, first landing on a metal fence, then falling to the quay having turned 90 degrees to lie on its side (**Figures 5a & 5b**). In the passenger terminal, a party of 26 school children who had been about to enter the walkway had been held back by their group leader to allow one of their members to catch up. At the other end of the walkway, a mother and child

Figure 5a



Passenger access structure

Figure 5b

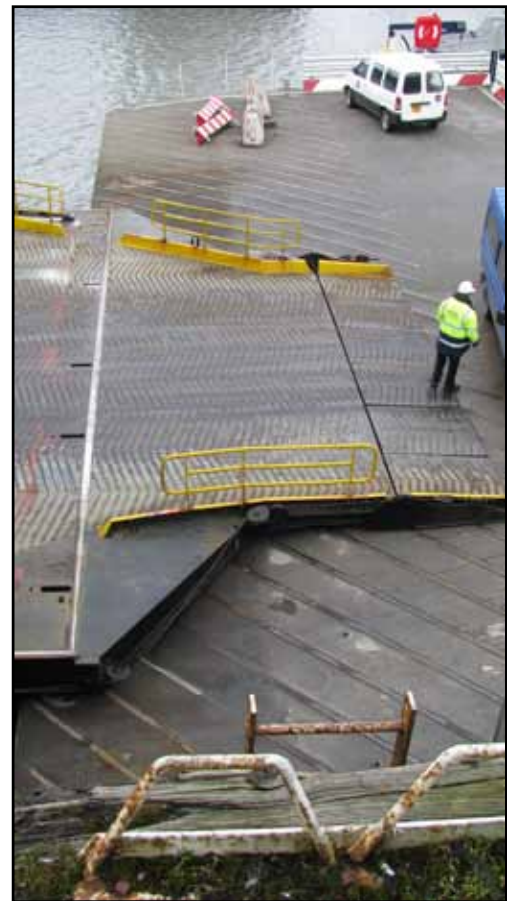


Passenger terminal and access structure

ran out of the walkway and into the gangway compartment as they heard the noise and felt the vibration of the structure moving. There were, therefore, no passengers in the walkway when it fell, but eight passengers including a 4 year old child were trapped in the gangway compartment.

At the stern of the vessel, a charge hand (harbour employee) was supervising vehicle loading at the linkspan while the ship's second officer was talking to the trainee second officer. They all noticed the ship's movement when they heard the stern ramp scrape along the linkspan (**Figure 6**). The second officer ran into the ship and raised the stern ramp, closing it completely, thereby preventing vehicles from embarking.

Following the chief officer's application of astern power, *Ben-My-Chree* returned to nearly the same position that she had been in before the accident.



Stern ramp on linkspan

1.3.6 Post-accident actions

The master, and shortly afterwards the charge hand, notified the harbour control tower of the accident. The duty port manager in the harbour control tower then called the emergency services. Meanwhile, other harbour employees checked that there were no casualties, isolated shore electrical supplies and secured the gangway to prevent it from falling any further.

At 1410, the chief engineer asked the master to test the bow thruster once again and, after this had been achieved successfully, the master shut down the starboard engine. The fire brigade arrived 10 minutes later and rescued the eight passengers trapped in the gangway compartment. The remaining passengers were taken on board *Ben-My-Chree* using a mini bus, and the last of the vehicles were loaded. Seven passengers cancelled their journey. The vessel sailed for Douglas at 1532.

1.4 COMPANY AND VESSEL

1.4.1 Isle of Man Steam Packet Company

The Isle of Man Steam Packet Company (IOM-SPC), based at Douglas and founded in 1830, has an agreement with the IOM government to provide guaranteed service levels of passenger and freight movement between the IOM, the UK and the Irish Republic. In addition to *Ben-My-Chree*, the company also operates two fast catamaran services.

The company was headed by its chief executive to whom the technical manager and the designated person ashore reported. Two technical superintendents reported to the technical manager.

1.4.2 Vessel

Ben-My-Chree was engaged in a twice-daily passenger and freight service between Douglas and Heysham. The vessel operated a year-round service except for ten Saturday nights, when maintenance was carried out, Christmas Day and New Year's Eve. Each leg of the round trip from Douglas to Heysham took around 3½ hours, with over 2 hours in port at each end.

Ben-My-Chree was taken out of service for dry dock maintenance twice in a 5-year period, with the duration of the maintenance period varying depending upon the work required. The vessel had to undergo an unscheduled dry docking for 4 days in January 2009 to address repairs to shell plating: a crack in the lower hull and water ingress into the port stabiliser system. After the previous scheduled dry dock from 2 to 14 April in 2008, the vessel had spent 48 hours conducting safety equipment and systems tests, as well as carrying out safety drills in the presence of surveyors from the UK's Maritime and Coastguard Agency (MCA) and the IOM administration, before re-entering normal service. All previous dockings had been at the Cammell Laird shipyard. During these periods a freight vessel was chartered in to transport the island's imports and exports, and one of the IOM-SPC's fast catamarans carried *Ben-My-Chree*'s passenger traffic.

1.5 CREW

1.5.1 General

Most of *Ben-My-Chree*'s crew were from the UK, IOM and Republic of Ireland. A day crew joined the vessel in Douglas at around 0700 and worked until about 1900 when a night crew joined ready for the evening departure from Douglas. The night crew worked the 12-hour period from 1900 to 0700. Both crews followed a 1 week on/1 week off rota system. Crew members changed from day to night duty and vice-versa when they returned to work after their week off.

On the day of the accident the deck officers included the master, chief officer a second officer and a trainee second officer. The designated loading officer was the second officer, and the chief officer was assigned as the bridge officer.

The engineering department comprised the chief engineer, 2/E, 3/E, a day work engineer and an electrician. The engine room was always manned, and the chief engineer had overall charge, but there was no designated duty engineer in charge of the machinery.

1.5.2 Master

The master was an IOM national, had 27 years experience in the rank, and had been employed on passenger ferries since 1980. He joined IOM-SPC in 1970, although he continued to work for short periods in other companies until 1999

when he became employed on *Ben-My-Chree*. He had a master's certificate of competency (STCW II/2) restricted to limited European areas. He had been on board *Ben-My-Chree* throughout the dry dock period.

1.5.3 Chief officer

The chief officer, who was from Northern Ireland, had 31 years sea service of which the last 9 years had been as chief officer, mostly on *Ben-My-Chree*. He had an unlimited master's certificate of competency (STCW II/2), and since April 2009 had also been acting as relief master on the fast catamarans owned by IOM-SPC. He had joined *Ben-My-Chree* on 17 March part way through the dry docking period.

1.5.4 Chief engineer

The chief engineer was from the IOM and had 44 years experience at sea, all of which were in the IOM-SPC company. He had a chief engineer's certificate of competency (STCW III/2). Since the mid 1980s he had been acting as relief chief engineer and from 1995 had been working as chief engineer. Since delivery of the vessel in 1998, he had been one of the two permanent chief engineers for *Ben-My-Chree*. He had been on board the vessel throughout the dry docking period.

1.5.5 Third engineer

A UK national, the 3/E had a Master of Science degree in marine engineering and a second class motor unlimited certificate of competency (STCW III/3). He had been employed by IOM-SPC on *Ben-My-Chree* since May 2009 and had 11 years experience as a third engineer, nearly 4 of which were on ro-ro vessels. He had joined the vessel on the morning of 25 March.

1.6 HEYSHAM PORT

1.6.1 History and management

Heysham Port was owned by Sea Containers Ltd until 1990. The port then changed ownership several times until 2001 when it was acquired by Mersey Docks and Harbour Ltd. In September 2005, Peel Ports Group acquired Mersey Docks and Harbour Ltd, including Heysham Port. The passenger terminal, dedicated for use by *Ben-My-Chree*, was owned by Heysham Port and was leased by IOM-SPC. In January 2010, the employment contracts of all the passenger terminal employees were transferred from Heysham Port to IOM-SPC.

1.6.2 Port Safety Management System

The Port Marine Safety Code (PMSC) was established following a review of the Pilotage Act in 1998. The main proposal resulting from this review was that a code of best practice should be developed, which summarised the legal duties and powers of harbour authorities relating to marine safety. Harbour authorities were expected to work to achieve the agreed standards in the PMSC, on a

voluntary basis, by implementing its requirements and following the associated guides to best practice. One of the primary aims of the PMSC is to enhance safety for those who use or work in ports, their ships, passengers and the environment.

The PMSC requires that harbour authorities should conduct a formal risk assessment of all aspects of their operation and, from this, derive a register of the risks involved and an effective port safety management system (PSMS) to control them. This should include plans and procedures to react to emergencies, and ensure that staff are properly trained to deal with them. The Port of Heysham's parent company formally reported that the port met the requirements of the PMSC at the first review in 2002, and subsequently at the required 3-yearly intervals, in 2005 and 2008. Following another accident the Peel Ports Group sent a further statement of compliance to the MCA in April 2009.

There is no requirement for the PSMS to be audited externally, but annual internal audits are mandatory. The MCA may undertake a PMSC verification visit at any time, but usually after an incident or if major non-compliances have been identified. There is no record of the MCA having undertaken a verification visit of Heysham Port before or after the accident on 26 March.

Heysham Port's PSMS did not identify risks relating to passenger and ro-ro vessels starting their engines in port while embarking or disembarking passengers or vehicles, or include any reference to the passenger access structure. In the last internal audit of February 2009, the Risk Register was identified as a *"relatively new document – in the process of being developed"*.

1.6.3 The Heysham Harbour Byelaws 1979

The harbour byelaws section 25(2) stated *'Except for the purpose of navigating to or from a berth, the master of a power driven vessel shall not, without the written authority of the harbourmaster, carry out engine trials within the harbour by turning her propeller or paddle when the vessel is attached to any post, dolphin, jetty or landing place.'* Although not explicit in the Byelaw, this requirement could logically be considered to apply to running the main engines in order to test the bow thrusters.

1.7 PASSENGER ACCESS STRUCTURE

1.7.1 Description of use

After checking in their luggage and clearing security in the terminal building, foot passengers entered the walkway and followed it along to the gangway compartment. Once there, they turned a 90 degree corner and crossed the gangway onto the ship (**Figure 5b**). The gangway was lifted into place with a crane, hooked on and lashed to the ship. The opposite end of the gangway was mounted on rollers, allowing it to move freely in and out of the gangway

compartment as required. When not in use, the gangway was lifted off the ship by a crane and partially retracted into its compartment, with the free end resting on a trestle positioned on the quay.

1.7.2 Construction

The passenger access structure at Heysham was constructed in 1998. The walkway was fabricated out of aluminium and was approximately 20m long, 2.2m high and 2.2m wide. It was believed to have been brought to Heysham from another port, but a detailed history of the walkway was unavailable.

The walkway was suspended above a disused subway between the passenger terminal at one end and the gangway compartment at the other. It was supported at each end by two 12mm steel bolts on the outer edges of the walkway near floor level. A third bolthole close to the centreline of the floor was available, but had not been used. There were no fixings at the roof level.

The gangway compartment was constructed over a disused underground tunnel originally used for cattle access. Although the original technical drawing showed that the supporting frames should have been secured to the foundation with 32mm diameter resin anchored bolts, the structure was free-standing and had not been bolted down. Settlement (**Figure 7**) of the ground in the area beneath the access structure and all along the quay had begun late in 1999 and had been a persistent problem.

Figure 7



Gangway compartment support and settlement

At the time of the accident, the ground had settled by approximately 800mm. The rate and extent of the settlement had been monitored since 2001 and, although efforts to strengthen the wall of the quay have been ongoing, there had been no investigation into the cause of the settlement. In 2000, additional concrete platforms were built and steel work added to the base of the gangway compartment to compensate for the settlement. Metal shims had also been added under the feet of the gangway compartment to maintain its height as the ground continued to settle. There was no routine maintenance or inspection of the passenger access structure, disused subway or cattle access tunnel.

1.7.3 Damage

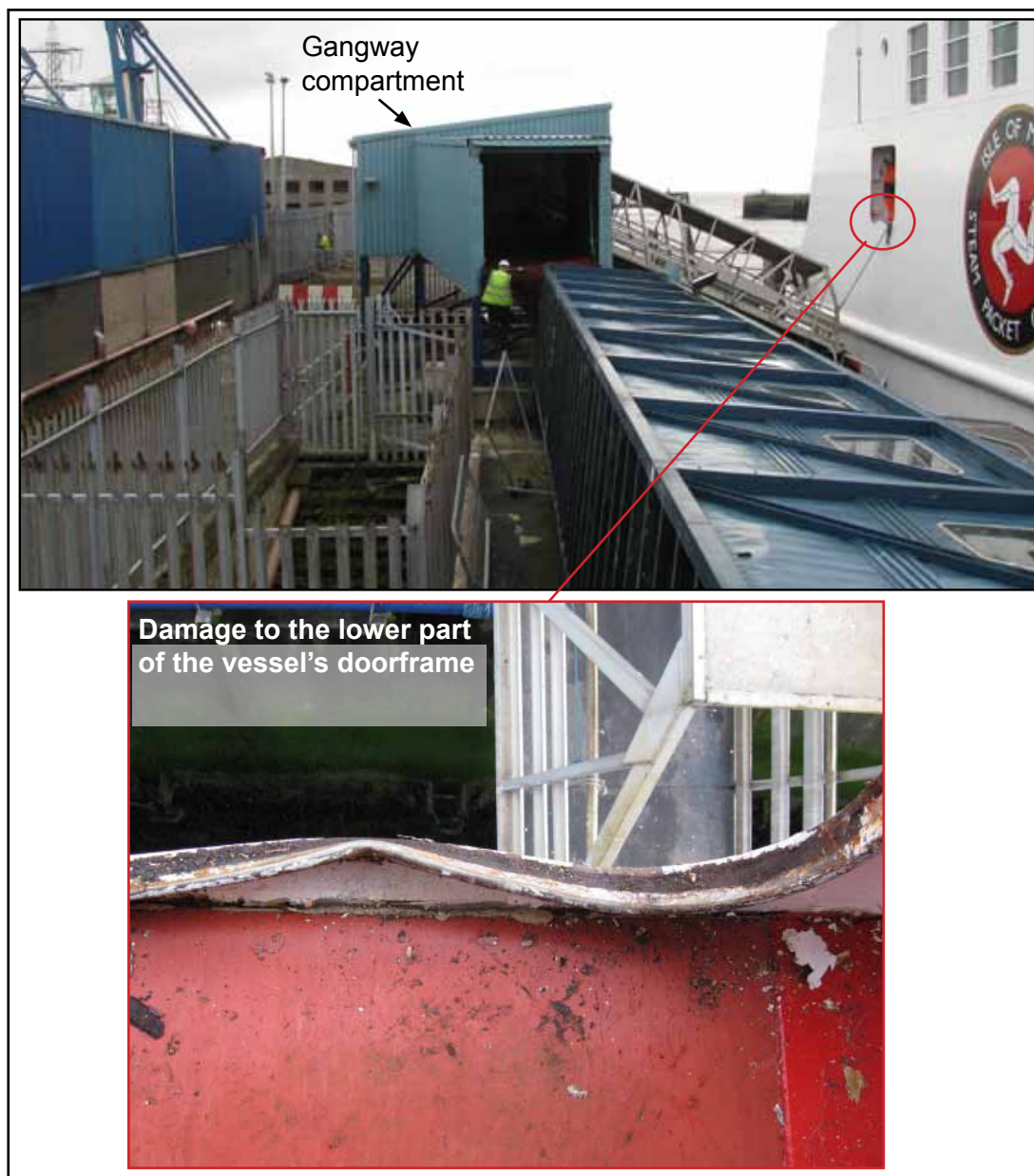
When *Ben-My-Chree* moved forward, the gangway compartment moved 2.4m to its side (towards the water), and it finally returned to a point 1.1m away from its original position (**Figure 8**) after the vessel had come astern. As the gangway pulled clear of the vessel, lugs at its outboard end damaged the vessel's shell door frame (**Figure 9**).

Figure 8



Movement of gangway compartment showing support frame in its final position after the accident

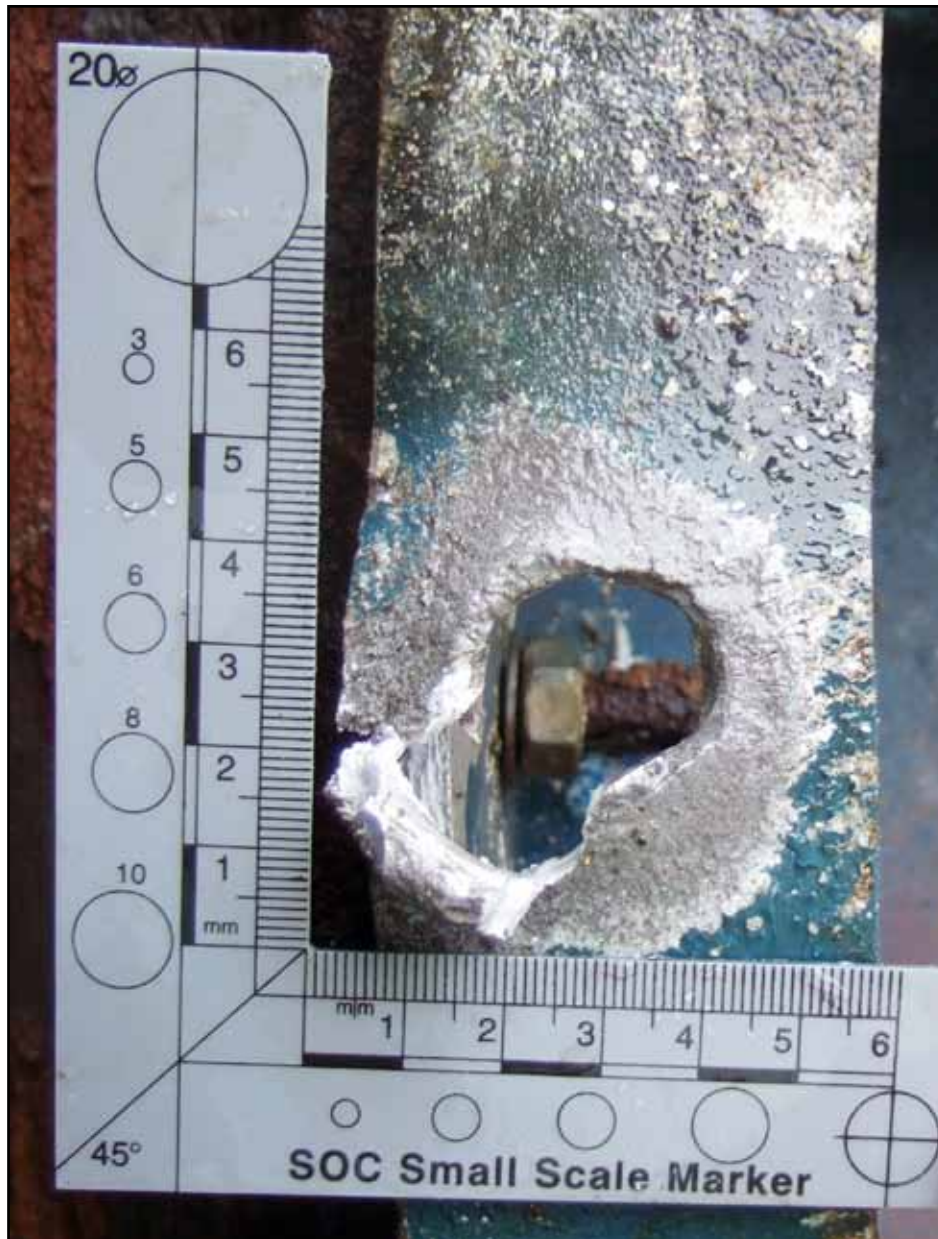
Figure 9



The scene immediately after the accident

The steel fixing bolts at both ends of the suspended aluminium walkway were ripped out as it detached from the steel structures of the passenger terminal and the gangway compartment. All the electric lighting cables were sheared and the walkway fell to the quay. The ends of both the steel and aluminium in the structure showed evidence of heavy salt water corrosion (**Figure 10**).

Immediately after the accident, the Health and Safety Executive (HSE) commenced an investigation into the collapse of the structure.



Walkway securing boltholes showing signs of corrosion

1.8 BRIDGE AND ENGINE ROOM

1.8.1 Main control panel on bridge

The main control panel in the centre of the bridge is shown in **Figure 11**. It was not possible to adjust main engine speed from the bridge, and the engine was maintained at a constant speed of 600 revolutions per minute (rpm) from the ECR. Each bow thruster had a selector switch that could be set to a test position allowing the movement of the bow thruster CPP blades to be checked while the propeller was stationary.

A talk-back system to the ECR was available at the main control panel and an internal telephone was located at the chart table. As the helm control panel was located at the end of the main control panel, the engine and bow thruster controls could only be reached from the side of the panel.

Figure 11



Centre control panel (bridge), looking forward

1.8.2 Engine rpm and pitch indication

The main control panel (**Figure 12**) and two wing control stations (**Figure 13**) had rpm indicators for both engines and pitch indicators for both CPPs. In addition, there were rpm indicators just below the deckhead in front of each control panel. There was also a separate panel between the port wing and the main control station duplicating most of the important displays and alarms in the ECR. Both this panel and the wing stations contained two additional rpm indicators for each engine: one before the reduction gear and another of the shaft after the gearbox. The port wing deckhead display contained an rpm indicator for the starboard engine only; the port engine rpm indicator at this location having been replaced by an anemometer. On the starboard side deckhead display the starboard engine rpm indicator had also been replaced by an anemometer.

1.8.3 Control panel in engine room

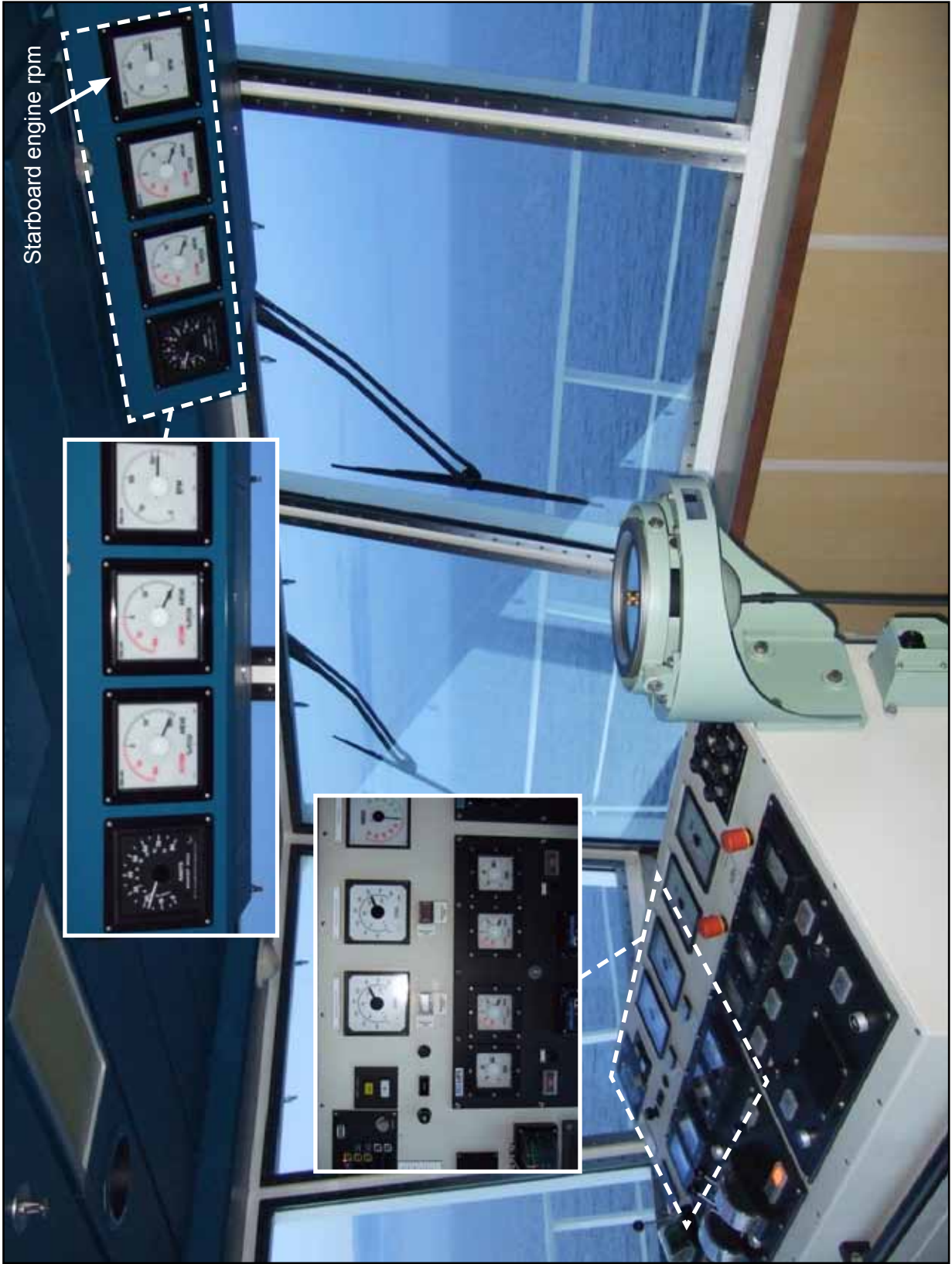
In the ECR, the pitch control levers had a Perspex cover to prevent accidental movement of the levers. There were several indications to show that an engine was running, including: engine and shaft rpm, turbocharger rpm, engine load, scavenge air pressure and several other technical parameters representing the operational state of the engines (**Figure 14**).

Figure 12



Centre control panel (bridge), looking down

Figure 13



Port wing station (inserts show rpm and pitch gauges)
Note: Black faced gauge is an anemometer that has replaced the port engine rpm gauge

Figure 14



ECR control panel

1.9 PRE-DEPARTURE PROCEDURES

Checks of onboard systems were carried out 15 to 20 minutes prior to departure. The bridge officer was expected to use a checklist (SM/04/03) (**Annex A**) to sequentially check off the listed items. There were 37 items on the checklist, including:

- (Item 12) *Telegraphs/Combinators/Pitch Indicators in conjunction with engine room*
- (Item 23) *All shore connections (power, water, gangways, ramps) disconnected*
- (Item 32) *Engine Start...*

On the day of the accident, the checklist was not used before the starboard engine was started for testing the MCBs. When the chief officer entered the bridge to test controls, he had not started completing the checklist.

The practice on board for carrying out checklist item 12 was for the bridge officer to call the duty engineer and request that control of the main engines be passed to the bridge; the main engines remained shut down throughout this time. On receipt of control, he would move the pitch control lever on the bridge to the full ahead, stop and full astern positions while monitoring the pitch gauges to observe the relevant movement. The bow thruster propeller pitch and steering controls would be tested immediately afterwards. On completion of the tests, main engine control would be returned to the engine room and the bow thruster switches set back to the 'off' position until departure. The telegraph was used only at departure to indicate to the engine room that the main engines were to be started (item 32).

It was normal practice on board to water-wash both main engines' turbochargers once every 3 days. This activity required the engines to be run up to approximately 500rpm, and it was conducted 20 to 30 minutes before departure while passengers and vehicles were boarding. After the water-wash the engines were normally left running ready for departure.

1.10 AUTOTENSION WINCHES

1.10.1 Guidance on the use of autotension

The SOLAS regulations, further explained in MSC/Circ.1175 and MGN 308 *Mooring, towing or hauling equipment on all vessels - safe installation and safe operation*, requires that the ship's mooring equipment should be designed so that in the event of an overloaded mooring line the winch motor should 'walk back', or the brakes should render, before the line parts. The lines are also required to part before any of the ship's fittings are damaged.

The Oil Companies International Marine Forum's (OCIMF) Mooring Equipment Guidelines state that spring lines should not be used in autotension mode "...as it has been known for the winches to cause the ship to 'walk' along the pier".

It advises against the use of autotension winches in port for oil tankers. The Nautical Institute's publication entitled *Mooring and Anchoring Ships Vol 1* states that most of the oil, chemical and gas terminals around the world prohibit the use of winches in this mode. It also states:

*Self-tensioning is only effective at preventing a ship's fore and aft movements if the **spring lines are held on the winch brakes** so that any changes in the head and stern line tensions, due to fore and aft movements, are **reduced** by the changing stretch in the spring lines [sic].*

1.10.2 Mooring

The OCIMF advice, which is generally accepted across the marine industry, is that the brakes on a mooring winch should render at 60% of the maximum braking load (MBL) of the rope. The MBL of all the mooring lines in use was 81 tonnes (794.6 kN) and the maximum braking capacity of *Ben-My-Chree's* mooring winches was 450kN. Therefore the mooring winches should have rendered at 56% of the ropes' MBL.

In Heysham, *Ben-My-Chree* moored using two head lines and a fore spring and two stern lines and a back spring (**Figure 15**). All the lines except the back spring were held by winches in the autotension mode (**Figure 16**) at 25% of 150kN (the rated tension or pull exerted by the winch). The back spring was secured on the brake on the port aft mooring winch.

1.11 EQUIPMENT

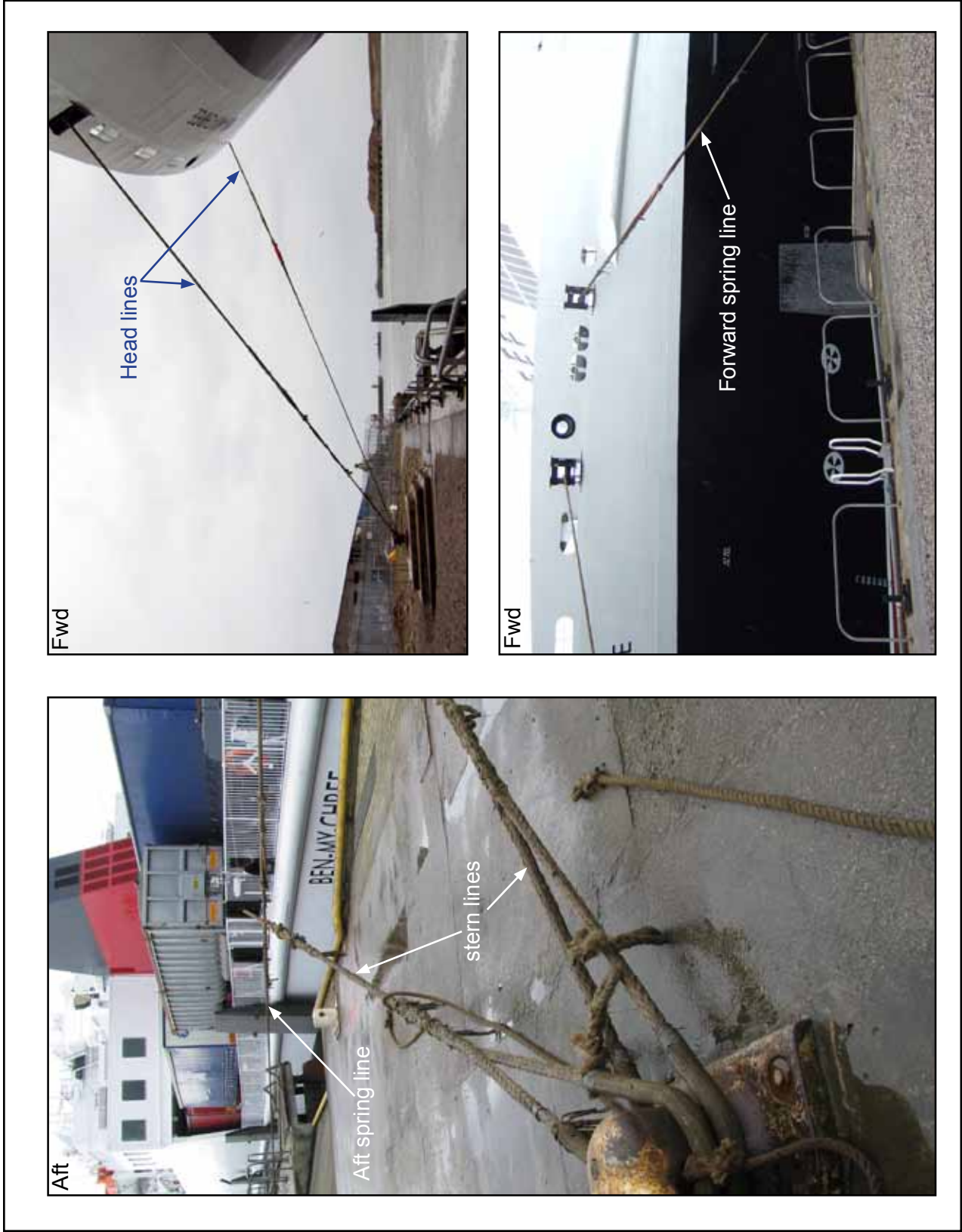
1.11.1 Shaft generators and bow thrusters configuration

Ben-My-Chree's two shaft generators were gear-driven directly by the main propulsion engines through a step-up gearbox (600 to 1500rpm). Each shaft generator had two MCBs: one for connecting it to the main switchboard and the other for supplying the bow thruster. The shaft generators could not supply both the main switchboard and the bow thruster simultaneously. The starboard shaft generator was dedicated to the forward bow thruster and the port shaft generator to the aft bow thruster (**Figure 17**). The port and starboard sides of the main switchboards were isolated from each other, but could be connected by an MCB known as the 'main tie'. The design of the breakers meant it was not possible to power the bow thrusters from any other source.

1.11.2 Main circuit breakers

The MCBs were manufactured by Asea Brown Boveri (ABB) SACE and were the SACE F1 and F2 models. The breakers were protected against over-current (short, medium and long term) by a solid state microprocessor-based protection unit SACE PR1. They were also protected against under-voltage. The MCBs could be racked out half way from the main switchboard into a test position where secondary current injection tests could be performed to test the over-current trips. The design of the breakers meant that it was not possible to operate the MCB electrically while it was in the test position.

Figure 15

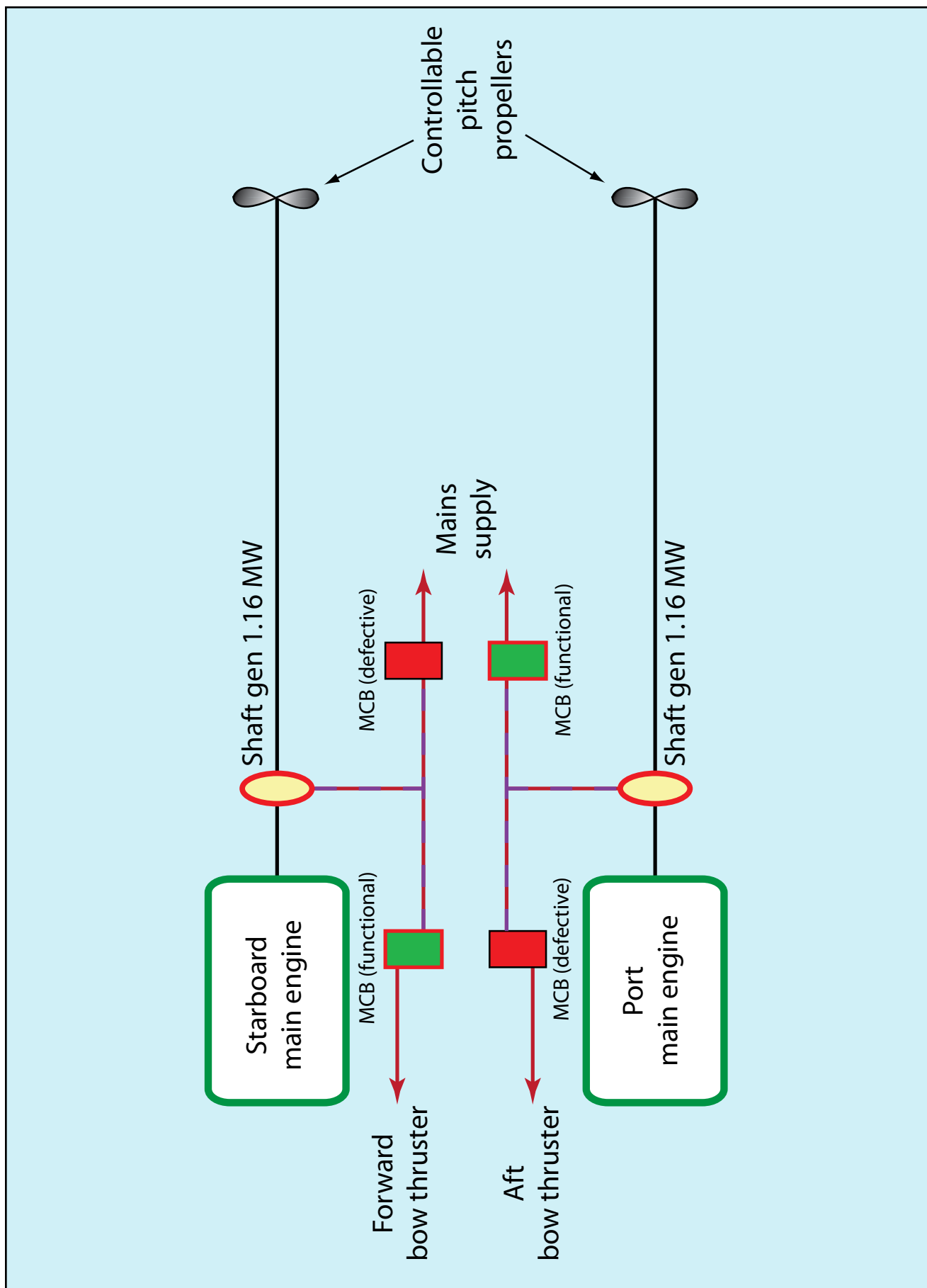


Mooring arrangements

Figure 16



Autotension winch setting



Shaft generators and bow thrusters configuration

The MCB main contacts were closed and opened by a stored energy spring-charged operating mechanism. The mechanism consisted of one closing spring and eight opening springs. The closing spring was charged by an electric motor which ensured that the spring was always charged and ready to close; it could also be charged by a manual handle accessible from the front of the MCB. The opening springs were charged by the action of closing the contacts.

Located underneath the SACE PR1 unit was a micro switch which would be activated if the breaker tripped due to an over-current fault. The micro switch was activated by a lever which, in turn, was connected to the PR1 unit. To access the micro switch, the PR1 unit had to be lifted. However, this unit could only be lifted partially, resulting in awkward access to the micro switch and its lever. Whether the micro switch was on or off would only become apparent when the generator associated with the MCB was run and power was restored.

Training and accreditation

ABB recommends that only engineers trained and accredited by the company should repair or service ABB SACE circuit breakers. ABB provides three levels of training (levels 1, 2 and 3), with the training/certification for levels 2 and 3 normally carried out at ABB SACE in Italy. Level 1 training is required in order to fit accessories to the circuit breaker, such as opening and closing springs and charge motors. Level 2 training is required to carry out routine maintenance of the breakers. Level 3 training is required to carry out extraordinary repairs and fitment of certain special spare parts. Apart from a very few exceptions outside the UK, training for Levels 2 and 3 is available to only ABB service divisions. Level 1 training is available to third parties in the UK.

There were no written warnings on the MCBs to advise against unauthorised repair. None of the Global employees had received any formal training from ABB, but the company had earned a good reputation with both LR and IOM-SPC for reliable work on a wide variety of MCBs. The technician who assembled the MCB components incorrectly had been employed for 1 year in the company.

Overhauls, tests and surveys

Ben-My-Chree's planned maintenance system included job card, EL3001 CMS No. 1946, which stated:

Circuit breakers (8 off) to be serviced and tested by approved agent to satisfaction of Flag State Surveyor. Certificates to be retained.

The job was to be completed at yearly intervals, and it had been carried out by Global for the last 7 years. The MCBs' maintenance history shows that since 2004 the breakers had operated without faults.

The second item on the job card was the 5-yearly classification society continuous survey of machinery (CSM). The survey for the MCBs was not due until 2011, but IOM-SPC had agreed with LR that the surveys would be conducted while the vessel was in dry dock.

On 8 and 9 March, four technicians from Global overhauled all eight MCBs. During the overhaul, a technician found that one of the eight contact opening springs on the MCB for the aft bow thruster motor had broken, and he replaced the spring with one from the spare MCB. Secondary current injection tests were carried out on all the breakers except the main bus tie. An authorised LR surveyor witnessed these tests. The technician from Global noticed that the starboard shaft generator MCB could not be reset after the current injection test. He found that the over-current indication micro switch's lever was damaged, and he replaced this with a part from the spare MCB.

Global's technicians subsequently prepared a separate report for each MCB. Each report consisted of inspection points and operation checks, including the current injection tests. Under the operation checks, there was an item which stated:

Electrically operated 10 times ; the check box next to it stated Yes.

However, it was not possible for the MCBs for the shaft generators and bow thrusters to be tested electrically, because the main engines could not be run at that time. A similar report dated February 2001 from R&B Electrical, the company that had carried out *Ben-My-Chree's* annual MCB servicing before being replaced by Global, shows the word *Electrically* to have been crossed out and replaced with the word *Mechanically* (**Annex B**).

An LR specialist electrical surveyor visited the vessel during its second week in dry dock and the technical superintendent presented him with the eight MCB test reports. The surveyor inspected the reports and carried out a visual inspection of the main switchboard. His understanding was that the MCBs were capable of being operated electrically while they were in the test position. He discussed the reports over the telephone with one of the directors of Global, and subsequently credited the MCBs for the next 5 years under the CSM scheme. The auxiliary engines' MCB function tests, reverse power trips and preferential trip tests were conducted after the dock was flooded in preparation for undocking, but the shaft generators' MCBs were not similarly tested. The vessel's certificate of class was stamped with its fourth annual survey endorsement on 25 March, the last day in dry dock.

LR rule 14.2.3 states:

Generator circuit breakers are to be tested, so far as practicable, to verify that protective devices including preference tripping relays, if fitted, operate satisfactorily.

1.11.3 CPP system

The CPP system was a LIPS BV4 supplied by Wärtsilä Netherlands. The four-bladed propellers' oil distribution boxes were controlled electrically, and the hydraulic pressure provided by the CPP's hydraulic pumps activated the pitch of

the blades. Although the pitch control lever could be moved to the 100% pitch ahead position, built in electronic controls only allowed the blades to assume 65% pitch initially to avoid overloading the engine. Each shaft was able to produce a maximum ahead thrust of 585kN in still water when the vessel was stationary.

1.12 SAFETY MANAGEMENT AND AUDITS

1.12.1 Standing orders

IOM-SPC's Standing Orders & Operational Procedures Manual (Conventional Vessels), Revision 1 was issued in February 1999, with subsequent revisions being made to individual sections. Section 4.19, Engineering Department, dated January 2006, stated:

A competent Engineer/Electrical Officer will always be in charge of the Engineering Department...The Duty Officer of the engine room must not be assigned or undertake any task or duty which would interfere with his supervisory duty in respect of the ship's machinery system.

Section 6.10/3 stated:

If at any time the engines are required to be run for test purposes it must be ascertained that the propellers are clear of obstruction and the vessel securely moored before starting engines. Also ensuring the propellers are at zero pitch. Where fitted the pitch recorder to be kept operational whenever the main engines are in use with dates and times ... to be written in the appropriate place on the recorder roll. [sic]

The master's standing orders, issued in 1998, required that while in port the bridge officer should monitor the position and safety of gangway and mooring arrangements at all times, and instruct the deck crew accordingly.

1.12.2 Audits

The ISM audit of the vessel's safety management system carried out by the IOM administration in March 2009 resulted in three non-conformities and one observation. One of the non-conformities pertained to the vessel using an engine room arrival checklist that was part of an obsolete operational manual. The observation referred to inconsistencies in the vessel's standing orders and operational procedures manual, and recommended that these should be revised. These recommendations were carried out by IOM-SPC.

An internal ISM audit carried out on 14 May 2009 remarked:

No non-conformances were observed. Any deviations from Company instructions were slight and well within the bounds of good seamanship and safety.

The IOM-SPC had also carried out bridge management audits since 2007. The purpose of these audits was to check that the bridge team complied with procedures and used the checklists effectively. The bridge management audits were concurrent with the internal ISM audits. Comments pertaining to the pre-departure checklist stated:

Completed and signed by Master before departure. New checklist form used – SM/04/03. Correct version in Company Standing Orders (Marine Office copy also checked and found correct).

1.13 PREVIOUS INCIDENTS

1.13.1 Port Ramsgate accident

In September 1994, six passengers were killed and seven others suffered multiple severe injuries when part of the passenger walkway at No 3 Berth, Port Ramsgate, collapsed. An HSE investigation into the accident *Walkway collapse at Port Ramsgate* (ISBN 0-7176-1747-5), published in 2000, concluded:

The overall design of the walkway support arrangements was totally inadequate for normal operating conditions and should have been rejected... Even without the faults in fabrication and welding, collapse of the walkway would have been inevitable.

The report further went on to state:

There was confusion about LR's role among all major parties to the project, including apparently LR itself. The other parties derived a sense of security from LR's involvement despite deficiencies in design procedure and fabrication... LR did not spell out its interpretation of its role to other major parties, which allowed the sense of security engendered by its involvement, to persist.

As a result of this accident, the Construction Industry Research and Information Association (CIRIA) published a report in 1999 titled, *Safety in ports, ship to shore linkspans and walkways*.

Two British Standards (BS) were also published subsequently. These are:

- Maritime Structures: Code of Practice for the Design of Ro-Ro Ramps, Linkspans and Walkways (BS 6349-8:2007)
- Maritime Works –Part 2: Code of Practice for the Design of Quay, Walls, Jetties and Dolphins (BS 6349-2: 2010)

1.13.2 Other similar accidents

The Maritime Authority of the Cayman Islands has recently published an investigation report into a similar accident that occurred on 18 February 2009 in Thailand. After berthing, the 696gt luxury yacht *Jemasa* dislodged three

mooring points on the quay when full ahead pitch was applied to the CPPs by a crew member who did not realise the main engines were still running. One person was killed and another suffered a serious fracture.

1.13.3 CPP failures

In a study of all accidents caused by the failure of CPP systems from 1991 to 2008, as recorded in the MAIB database, of the 67 cases studied 50 were due to control equipment failures. Failure mechanisms included worn or broken linkages, stuck solenoid valves, loss of pneumatic or hydraulic pressure, and feedback circuitry anomalies. The following accidents provide examples of the consequences of CPP failure in the port environment:

- In April 2000, the UK registered 28,833gt cross-Channel ro-ro passenger ferry *P&OSL Aquitaine*² struck No 7 berth in Calais at 7kts after a loss of control to her port CPP. One hundred and eighty passengers and 29 crew were injured including 5 with bone fractures and several who were rendered unconscious.
- In February 2010, the UK registered 3,296gt ro-ro passenger ferry *Isle of Arran*³, struck the linkspan in Kennacraig, West Loch Tarbert, Scotland, at a speed of over 8kts. The accident occurred after control of the starboard propeller pitch was lost due to a mechanical failure. There were no injuries but both the vessel and the linkspan were damaged.
- In September 2006, the Finnish registered 3828gt general cargo vessel *Klenoden* collided with the German registered 65131gt container vessel *Hanjin Cairo*, which was moored in the port of Hamburg. The cause of the collision was the incorrect assembly following repair of *Klenoden*'s CPP system.

² Report on the investigation of the impact with the quay by the passenger ro-ro ferry *P&OSL Aquitaine* at Calais on 27 April 2000; Report No 27/2001
http://www.maib.gov.uk/publications/investigation_reports/2001/p_osl_aquitaine.cfm

³ Report on the investigation of the contact by *Isle of Arran* with the linkspan at Kennacraig, West Loch Tarbert, Kintyre on 6 February 2010; Report No 13/2010.
http://www.maib.gov.uk/publications/investigation_reports/2010/isle_of_arran.cfm

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 FATIGUE

There is no evidence that any of *Ben-My-Chree's* crew were suffering from fatigue, therefore it is not considered to be a contributing factor to this accident.

2.3 ENGINE MOVEMENT RESULTING IN THE ACCIDENT

The accident resulted from misapplication of ahead pitch to the running starboard engine. Of the six mooring lines, three (the forward spring and two stern lines) should have restrained forward movement. However, as these ropes were held on autotension winches set at 25% of the maximum force available, each rope would have released when it experienced a tension force exceeding 37.5kN. The total force to restrain the forward movement of the vessel was therefore only 112.5kN. Even allowing for the losses caused by the position of the rudder and the flow constrictions from the relatively shallow water and proximity of the harbour walls, the propeller would have developed in excess of three times the restraining force from the winches, causing *Ben-My-Chree* to surge forward shortly after the pitch was applied.

The collapse of the shore structure was initiated by the vessel's movement acting on the end of the gangway, which levered the gangway compartment off its supports and away from the walkway. The quay had settled and the structure's holding down arrangements were inadequate. With no articulation in the structure to accommodate any longitudinal vessel movement, as *Ben-My-Chree* surged forward the gangway compartment was dragged across the jetty. This caused the walkway securing arrangements to fail, and the walkway to fall. It was extremely fortunate that no one was in the walkway at the time it collapsed; otherwise the accident could have resulted in multiple casualties.

2.4 MAIN CIRCUIT BREAKERS

2.4.1 Repair

Global Switchgear Services Ltd was trusted by both IOM-SPC and LR due to its long association with these organisations and its history of satisfactory performance. Unfortunately, while repairing *Ben-My-Chree's* MCBs the technician's relative inexperience and lack of formal training in ABB circuit breakers resulted in him introducing new faults, which then lay dormant until the shaft generators were run up after undocking.

It is possible that the error in assembling the trip indicator was not an uncommon one considering the speed with which the faults were subsequently identified and rectified at Heysham by more experienced Global technicians. Nonetheless, as Global had not been accredited by ABB as an approved repair

company, and its employees had not had the requisite training, the technicians had to rely on their own accumulated knowledge and experience to carry out repairs.

Manufacturers accumulate a vast corpus of knowledge about their products as they collate information on failure rates and issues arising from in-service equipment. As a result, they can continually change and improve the design and construction of their products and introduce new procedures to mitigate against failure. Non-approved companies are disadvantaged in that they are not privy to failure data and often are unaware of new developments.

As there was nothing to warn against having the MCBs repaired by unauthorised technicians, and as the MCBs were well past their guarantee period, it is understandable that IOM-SPC did not use the original equipment manufacturer for their annual service. It is not uncommon for ship operators to employ alternative firms to overhaul and repair ship-board equipment because the price differentials can be significant. However, this accident demonstrates the importance of owners and managers taking steps to assure themselves that when they choose not to use authorised repair agents, they select companies that do have the technical expertise to carry out the work required to a satisfactory standard, especially when critical equipment is involved.

2.4.2 Tests and survey

An authorised LR surveyor witnessed the secondary current injection tests of seven out of the eight MCBs. However, he was not an electrical specialist and was not able to identify that electrical operation of the breakers had not been possible and that, therefore, the reports had been completed incorrectly. When LR's electrical specialist surveyor was later presented with the reports from Global, he knew that the tests had been witnessed by one of his colleagues and noted that the MCBs were confirmed as having been electrically operated ten times in addition to opening the contacts as required during the current injection tests. He was not to know that electrical operation of the MCBs had not been carried out, and therefore he was sufficiently confident to assume that the MCBs would work in service.

The function test of the shaft generator MCBs was not conducted, so the anomalies with the breakers were not apparent before the annual class certificate was granted.

From LR's perspective, the focus of the survey was the functioning of the safety trips rather than the normal operation of the equipment. However, IOM-SPC was deriving its assurance that the MCBs were serviceable and fit for purpose from the classification society's certification that credited the MCBs for 5 years. In this case, LR's inspection regime did not provide the level of assurance the vessel's owners were expecting. Where owners are relying on external approval and verification of systems, they need to ensure that they understand the limitations of these endorsements and, if necessary, take additional steps to check that their systems are functional and fit for purpose.

2.5 POST-DOCKING PREPARATIONS FOR SERVICE

Difficulties inserting the tail shaft meant that *Ben-My-Chree* missed a tidal window and so left dry dock 12 hours later than planned. This significantly reduced the time which could have been utilised to ensure that all the systems were fully functional. As the vessel was committed to starting her scheduled service on the morning of 26 March, the ship's staff had only 14 hours, which included a 5-hour voyage from Birkenhead, in which to remedy any technical problems which remained after the extended maintenance period. The opportunity to rectify defects was further reduced by the lack of a lay-by berth at the Cammell Laird yard, meaning that once the vessel had undocked it either had to re-enter the dry dock or depart.

In the event, having considered the weather forecast and the vessel's manoeuvrability, the master was content not to delay the vessel because one of the two bow thrusters was not serviceable. However, this meant that the repair needed to be conducted after the vessel had gone back into service.

If there had been more time between undocking and entering passenger service for effective system testing and defect rectification, the MCB faults could have been repaired and it would not have been necessary to operate the main engine for this purpose while embarking passengers and loading vehicles.

2.6 ENGINE OPERATION IN PORT

The starboard main engine was started during passenger embarkation and vehicle loading operations. It remained running for nearly 20 minutes before the chief officer moved the pitch control to the full ahead position. As this accident has shown, without a clutch in the shaft line either the inadvertent application of pitch or a malfunctioning CPP system could have disastrous consequences considering that the main engine was capable of developing in excess of 4000kW of power.

Ben-My-Chree's senior officers had not considered the potential consequences of an unintended application of CPP pitch to a running shaft while embarking/disembarking passengers. The regular practice of starting engines in port to water-wash the turbochargers made the activity appear to be routine. This could explain why the master did not consider any additional safety precautions, other than informing the loading officer, when the chief engineer sought his permission to start an engine. That the shore-based managers acquiesced to the practice of turbocharger washing while embarking passengers indicates that they too had not sufficiently considered the risks. The IOM-SPC's standing order for starting engines in port only required the propeller blades to be on zero pitch and the moorings to be secure, indicating that the shore managers also were relying heavily on the integrity of the CPP system.

Although the pre-departure checklist implied that passenger embarkation was separated from starting engines and turning shafts, in reality these activities overlapped. The SMS did not effectively proscribe the starting of engines in

port while the gangway was attached and the stern ramp was lowered, nor did it attempt to mitigate the potential consequences of the vessel moving unintentionally.

In carrying out its risk assessments as required by the PMSC, Heysham Port did not take note of its own Harbour Byelaws which imposed restrictions on conducting engine trials without written authority from the harbourmaster. The crew of *Ben-My-Chree* did not consider the requirements of the Byelaws either, and greater awareness of this procedure should prompt both crew and shore staff to give more consideration to engine trials. Other ports have more detailed controls on this activity having identified the potential for sudden uncontrolled movement of vessels alongside to cause damage to other vessels and dock infrastructure, and risk harming shore workers, passengers and crews. Although currently not obligatory, an external audit of Heysham Port's PSMS would have perhaps identified this shortcoming.

2.7 USE OF WINCHES IN AUTOTENSION MODE

In ports such as Heysham, which have a large tidal range, but limited tidal stream, autotension winches can enhance the safety of the vessel by always maintaining the correct tension on the lines while the tide rises or falls. Conversely, the use of winches in autotension mode is prohibited in most oil, chemical and gas terminals due to their propensity to cause the vessel to 'walk' along the jetty.

Ben-My-Chree's forward spring line was always held in autotension mode, and the only reason that the back spring was not the same was that there were insufficient autotension winches aft. If the winch holding the forward spring had been switched over to manual mode and the brake applied in preparation for engine trials, the vessel might have been restrained by the line initially. The associated build-up of vibration in the vessel might have alerted the chief officer to the problem before the winch brake rendered.

Unlike the tanker sector, which has implemented a risk-based approach to the use of autotension winches and specific requirements from some harbour authorities (**Annex D**), other sectors of the shipping industry have been less proactive. Ro-ro ferries commonly moor using autotension winches as the dependence on the crew to maintain the correct tension in the mooring lines is significantly reduced. This practice had been used throughout the 12 years that *Ben-My-Chree* had operated at Heysham without incident. However, *Ben-My-Chree's* crew were not fully conversant with the limitations of autotension winches, particularly for holding spring lines, with the consequence that there was little to restrain the vessel when it surged forwards. A detailed risk assessment of mooring practices is therefore required to decide, on the balance of risks, the optimum mooring practice.

2.8 COMPLIANCE WITH PROCEDURES

The investigation has identified a number of practices on board *Ben-My-Chree* that did not comply with IOM-SPC policies:

- The company standing orders explicitly stated that a designated duty engineer shall always be available in port, but the practice on board was more informal and the engineers chose to ignore this requirement.
- The engine room departure checklist focused only on the technical preparations for sailing, and not on procedural aspects such as control testing; in any case the checklist was not used by the engine room staff.
- The SMS made references to pitch recording paper rolls which did not exist on board.
- Turbocharger water-washing operations were carried out while vehicle loading and passenger embarkation was ongoing. It therefore follows that it was impossible to follow the bridge departure checklist, which required gangways and ramps to be disconnected before starting engines.

Neither the internal and external ISM audits, nor the bridge management audits had identified these discrepancies. An audit is a sampling process and cannot be expected to identify every deviation from procedures. However, had the audits provided some insight into the general disconnect which existed between company procedures and onboard practices, corrective measures could have been taken.

2.9 COMMUNICATIONS

After his telephone conversation with the chief engineer, the master told the loading officer about the engineers' intention to start the starboard engine. Although the chief officer overheard this conversation, he had forgotten about it by the time he entered the bridge. The master erroneously assumed that the starboard engine had been shut down after the apparently successful bow thruster test. The chief engineer was so engrossed in the continuing fault diagnosis of the bow thruster MCB that he neither maintained a dialogue with the master nor instructed any of his subordinates to do so.

The 3/E reacted very differently to the chief officer's request to test controls than he did when the master called him a short while later to ask if the bow thrusters could be started. In the first case, the 3/E simply handed over engine controls to the bridge despite being fully aware that the starboard engine was running; in the second case, he denied the master permission to start the bow thrusters. He perhaps did not challenge the chief officer because the testing of controls was a twice daily routine activity that required very little thought. Conversely, when asked directly to make a decision regarding the bow thruster, he could only do so by setting aside his pre-occupation with the bunkering and evaluating the activities around him; his attention to the situation being heightened by the need to evaluate before coming to a decision.

In the absence of an established protocol for carrying out jobs which are not part of the daily routine, it is crucial that all those involved communicate openly, without making any assumptions about each others' actions. For example, the master assumed that the starboard engine had been shut down once the bow thruster tests were completed; and the 3/E assumed the bridge staff knew that the engine was running, and did not question their apparent intention to test the controls with the shaft turning. The absence of effective communication between individual crew members, and between the deck and engine departments, immediately before the accident allowed the running of the engine to become an unsafe condition that enabled the accident to occur.

2.10 PASSENGER ACCESS STRUCTURE

In 1998, when the passenger access structure at Heysham was built, there was very little guidance on the construction of ship to shore connecting structures. Therefore it is unreasonable to expect the design of the structure to comply with current standards and best practices, or to incorporate the lessons from the Ramsgate accident, the report for which was only published in 2000.

Nevertheless, had the passenger access structure been the subject of a risk assessment, inspection or maintenance programme, the risk to the structure of vessel movement, however generated, would likely have been considered. This in turn should have given rise to questions over the structure's design, strength and resilience to the effects of vessel movement. Subsequent comparison with the guidance and technical standards available since 2000 would have shown the significant shortcomings of the structure, its maintenance and inspection routines.

The structure had deteriorated over time and, except for propping it up to compensate for the ongoing settlement, there was no regular system of maintenance or inspection to ensure it was fit for purpose. The requirement to bolt down the gangway compartment to the foundation, as per the original drawings, was ignored as these ad-hoc reinforcement activities took precedence. The uncertain internal condition of the defunct underground tunnels made the access structure above it unsafe; a possible collapse of either of these tunnels could have resulted in the loss of ground beneath the passenger access structure. The consequences could have been severe.

Heysham Port had changed ownership several times in its recent history, and consequently there might have been uncertainties regarding whose responsibility it was to maintain the passenger access structure. However, since 2005, the port has been owned by Peel Ports. It is unfortunate that little or no effort was made to look after the access structure and the surrounding area. To discharge their legal obligation to ensure the safety of people working in or using their ports, it is vital that harbour authorities examine their facilities regularly, especially those in use by the general public, to ensure that they are safe.

SECTION 3 - CONCLUSIONS

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

1. *Ben-My-Chree's* senior officers, the vessel's technical managers and Heysham Port management did not fully appreciate the risks of the vessel running the engine while moored alongside and embarking passengers. Relying entirely on the CPP system to maintain the zero position of the propeller blades was an unsafe practice, and safeguards to uncouple the hazards of engine operation from passenger or vehicle operations were non-existent [2.6].
2. *Ben-My-Chree's* crew were not fully conversant with the use of autotension winches and, in particular, the hazards of using autotension on spring lines. Ro-ro ferries commonly moor using autotension winches as it offers significant savings in manpower and a wider dissemination of the hazards posed by incorrect usage of winches in autotension mode would benefit the ferry segment and the shipping industry in general [2.7].

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

1. The design of the passenger access structure in Heysham did not accommodate the potential for vessel movement while connected, and it was not resilient to damage caused by vessel movement. Further, there was no regular system of maintenance or inspection to ensure the structure was fit for purpose [2.10].
2. Had the passenger access structure been the subject of a risk assessment, inspection or maintenance programme, the risk to the structure of vessel movement, however generated, would likely have been considered. This in turn should have given rise to questions over the structure's design and strength [2.10].

3.3 SAFETY ISSUES IDENTIFIED DURING THE INVESTIGATION WHICH HAVE BEEN ADDRESSED

1. There was nothing to warn against having the MCBs on *Ben-My-Chree* repaired by unqualified technicians. This accident demonstrates the importance of owners and managers taking steps to assure themselves that when they choose not to use authorised repair agents, they select companies that do have the technical expertise to carry out the work required to a satisfactory standard, especially when critical equipment is involved [2.4.1].

2. IOM-SPC was deriving its assurance that the MCBs were serviceable and fit for purpose from the classification society signing the annual class certification and crediting the MCBs for 5 years. In this case, LR's inspection regime did not provide the level of assurance the owners were expecting. Where owners are relying on external approval and verification of systems, they need to ensure that they understand the limitations of these endorsements and, if necessary, take additional steps to check that their systems are functional and fit for purpose [2.4.2].
3. If there had been sufficient time available between undocking and entering passenger service for effective system testing and defect rectification, the MCB faults could have been repaired and it would not have been necessary to operate the main engine for this purpose while in port and embarking passengers [2.5].
4. Neither the ISM audits nor the bridge management audits had identified the general disconnect which existed between company procedures and actual practices on board *Ben-My-Chree*, with the consequence that corrective measures were not taken [2.8].
5. The absence of effective communication between individual crew members, and between the deck and engine departments, immediately before the accident allowed the running of the engine to become an unsafe condition that enabled the accident to occur [2.9].

SECTION 4 - ACTION TAKEN

4.1 MAIB ACTIONS

The MAIB has published a Safety Flyer highlighting the potential hazards to passengers of vessels starting engines while embarking/disembarking passengers and vehicles; the appropriate use of auto-tension winches; and the need to properly assess the safety of passenger access structures.

4.2 ACTIONS TAKEN BY OTHER ORGANISATIONS

The Isle of Man Steam Packet Company:

- Has introduced a mandatory minimum period of 24 hours for testing and proving of all safety critical and other systems necessary for the safe operation of the vessel following any extended period of maintenance activity, such as dry docking, and before the vessel commences passenger service.
- Has decided that all future servicing of the main circuit breakers will be carried out by the manufacturer (ABB).
- Is investigating methods of combating complacency.
- Is reviewing its risk assessment procedures, including dynamic risk assessments and its permit-to-work system.
- Has increased the frequency of bridge management audits and vessel inspections on *Ben-My-Chree*.
- Introduced new procedures prohibiting passenger or vehicle embarkation/disembarkation while running engines in port.
- Carried out a special risk assessment covering the general mooring arrangements and mooring practices in Heysham Port (**Annex E**).

The Health and Safety Executive:

- Has carried out a specialist investigation into the collapse of the Port of Heysham passenger access structure and has made the following recommendations:
 1. *Clarification should be sought from the designers of the Passenger Access (Beckett Rankine Partnership, Marine Consulting Engineers, London) as to how they satisfied themselves that the connection between the supported walkways and suspended walkway was satisfactory;*
 2. *An inspection regime, similar to that for bridges, should be adopted with the findings of the inspection recorded and any remedial work identified should be carried out within an appropriate timescale. Particular attention should be given to safety critical parts of the structure. The inspection should be carried out by a competent person;*

3. *Records should be kept of any maintenance work or modifications made to the structure;*
4. *Investigations should be carried out to understand the reasons for the ground settlement. Suitable remedial/stabilisation works should then be undertaken.*
5. *An inspection should be carried out on the two subways to ascertain whether structures present a risk of collapse. They should also form part of the inspection and maintenance regime as recommended for the Passenger Access;*
6. *For the procurement, operation and maintenance of ship to shore structures, reference should be made to the guidance provided in CIRIA Report C518, Safety in Ports, ship to shore linkspans and walkways.*

Heysham port:

- Has introduced procedures and a permit system for running engines while alongside, and introduced the risk assessment of this issue in its safety management system.
- Has begun the process for reconstructing the passenger access structure in accordance with the HSE recommendations.

SECTION 5 - RECOMMENDATIONS

UK Major Ports Group and **British Ports Association** are recommended to invite their members to:

2010/139 Take action as appropriate to:

- Review the risks associated with passenger vessels in their ports operating engines while embarking/disembarking passengers or loading/unloading vehicles, taking into account the possible failure modes of various propulsion systems, and introduce appropriate control measures where necessary.
- Inspect their ports' passenger embarkation and vehicle loading structures, in liaison with the Health & Safety Executive where appropriate, to ensure that they are fit for purpose and comply with current industry guidance and best practices.

**Marine Accident Investigation Branch
December 2010**

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