Report on the investigation of the contact by

Isle of Arran

with the linkspan at Kennacraig

West Loch Tarbert, Kintyre

6 February 2010

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Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

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CONTENTS

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AB	-	Able bodied seaman
BHP	-	Brake horse power
CFL	-	CalMac Ferries Ltd
CMAL	-	Caledonian Maritime Assets Ltd
CPP	-	Controllable pitch propeller
CRM	-	Crew Resource Management
DPA	-	Designated person ashore
ECR	-	Engine control room
ISM Code	-	International Safety Management Code
kts	-	Knots
kW	-	kilowatt
LR	-	Lloyd's Register
MVOM	-	Major Vessel Operations Manual
OD box	-	Oil distribution box
OOW	-	Officer of the Watch
PMS	-	Planned Maintenance System
QM	-	Quartermaster
ro-ro	-	Roll-on, roll-off (ferry)
rpm	-	revolutions per minute
SOG	-	Speed over the ground
UTC	-	Universal Time Co-ordinated
VHF	-	Very High Frequency

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

SYNOPSIS

At 0855 on 6 February 2010, the UK registered ro-ro passenger ferry *Isle of Arran*, struck the linkspan in Kennacraig, West Loch Tarbert, Kintyre at a speed of over 8kts. The vessel was on passage from Port Askaig to Kennacraig, with 14 passengers and 24 crew on board. There were no injuries but both the vessel and the linkspan were damaged.

The accident occurred after control of the starboard propeller pitch was lost due to a mechanical failure. Consequently, the starboard propeller remained at full ahead as the ferry made her approach to the berth. Although the port propeller was put to full astern, the starboard anchor was let go, and the starboard engine was shut down, this did not prevent *Isle of Arran* from landing heavily on the linkspan.

Factors leading to the mechanical failure included the fitting of a manufacturer's original spare component which was incorrect, a lack of technical information leading to incorrect adjustment, inadequate testing of the pitch control system, and the lack of a robust technical investigation following a previous failure. There was no test of the pitch control system before *Isle of Arran* was committed to the final approach into Kennacraig. As a consequence, the high speed of approach to the berth and the inability of the ship's crew to quickly identify the cause of the loss of pitch control, made the resultant heavy contact with the linkspan inevitable.

This is one of a number of recent accidents in the shipping industry as a whole in which complacency has undermined the effectiveness of ships' crews. Preventing complacency on ferries, which are inevitably engaged on regular and familiar routes, is a challenge for all ferry owners and operators. Therefore, a recommendation has been made to the UK Chamber of Shipping designed to encourage and facilitate the regular sharing of experiences and initiatives by UK ferry owners and operators, with particular emphasis on the prevention of complacency.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *ISLE OF ARRAN* AND ACCIDENT

Vessel details

Registered owner	:	Caledonian Maritime Assets Ltd (CMAL)
Manager/Operator	:	CalMac Ferries Ltd (CFL)
Port of registry	:	Glasgow
Flag	:	UK
Type	:	Ro-ro, vehicle passenger ferry
Built	:	1984, Ferguson Ailsa Ltd, Port Glasgow
IMO number		8219554
Classification society	:	Lloyd's Register (LR)
Construction	:	Steel, welded, one deck
Length overall	:	84.92m
Gross tonnage	:	3296
Engine power and/or type	:	2 x 8MB275 diesel engines; 1756kW each
Service speed	:	15kts
Other relevant info	:	Twin CPP, single bow thruster

Accident details

Time and date	:	0855 on 6 February 2010
Location of incident	:	Kennacraig ro-ro berth, West Loch Tarbert, Kintyre
Persons on board	:	24 crew; 14 passengers
Injuries/fatalities	:	None
Damage (ship)	:	Penetration of bow visor and forepeak tank. Forefoot set back. Buckling of visor deck, forepeak and surrounding structure.
Damage (shore)	:	Linkspan arm; concrete ramp and passenger gangway.

1.2 NARRATIVE

At 0655 on 6 February 2010, *Isle of Arran* sailed from Port Askaig, Isle of Islay for Kennacraig, West Loch Tarbert, Kintyre. On board were 24 crew, 14 passengers, 5 cars and 2 commercial vehicles. Pre-departure checks and tests had been conducted on the vessel's propulsion, steering and communication systems by the officer of the watch (OOW) and the duty engineer **(Annex A)**. No deficiencies or defects were identified. The estimated time of arrival at Kennacraig was 0905.

The chief officer was the OOW. Shortly after leaving Port Askaig he placed the combinator levers, which controlled the vessel's speed, to their maximum setting of '10' ahead. This resulted in a speed over the ground of about 15kts.

At about 0800, the chief officer passed the passenger and cargo details to Kennacraig terminal via VHF radio. In response, he was advised that the wind at the berth was 10kts from the north-east.

When the vessel was 1 mile from the entrance to West Loch Tarbert, the chief officer called the master. By 0830, the vessel was approaching the loch entrance and the chief officer ordered the engines to be put on standby. He also started to complete the port arrival checklist **(Annex A)**.

Shortly afterwards, the master arrived on the bridge. The quartermaster (QM) was placed on the helm and hand steering was selected. The setting on the combinator levers was reduced to between '7' and '8' ahead to reduce the vessel's speed to about 13kts when passing nearby oyster bed farms.

As *Isle of Arran* headed up the loch on a course of about 031˚ **(Figure 1)**, the master informed the OOW and QM that he would berth the vessel at the linkspan on the south side of the pier. The second officer and a deck cadet then arrived on the bridge. The weather was overcast and dry. The sea was calm and the visibility was good. Within the loch the tidal stream was negligible and the predicted height of tide was 2.2m.

At about 0850, shortly before passing Black Rocks at a speed of 13.5kts SOG **(Figure 2)**, the vessel's carpenter and an AB went to the foredeck to clear away the anchors and open the vent for the bow thruster. At about the same time, the master took the con and altered course to about 048˚ to follow the planned track. The bow thruster was also started.

At about 0852, the master reduced both combinator levers to about setting '5' ahead and ordered the QM to "*head for the roundhead of the pier"*. The QM applied starboard helm and then steadied the ferry on a heading of about 080˚.

When the vessel was between 5 and 6 cables from Kennacraig pier, her speed was 11.5kts and the master adjusted the combinator levers to about '3' ahead. He did not look at the pitch feedback indicators. The master then moved to the port bridge wing to get a better view of the berth.

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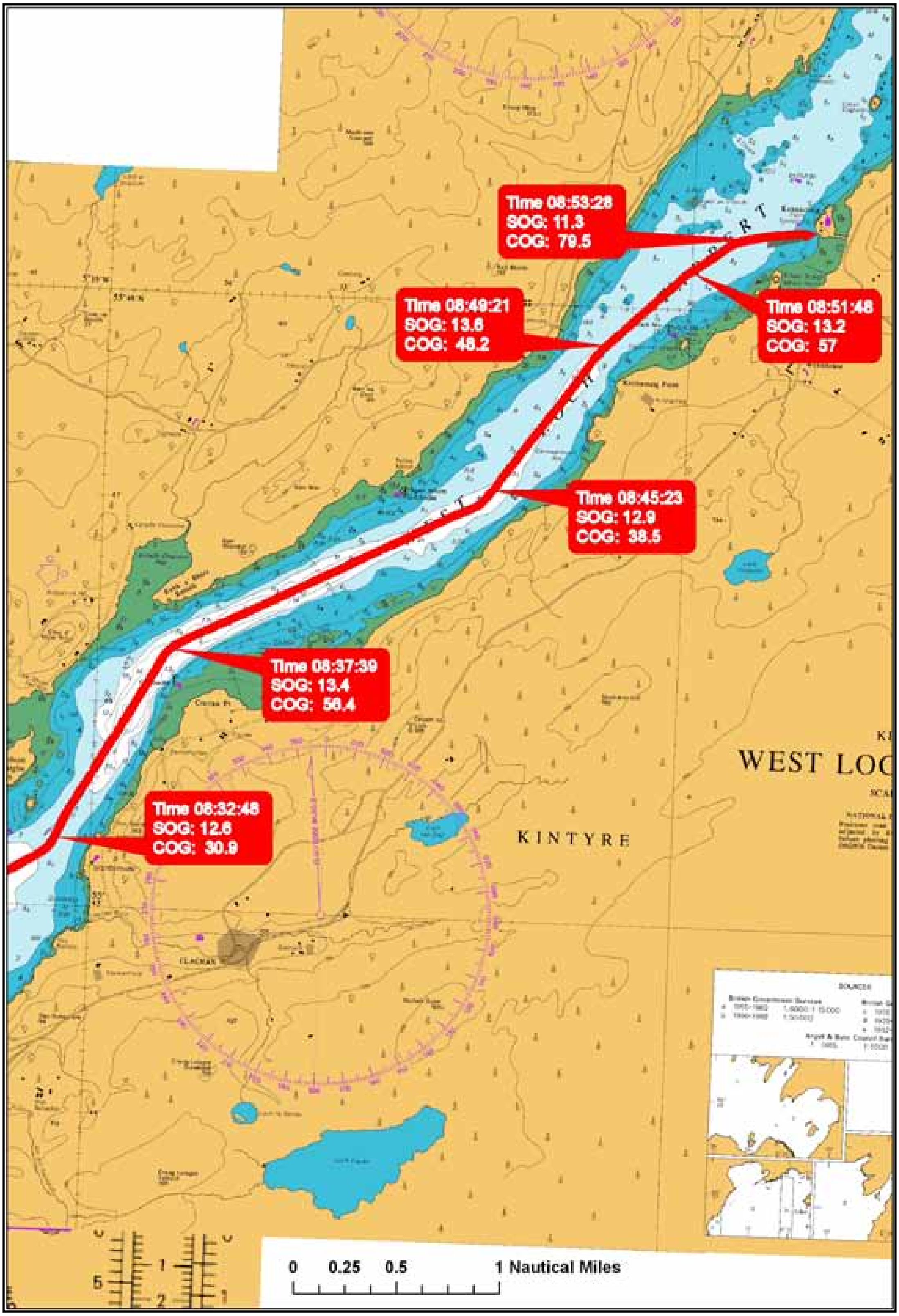
Figure 1



Vessel track in West Loch Tarbert

Reproduced from Admiralty Chart BA 2476 by permission of the Controller of HMSO and the UK Hydrographic Office

Figure 2

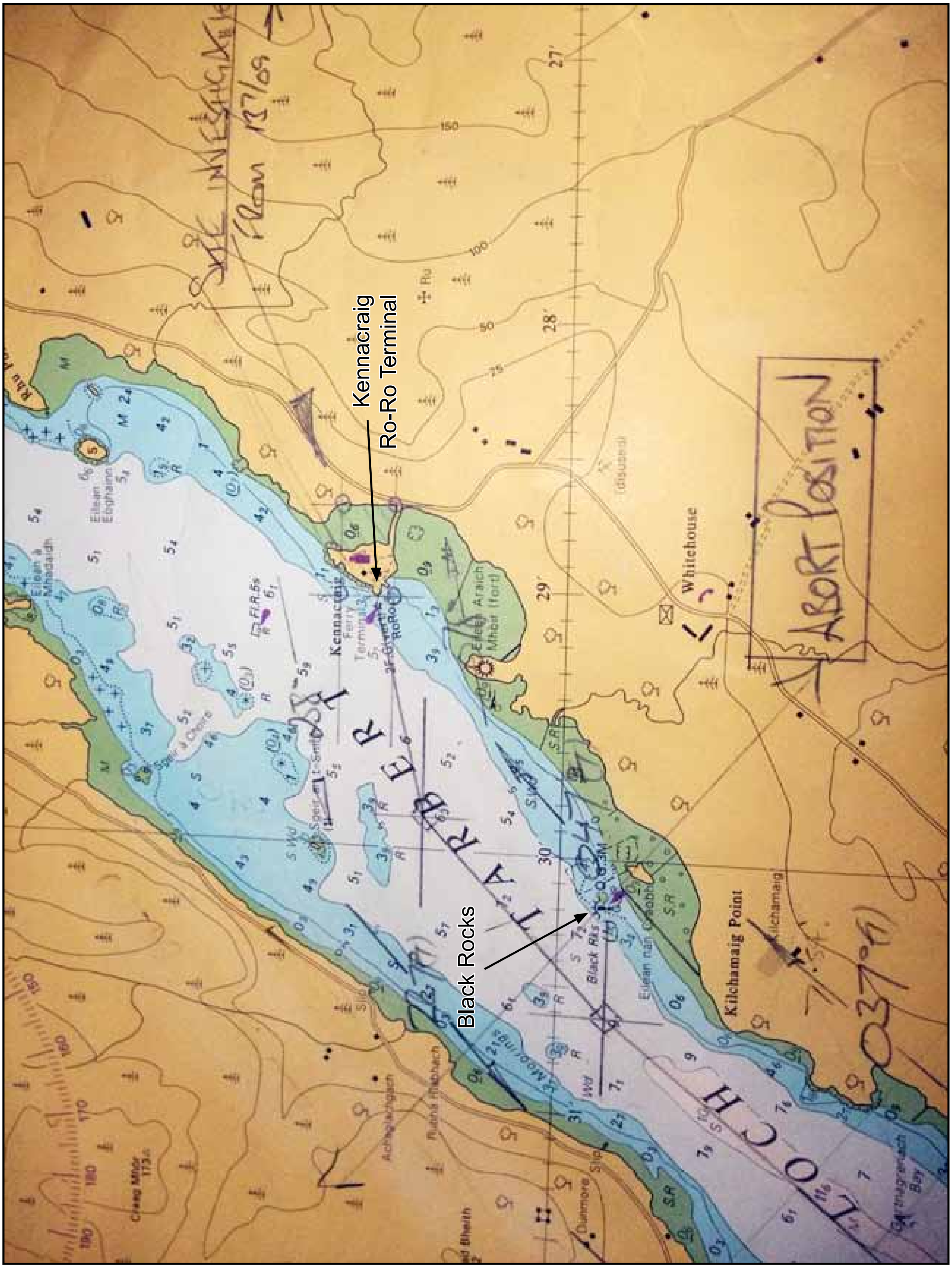


Chart: West Loch Tarbert

On the wing, the master opened the control box lid and set the combinator levers to '3' ahead to match the levers on the bridge console **(Figure 3)**. He then pressed the "in command" button; the blue "in command" light on the wing console illuminated. The chief officer, who was still inside the bridge, confirmed that the "in command" lights on the bridge centre consoles had extinguished. The master interpreted noises from the pitch control pneumatic system within the port wing control box as further confirmation that control had been transferred.

Figure 3

Port bridge wing control console and insert

The master then reduced the combinator levers to a setting of about '1.5' ahead, but soon realised that the vessel was not slowing as quickly as expected. He looked down at the pitch feedback indicators and saw the starboard pitch was full ahead. Aware that the indicators could stick, he moved both combinator levers to position '4' astern, but there was still little discernible reduction in the vessel's speed.

The master immediately told the chief officer that he didn't have control of the propulsion at the wing console. The chief officer was unsure whether the master meant one or both of the combinator levers. Although he had now moved to the port wing door, his view of the wing console was obstructed by the master. The chief officer immediately asked the second officer if the port entry checklist had been completed and if the centre console still had control of the propulsion. The second officer confirmed that the checklist had been completed and that the bridge console was not controlling the propulsion.

Isle of Arran was still making 10kts and was now only between two and three vessel lengths from the pier **(Figure 4)**. The master ordered the chief officer to "*Take control, and go astern*". The chief officer went back inside the bridge and transferred control of the propulsion to the centre consoles. He then put the combinator levers to about '5' astern, quickly followed by '10' astern (full astern) on instruction from the master. Almost immediately, the vessel's bow started to sheer to port. The master again transferred control of the propulsion to the port wing console and put the combinator levers to '10' astern.

Meanwhile, the second officer phoned the engine control room (ECR) and informed the chief and second engineers that the starboard engine was not responding. The chief and second engineer checked the various engine and controllable pitch system indicators. All of the machinery appeared to be operating correctly, so the second engineer went in to the engine room and inspected the starboard engine. No problems were found.

With the vessel's speed just below 9kts and only half a vessel length from the linkspan, the master set the bow thruster to full thrust to starboard and ordered the starboard anchor to be let go. He also ordered the emergency stop of the starboard engine. At the same time, the chief engineer stopped the starboard engine from the ECR.

The starboard anchor was let go just as the vessel's bow hit the pier roundhead **(Figure 5)**. The carpenter applied the brake when about one shackle of anchor cable had payed out, but *Isle of Arran* continued to move towards the linkspan, scraping her bow against the pier's protective rubber fendering.

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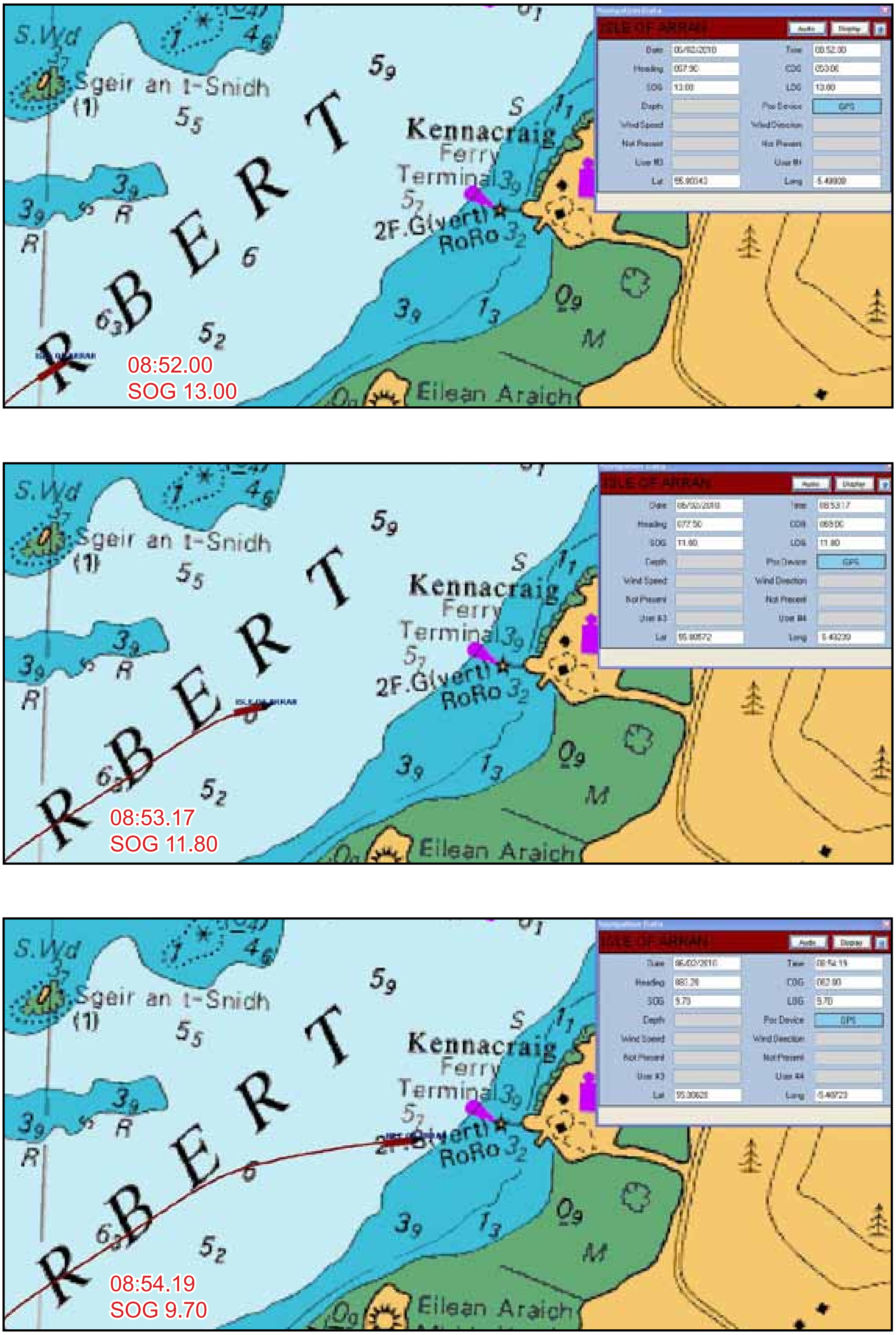
Figure 4



Approach to Kennacraig terminal: AIS data extract

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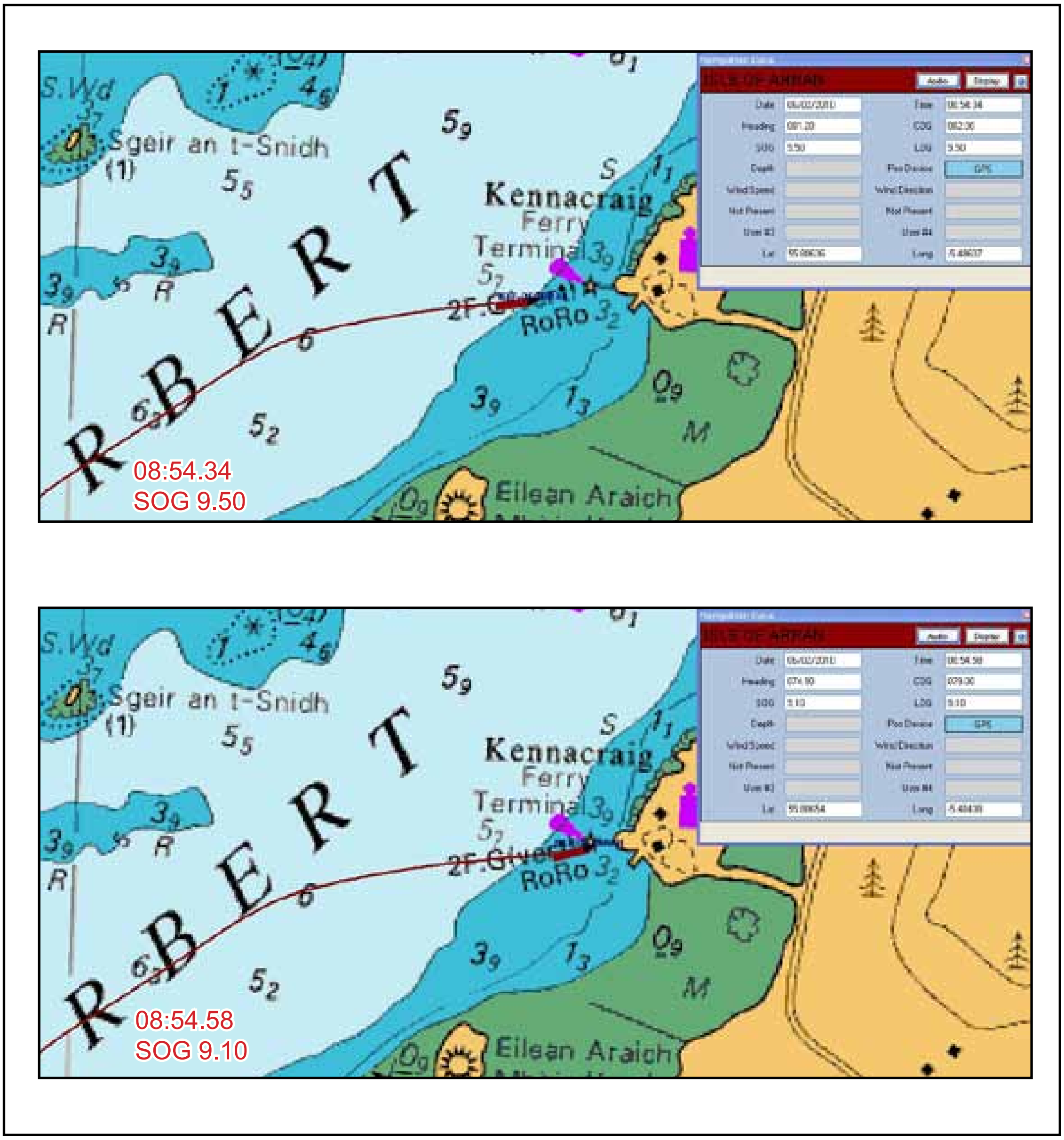
Figure 5



Approach to Kennacraig terminal: AIS data extract

At 0855, *Isle of Arran* struck the linkspan and concrete ramp at a speed of about 8.4kts, causing the vessel to roll heavily to starboard. The vessel was impaled on the inner linkspan arm and was wedged between the linkspan arm and concrete ramp.

There were no injuries to the passengers, all of whom were sitting in the cafeteria and bar areas at the time of the impact. The chief engineer was thrown heavily against the switchboard in the ECR but was not seriously injured.

1.3 POST-ACCIDENT EVENTS

After impact, *Isle of Arran*'s stern swung to starboard until she was about 30˚ to the pier **(Figure 6)**.The port engine was stopped and shore lines put out fore and aft. Inspection of the starboard oil distribution (OD) box revealed a control linkage failure **(Figure 7).** A spare linkage was fitted by the second engineer and was adjusted to allow operation of the starboard CPP.

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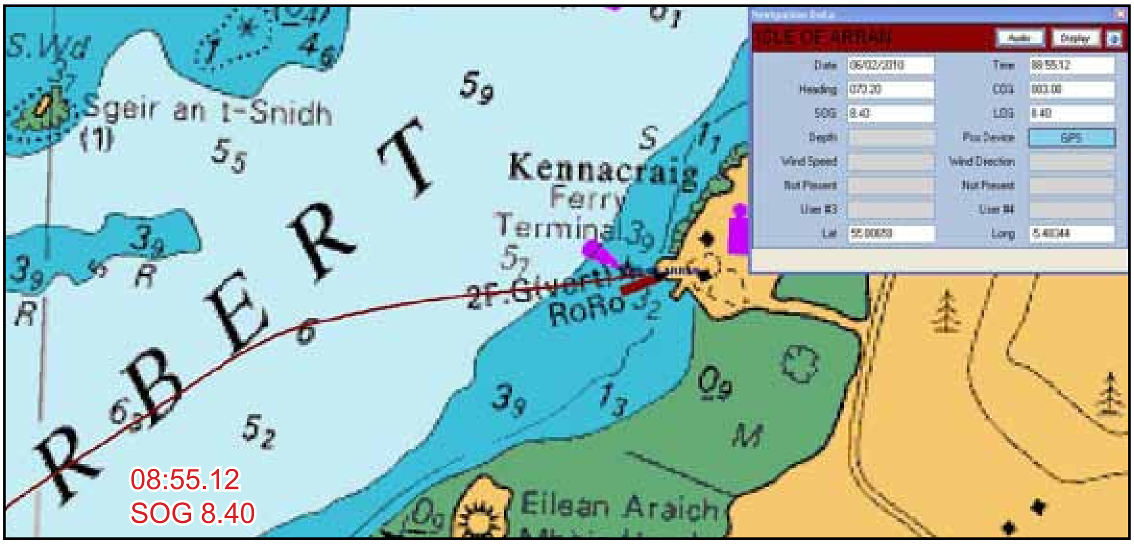
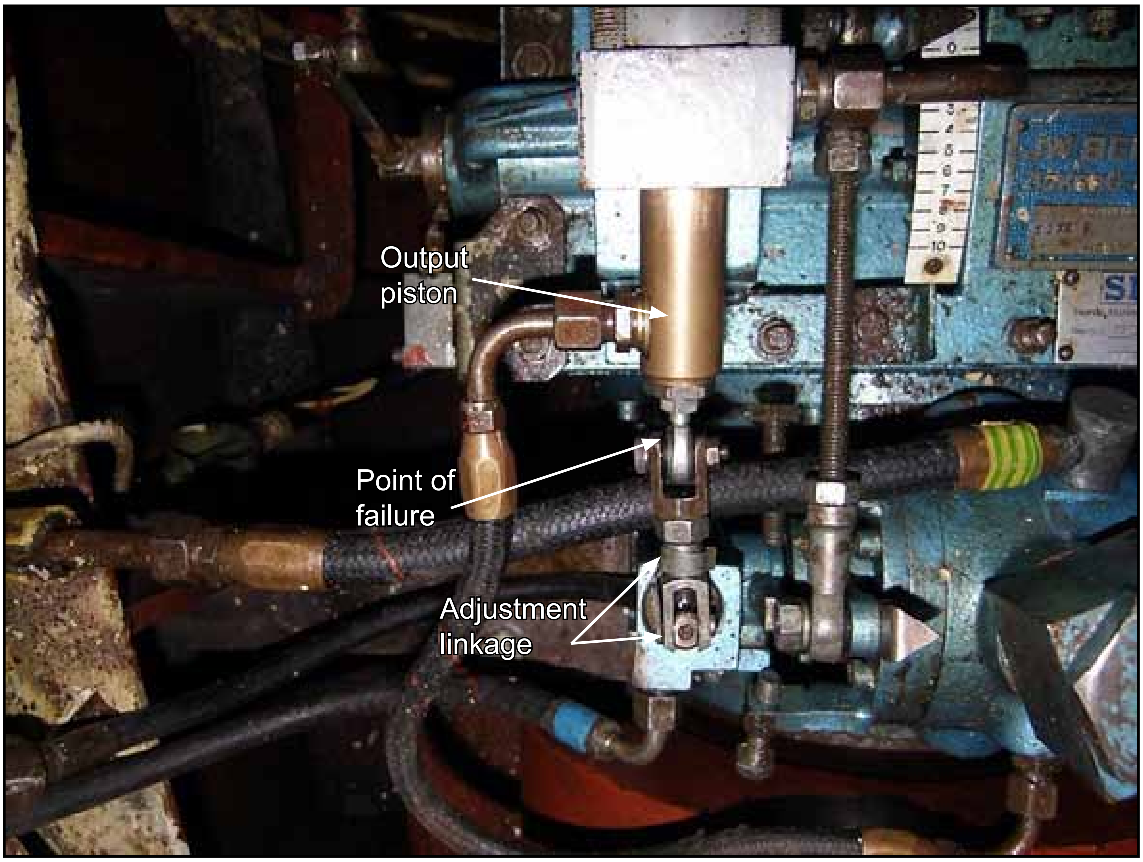
Figure 6



Contact with Kennacraig ro-ro terminal: AIS data extract

Figure 7



Starboard OD box control linkage and point of failure

After the damage to the vessel was assessed, *Isle of Arran* was ballasted by her stern and cleared the linkspan arm under her own power. She was then manoeuvred stern to the linkspan, where her passengers and vehicles disembarked.

The port manager tested the master, chief officer, chief engineer and second engineer for alcohol, and they were found to be clear.

Following inspection, Lloyd's Register (LR) issued a condition of class which allowed the ferry to sail to the River Clyde for repairs. *Isle of Arran* sailed at 0630 on 7 February and arrived in Gourock at 1700 the same day. During the passage, the visor space was observed continuously from the bridge using closed-circuit television.

1.4 DAMAGE

1.4.1 Ship

Isle of Arran's bow suffered considerable damage in way of the visor, the visor space and the forepeak tank **(Figure 8)**. The starboard side of the visor was penetrated by the inner linkspan arm, which caused a jagged hole of between 4m² and 6m² **(Figure 9)**.

Figure 8

Bow visor damage

Figure 9

Linkspan arm penetration of bow visor

The visor deck within the visor space was crumpled longitudinally and athwart ships back to the vehicle ramp. Its leading edge, which formed the upper part of the forepeak tank, was bent downwards **(Figure 10)**.

Internal framing within the forepeak was buckled and badly distorted. The forepeak tank shell plate suffered extensive folding on both the port and starboard sides, and was holed at a folded section on the starboard side. The bow was significantly indented and the forefoot was bent to port.

1.4.2 Ashore

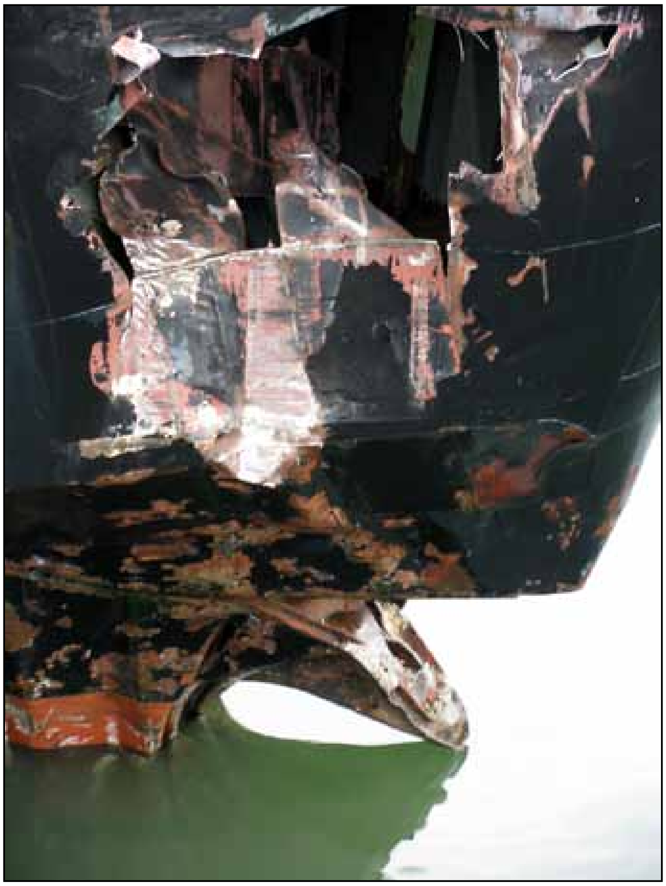
The vessel's contact with the pier damaged the pier's rubber fendering and her impact with the linkspan caused damage to the inner linkspan arm, the concrete ramp **(Figure 11)**, the passenger gangway, and the linkspan, which was moved sideways and lifted from its roller guides.

1.5 CPP CONTROL

1.5.1 Bridge and bridge wings

The bridge controls for the port and starboard engine and CPP systems were on separate panels sited on a console in the centre of the bridge **(Figure 12)**. Each panel had a combinator lever that controlled both engine speed and propeller pitch.

Figure 10



Bow visor and forepeak damage

Figure 11

Kennacraig ro-ro berth damage

Figure 12

Bridge CPP control console

The combinator levers operated through a range of between ‘0’ and ‘10’ ahead and astern. It was reported that between settings ‘0’ and ‘3’, the engine speed remained at 650 rpm but the pitch of the propeller blades was increased from zero to full ahead or astern. Between settings ‘3’ and ‘10’, the pitch of the propeller blades remained at full ahead or astern, but the engine speed progressively increased to 750 rpm. This resulted in a maximum speed (ahead) of 15kts.

Each control panel also had indicators for engine overload, console in command, bridge control, engine room control, and propeller pitch. The pitch indicators were not calibrated, but gave a rough indication of the increase or decrease of pitch from zero to full ahead or from zero to full astern. The pitch indicator gauges were listed as part of the deck department primary systems and equipment in CFL’s Major Vessel Operations Manual (MVOM).

Each bridge wing was fitted with a console containing combinator levers for the port and starboard propulsion systems **(Figure 3)**. These consoles, which were protected by hinged covers when not in use, also contained controls for the bow thruster and emergency stops for the main engines.

Control of the CPP systems was tested from the bridge and bridge wing consoles prior to every sailing. The OOW moved the combinator levers from each of the consoles in turn while the on-watch engineer monitored the pitch operation using gauges in the ECR.

1.5.2 ECR

The ECR control consoles for the port and starboard engine and CPP systems included: a pitch lever; a main engine speed lever; a main control air pressure gauge; a CPP control air gauge (labelled “From Bridge Control”); a pitch feedback gauge; a hydraulic oil pressure gauge; a feed air pressure gauge; lamps to indicate whether the bridge or ECR had control; and an engine overload lamp **(Figure 13)**.

Figure 13

ECR starboard engine/CPP control console

The separation of the control of the engines and propeller pitch enabled the engines and pitch to be operated independently during maintenance and testing. In common with the control panels fitted on the bridge, the pitch feedback gauges were not calibrated, but gave a coarse indication of propeller pitch between zero and either full ahead or full astern.

1.6 OIL DISTRIBUTION BOX

1.6.1 Description

Isle of Arran was powered by two Mirrlees Blackstone medium-speed diesel engines each developing 2310bhp (1756kW), driving through controllable pitch propellers via a clutched flexible coupling and single reduction gearing. The pitch control or oil distribution boxes mounted on each shaft **(Figure 14)** were located in the gland space, aft of the engine room, and separate from the main engines and gearboxes. *Isle of Arran* was the only vessel in the CFL fleet fitted with these boxes, which were manufactured in Sweden by Berg, and were no longer in production.

Figure 14

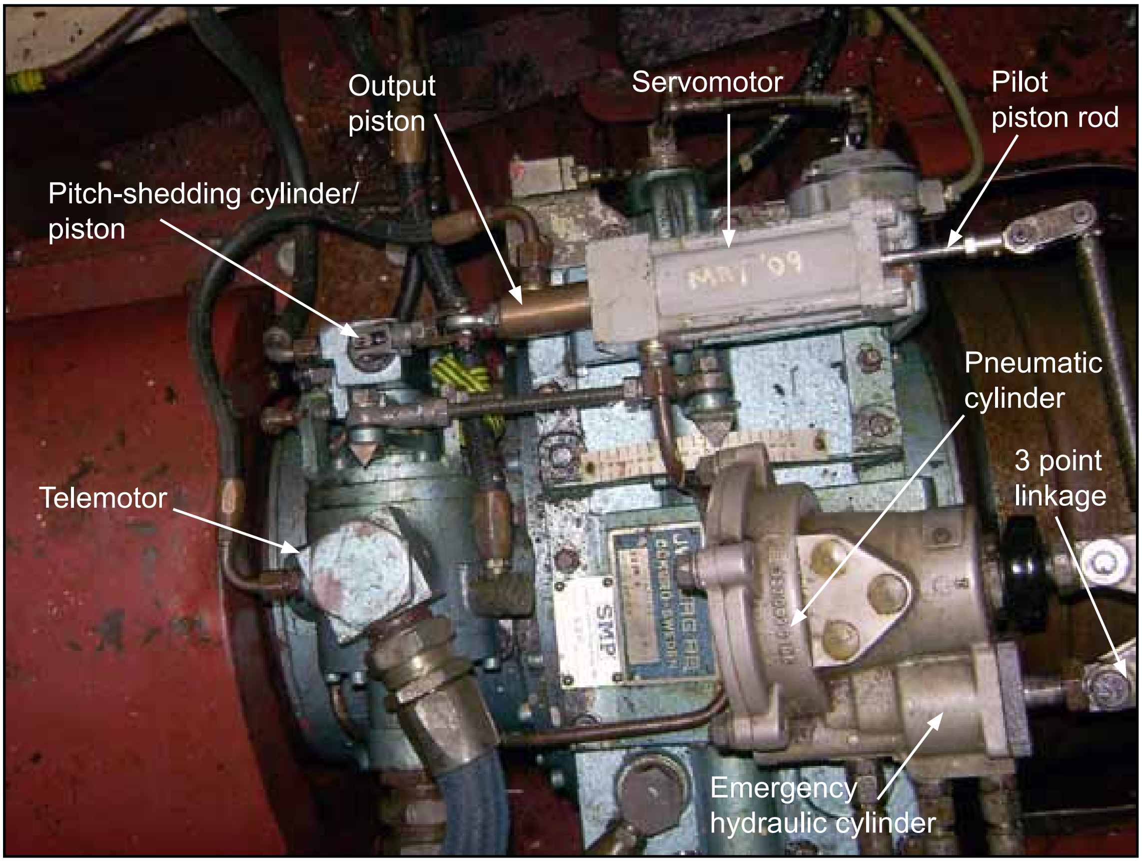
Starboard CPP OD box and propeller shaft

The pitch was controlled by a compressed air signal from the combinator levers on the bridge and bridge wings, or from the pitch levers in the ECR. The compressed air operated between 0 and 5 bar pressure to move the propeller blades from full ahead (0 bar) to full astern (5 bar). If air pressure was completely lost on either propulsion system, pitch would increase to full ahead. The propeller pitch could also be operated hydraulically from within the gland space.

The compressed air signal was converted to mechanical movement at the OD boxes via a pneumatic actuator cylinder and linkage. A hydraulic cylinder was located alongside the pneumatic cylinder in the same casting which provided local hydraulic control of the pitch in an emergency, or when testing. The output from these cylinders operated a hydraulic servomotor via a linkage, giving a three point connection which acted in the same way as the hunting gear arrangement on some steering gear systems. The servomotor had an input (pilot) piston and an output piston.

A further linkage connected the servomotor cylinder output piston rod to the hydraulic telemotor via a pitch-shedding or load reduction cylinder. This linkage comprised a spherical rod-end bearing at the end of the piston rod, and two swivel hinge links, or clevis pins, on a threaded adjuster rod **(Figure 15)**.

Figure 15

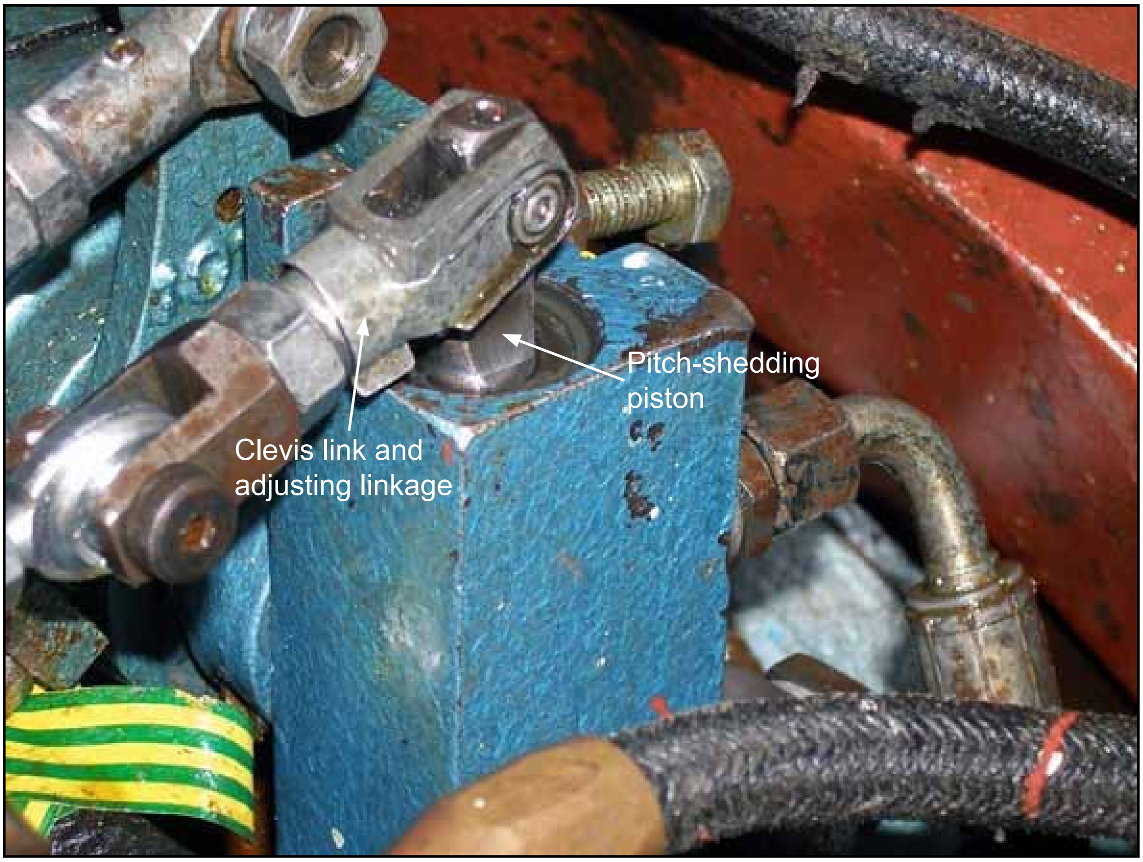


Starboard OD box

This linkage had sufficient range of movement to allow the operation of the servomotor cylinder rod and the pitch-shedding cylinder rod at the same time. The telemotor altered the hydraulic flow to the propeller hub push-pull rod and gearing which altered the blade pitch. The CPPs were operated hydraulically, with hydraulic pressure pumps producing a normal system static pressure of about 28 bar and an operating pressure of about 45 bar.

When an engine was overloaded, possibly due to operating in heavy weather, the pitch-shedding cylinder was operated by an electrical signal from a switch on the engine fuel rack via a hydraulic solenoid. The piston of the pitch-shedding cylinder rose a maximum of about 34mm and pushed back the servo cylinder rod **(Figure 16)**. This movement forced oil to the opposite side of the two-way servomotor cylinder pilot piston and reduced the servomotor piston stroke. This decreased the angular position of the telemotor, which reduced the propeller pitch and the load on the engine.

Figure 16



Starboard OD box pitch-shedding cylinder

1.6.2 Maintenance and survey

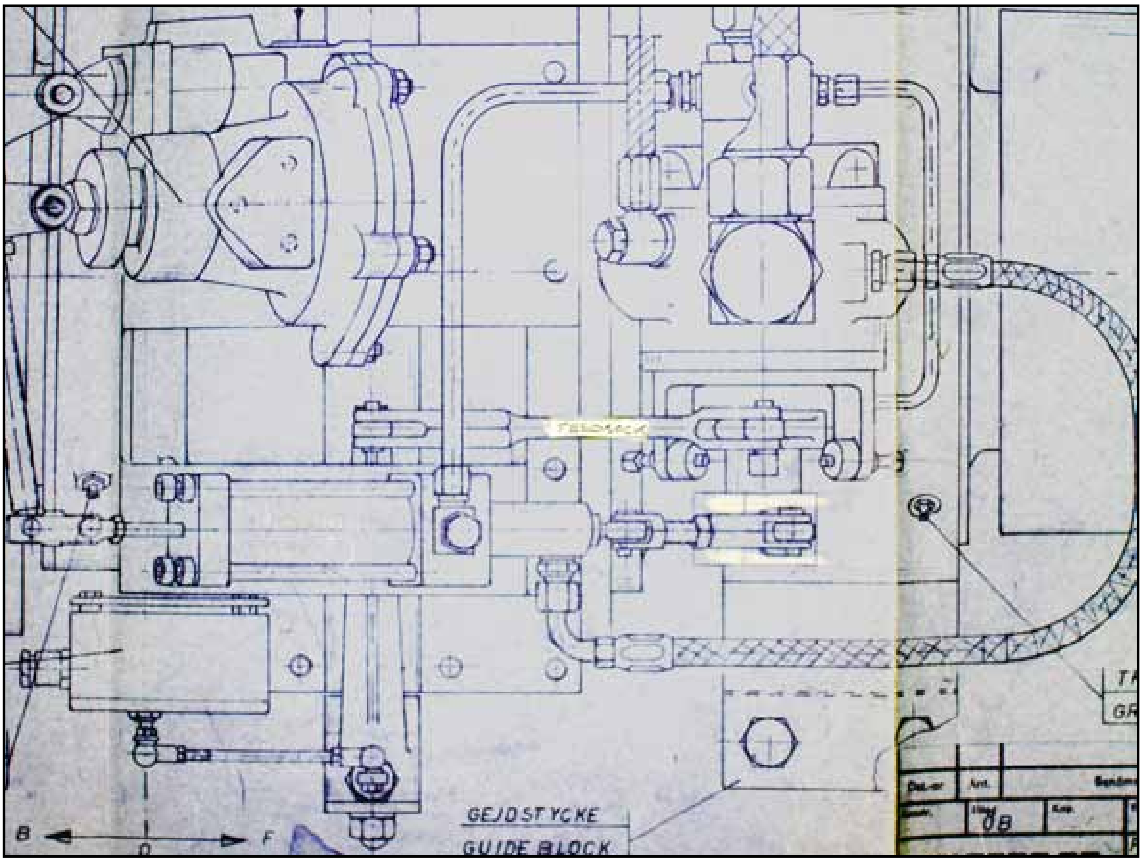
Pre-departure and daily checks of the OD boxes were conducted by the on-watch engineer and motorman, and included the cleaning of the main hydraulic system oil filter. Monthly checks included the testing of the emergency hydraulic system using the local solenoid controls, and the lubrication of grease nipples. The test of the emergency system enabled the ship's engineers to see the movement of the servomotor, the hunting gear, telemotor and the associated linkages. None of the checks conducted tested the pitch-shedding cylinder operation. Adjustment of the clevis pin linkages on the starboard OD box was required periodically to prevent the starboard engine from overloading.

Because the OD boxes were considered to be major components of the ship's propulsion system, they were the subject of 5-yearly surveys by the vessel's classification society, Lloyd's Register (LR). The last survey on the starboard propeller and associated equipment was conducted in March 2005; no observations were recorded. The next survey was planned for February 2010.

1.6.3 Onboard information

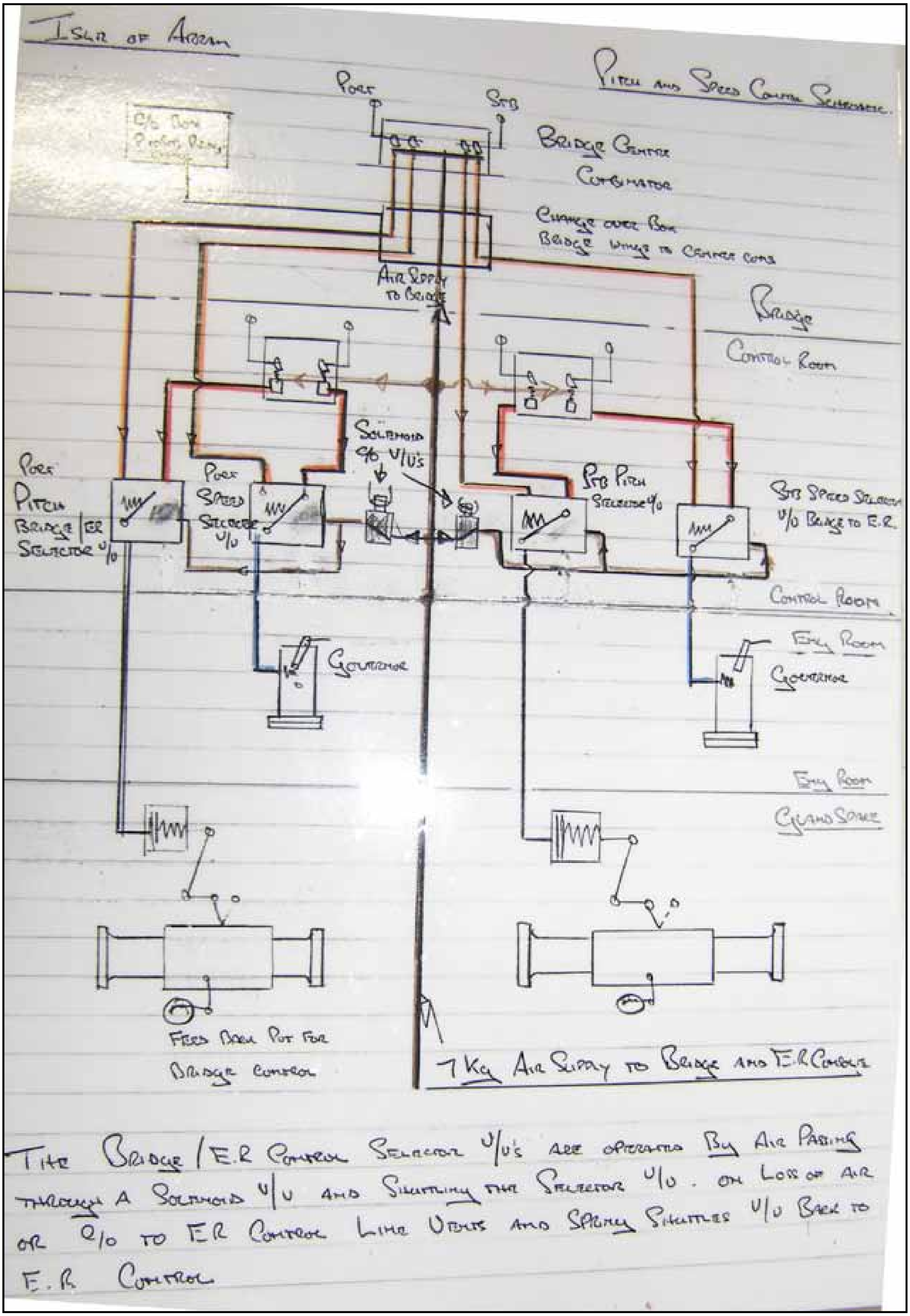
The CPP system manual held on board *Isle of Arran* was provided by Berg. It included an overview of the operation of the system and general drawings **(Figure 17)**. However, because this information lacked sufficient detail, the ship's engineers had developed their own drawings of the system and its operation **(Figure 18)**.

Figure 17



Berg manual drawing

Figure 18



Vessel engineer's CPP system drawing

1.6.4 Repair history

- In November 1998 a lube oil pipe in the port OD box burst when the vessel was manoeuvring at Kennacraig. The box was removed and overhauled by Berg and then refitted.

- In March 2007, Stone Manganese Marine, the UK service agents for Berg at the time, removed both propellers and machined various components to prevent the propeller pitch from sticking. This problem had been experienced for several years, and its cause was traced to the propeller hub. Following this work, the service agent recommended that the OD boxes be overhauled in 2008, which was 10 years after their last overhaul, although this was not a requirement of the manufacturer. This action was not taken.

- In May 2009, the servomotor cylinder pilot rod linkage on the starboard OD box was found to be loose and worn, and the complete servomotor was replaced with an onboard spare. Prior to use, the spare servomotor was found to be wrapped in bubble wrap and had been stored with other spares supplied by Stone Manganese. There were no markings on the servomotor or its packaging, and it appeared to be exactly the same as the servomotor it replaced.

  After the spare servomotor had been fitted, a minor adjustment was required with the vessel at sea to match propeller pitch with engine load. This entailed disconnecting the clevis link from the pitch-shedding rod and rotating it by half a turn to decrease the stroke of the servomotor. The adjustment resulted in only a small amount of the adjusting screw thread protruding into the clevis link space. When the ship's engineers conducted this work, no guidance on the procedure was available in the Berg manual held on board, so the ship's engineers relied on the advice given by the service technician during the repair in 2007 and from their experience of the system gained during their time on board.

- On 3 September 2009, pre-departure checks identified that the spherical rod-end bearing between the servomotor cylinder and pitch-shedding cylinder on the starboard OD box had failed. It was repaired by using the rod-end from the servomotor replaced in May 2009, which had been overhauled. Before fitting, the replacement linkage was modified by cutting 5mm off the rod-end thread to make it the same length as the failed component. The rod-end was then adjusted to the same position within the servomotor piston as the failed component.

  The ship's engineers assessed the failure to be caused by fatigue or age, and it was not considered to be a cause for concern. The component failure was recorded in the ECR logbook, the vessel's planned maintenance system (PMS) and in the master and chief engineer's end of voyage report. The chief engineer also sent an email to the ship's technical manager, which provided detail of the failure and of the corrective action taken. A defect, non-conformance or near miss report was not considered necessary as the failure had been repaired while the vessel was alongside, and there had been no danger to the vessel, crew or environment.

- In January 2010, the pitch-shedding cylinder on the starboard OD box was found to be loose. The cylinder was removed to allow its seals to be replaced. The cylinder was then refitted but no adjustments were made to the linkage. However, it was noted that the screw thread protruding into the clevis link space was longer than when the servomotor was replaced in May 2009. This increase was considered by the ship's engineers to be due to the adjustments made on 3 September 2009. No damage was observed to the pitch-shedding piston rod or the adjusting thread.

1.7 POST-ACCIDENT INVESTIGATION

1.7.1 Service agents

Harris Pye, based in Penarth, South Wales has been the authorised UK service agent for Berg CPP systems since 2009. Its investigation report of the failure of the starboard OD box **(Annex B)** highlights that an indentation on the pitch-shedding cylinder piston, where the clevis pin or link claw was attached, resulted from the adjusting screw protruding too far through the clevis link and fouling the piston rod when the pitch-shedding piston operated. This contact induced a bending force on the servomotor rod-end that caused the linkage to fail. The difference in the positions of the adjusting screws on the port and starboard systems is shown in **Figure 19**.

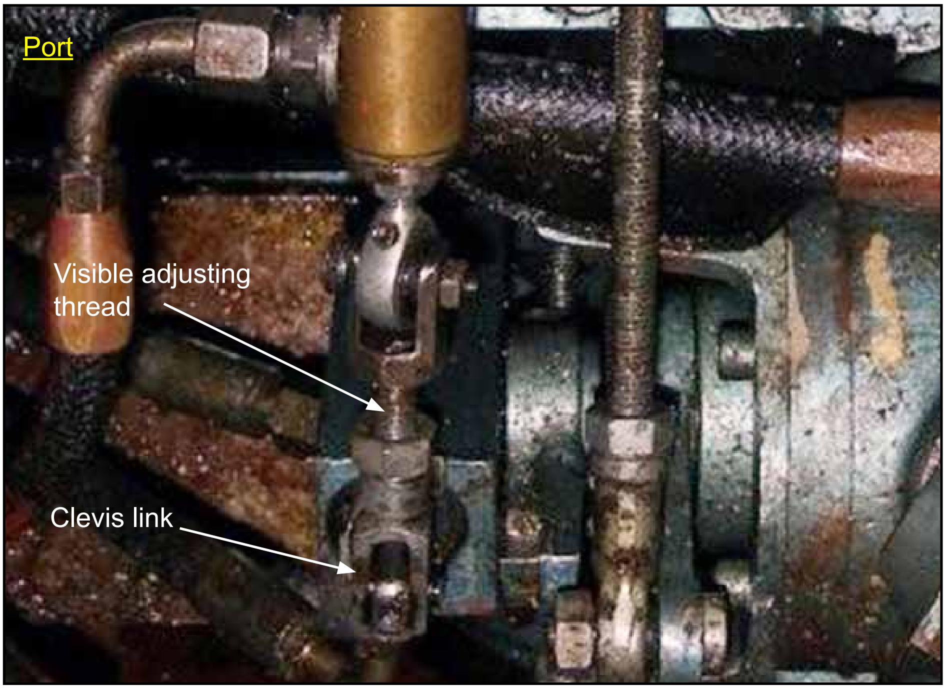
1.7.2 Metallurgical analysis

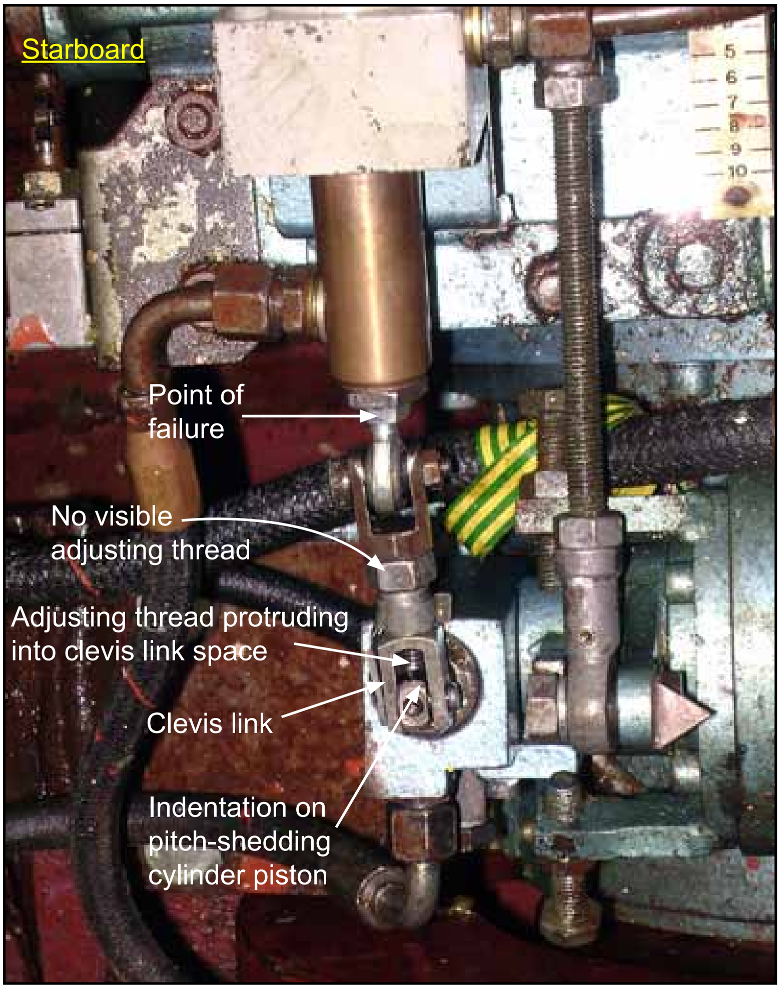
The spherical rod-end bearings which had failed in September 2009 and those which had failed on this occasion were sent for metallurgical analysis. The report **(Annex C)** concludes that the mechanism for both failures included a bending fatigue component.

1.7.3 Calmac Ferries Ltd (CFL)

Detailed examination by CFL of the servomotor fitted in May 2009 identified that its pilot valve spindle was 13mm longer than the pilot valve spindle in the servomotor it replaced. CFL also identified that following the re-commissioning of the starboard OD box after this accident by a Berg representative, the setting at which the combinator levers changed pitch rather than engine speed, was '5.5' and below, rather than '3' and below.

Figure 19





Comparison of port and starboard OD box adjustment linkages

1.8 BRIDGE AND ENGINE ROOM PERSONNEL

1.8.1 Master

The master had been employed by CFL for 12 years. He obtained a master's Certificate of Competency in 1984 and had sailed as a master for 4 years, three of which he had rotated between *Isle of Arran* and *Loch Nevis*, another CFL ferry, as relief master.

The master's work cycle comprised 2 weeks on, followed by 2 weeks off, 2 weeks on, then 4 weeks off. Due to time spent on board *Loch Nevis,* the master worked on board *Isle of Arran* for 2 weeks in every 10. He had been on the vessel since 27 January 2010, following a 4-week break. He was well rested and was not taking any medication. The master had attended a crew resource management course at South Tyneside College.

1.8.2 Chief officer

The chief officer had been employed by CFL for 15 years. He had obtained a master's Certificate of Competency in 2002 and had sailed as chief officer since 2004.

The chief officer was the vessel's safety officer. He had served on board *Isle of Arran* for 22 months and worked a 2 weeks on, 2 weeks off rota. He had also been on the vessel since 27 January 2010 and had attended a crew resource management training course at South Tyneside College.

1.8.3 Second officer

The second officer held a chief mate's Certificate of Competency and had been employed by CFL since November 2008. He had gone to the bridge prior to the vessel's arrival in Kennacraig to prepare for unloading and loading the vehicle deck. The duties of OOW and loading officer were rotated between the chief and second officers. In an emergency the second officer was designated as the communications officer.

1.8.4 Chief engineer

The chief engineer had held a chief engineer's Certificate of Competency since 2001 and he had been employed by CFL for 4 years. He had sailed on board *Isle of Arran* since October 2009 and worked a similar cycle to the master. He had been on the vessel since 3 February 2010.

1.8.5 Second engineer

The second engineer had been employed by CFL since January 2001 and had worked on board *Isle of Arran* for 5 years. He last joined the vessel on 27 January 2010.

1.9 ARRIVAL PLAN AND PROCEDURES

1.9.1 General information

CFL provides generic passage plans for the routes on which its vessels operate. The plans were reviewed by CFL in 2009. For entry to Kennacraig, the plans provided general information on the pier, VHF communications, navigational marks, navigational hazards, weather and tides, and emergency anchorages. With regard to speed within Loch Tarbert, the passage plan stated:

> *To minimise wash within the loch, speed should be reduced at Corran Point to 11 kts and maintained till berthing* [sic].

1.9.2 Arrival procedures

Port arrival and departure procedures specific to *Isle of Arran* were developed by the vessel's masters and the company's shore staff **(Annex D)**. These included:

- *Follow and complete Arrival Checklist –CL/IOA/D13 (Arrival Section)* [sic]
- *Carpenter to stand by for'd and report anchors clear and thruster vent open.* [sic]
- *Reduce pitch depending on port. (60% transiting W. Loch Tarbert between designated points)* [sic]
- *Bridge Team to be briefed on berthing plan, including any anticipated special or unusual manoeuvres and line of approach to berth.* [sic]
- *Master takes control of engines, thruster and steering on bridge wing, confirming that all dials and lights are at normal status.* [sic]
- *When command lights on centre console go off, OOW must check shaft and engine revs and clutch in lights, then report "control transferred" to Master. He shall then complete and sign the Arrival Checklist.* [sic]
- *He should then proceed to bridge wing and continue to monitor the Master.* [sic]
- *OOW to continue monitoring Master and observe for anything untoward and deal with communications.* [sic]

The chart in use included an abort line adjacent to Black Rocks **(Figure 2)** to indicate the position by which the arrival checklist **(Annex A)** was to be completed. The checklist included the requirements to transfer control of the propulsion to the bridge wing and to confirm control had been transferred.

1.9.3 Approach to Kennacraig terminal

The conduct of the approach to the linkspan at Kennacraig was left to the discretion and judgment of the vessel's master. The approach usually adopted by one of the vessel's regular masters included a speed reduction at the bar of the loch by adjusting the combinator levers to '8' ahead, followed by a further reduction by setting the levers to '6' ahead prior to crossing the abort line in the vicinity of Corran Point. This usually resulted in the vessel slowing to 12kts or below.

The combinator lever settings were next adjusted to setting '5' ahead just before the course was altered towards the pier (065˚) and again to '3' ahead during the turn. This usually resulted in the vessel's speed reducing by about 2kts in the turn and allowed sufficient time and room once steady to abort the approach if necessary.

Control of the engines and propeller pitch was transferred from the bridge console to the port wing once the turn had been completed. This was done at this point because it was difficult to gauge the vessel's rate of turn from the wing due to the short distance to the bow from the bridge.

When transferring control it was the practice of the regular master to leave the combinator levers set at '0' on the port wing console when he pressed the button to take control. Transfer was then confirmed by both the illumination of the control light and the movement of both propeller pitch indicators. A further check was conducted by then setting both combinator levers to '1' astern.

The aim of these measures, which were adapted to suit differing conditions, was to have reduced the vessel's speed to no more than 3kts when passing the pier roundhead, and to be stopped 10 metres from the linkspan. The vessel was then manoeuvred into position using the combinator levers rather than the helm to steer.

1.10 EMERGENCY PROCEDURES AND MACHINERY DRILLS

Various emergency scenarios including collision, pollution and primary equipment failure (main engine, steering gear, electrical power) had been developed. Accordingly, specific tasks and duties had been allocated to designated ship's crew in the event of these emergencies occurring. Onboard procedures did not include a requirement to warn passengers when a collision or heavy contact was imminent.

Machinery drills on board *Isle of Arran* were largely limited to the periodic operation of the emergency stops for the main engines. Although the loss of 50% propulsion was scheduled to be drilled annually, no drill was conducted in 2009.

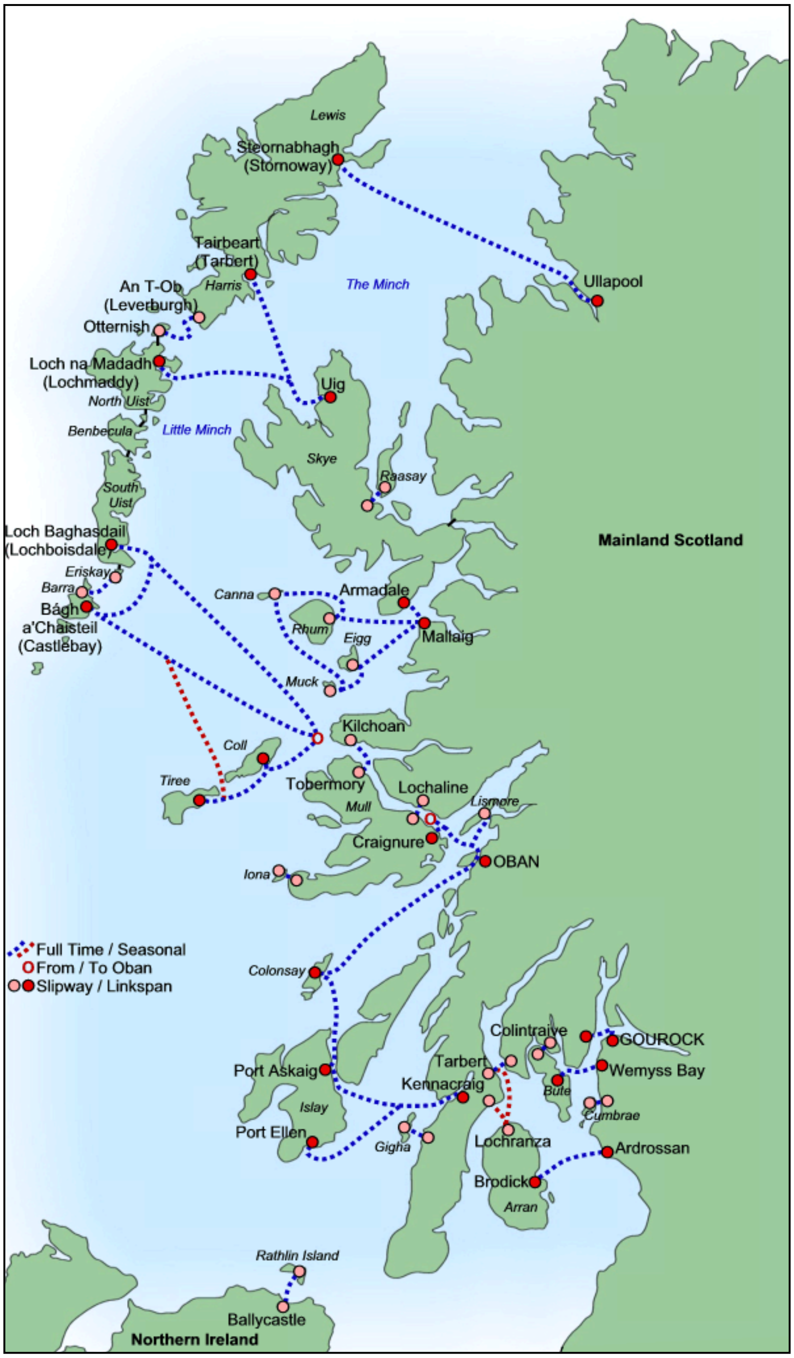
1.11 OWNERSHIP AND OPERATION

Until 2006 the majority of Clyde and Hebrides ferry services were provided by Caledonian MacBrayne Ferries Ltd, which was wholly owned by Scottish Ministers. To comply with European guidelines on state aid to maritime transport, the services provided by Caledonian MacBrayne Ferries Ltd were put out to open tender.

In recognition of the uniqueness of its fleet and in order to ensure a level playing field for all bidders, Caledonian MacBrayne Ferries Ltd was split into two companies on 1 October 2006: Caledonian Maritime Assets Ltd (CMAL) and CFL. CMAL owns all vessels and land-based assets (ports, harbours, etc) and makes them available to an operator through an open tendering process. Since 1 October 2007 CFL has provided its ferry services using CMAL-owned vessels. CFL currently operates 31 ferries of varying sizes, the majority of which are on bareboat charter until October 2013. The ferry routes which CFL operates are shown at **Figure 20**.

Image courtesy of Ships of CalMac

Figure 20



CFL ferry routes

Isle of Arran was launched in 1983 and entered service in April 1984. Under the Merchant Shipping (Passenger Ships on Domestic Voyages) Regulations 2000, *Isle of Arran* was a Class B[1] vessel. Her voyages were restricted to 10 hours or less within an area covering the north and west coasts of Scotland, the Western Isles and the Orkney Islands. She was permitted to carry a maximum number of 446 passengers and a minimum crew of 22.

1.12 SAFETY AND TECHNICAL MANAGEMENT

1.12.1 Fleet safety manager

The fleet safety manager joined CFL in September 2007. His responsibilities included: vessel audits, implementation and monitoring of corrective actions, the review of near miss reports, minutes of safety meetings, masters' reviews, and advising on shipboard safety issues.

The fleet safety manager was also the Designated Person Ashore (DPA) for the company's vessels and, with the marine and technical managers, reviewed approximately 90 near-miss reports each year. He had attended a crew resource management training course in November 2008 to assess the usefulness of the course, which was used by CFL to train its crews and marine and technical managers in the principles of human performance and non-technical skills.

The fleet safety manager met weekly with the vessels' technical managers. There was no formal agenda for these meetings but any issue considered important was discussed. The failure of the starboard OD box spherical rod-end bearing on *Isle of Arran* on 3 September 2009 was not raised during these meetings.

1.12.2 The technical manager

The vessel's technical manager, one of three within CFL, joined the company in July 2008 after more than 30 years as a seagoing marine engineer officer. In addition to *Isle of Arran,* he was responsible for the technical operation for four other vessels in the CFL fleet. Two of these vessels were also fitted with CPP systems, but only *Isle of Arran* was equipped with independent OD boxes.

On 3 September 2009 the technical manager received an e-mail from the chief engineer on board *Isle of Arran* informing him of the failure of the starboard OD box linkage. The technical manager accepted that the rectification work carried out was sufficient and that the company's defect reporting procedures had been followed correctly. Consequently, no further action in response to the failed linkage was taken.

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[1] Class 'B' means a passenger ship engaged on domestic voyages in the course of which it is at no time more than 20 miles from the line of coast, where shipwrecked persons can land, corresponding to the medium tide height.

1.12.3 Internal audit and inspection

The DPA conducted annual safety audits on each vessel. The last safety audit on board *Isle of Arran* was conducted on 16 September 2009. No non-conformities were identified during this visit.

Ship inspections were conducted twice yearly by CFL's marine and technical managers, with one of the visits coinciding with each vessel's annual dry-docking. These visits were separate from the safety audits conducted by the DPA, and afforded the managers the opportunity to inspect the material state of each vessel, and to observe the effectiveness of procedures and training.

Isle of Arran was last inspected between 14 and 15 September 2009 when the vessel was in service. As company procedures only require inspection reports to be completed following the successful completion of sea trials and the issue of certification after dry dock, no report was made of the inspection findings.

1.12.4 Major Vessel Operations Manual

The Major Vessel's Operations Manual (MVOM) was developed by CFL between 2004 and 2005. It gave both general and specific information on: the management organisational structure; on vessel operational responsibilities and system management; and on vessel routes, propulsion systems and operational checks to be conducted.

1.13 DEFECT REPORTING

1.13.1 Flowchart

A 'Defect Reporting Flowchart' **(Annex E)**, included in the MVOM, was also printed on the reverse side of CFL's defect report form. The chart was intended to ensure a pre-determined course of action was followed when dealing with defects on board. It detailed four sub-sections, labelled: *Maintenance Event, Critical Defect, Operational Defect* and *Notifiable Defect*. These were defined as:

> *A **Critical Defect** is the failure in the operation of a part of the ship's structure or its machinery, equipment or fittings that could adversely and directly affect the safety of personnel, vessel or impact on the environment and requires the Ship Management team to be advised by the quickest means possible.*
>
> *An **Operational Defect** is the failure in the operation of a part of the ship's structure or its machinery, equipment or fittings that does not affect the safety of personnel, vessel or impact on the environment which the pooled resources of the onboard Management Team are unable to repair with the facilities at their disposal. Items which can be repaired by the onboard Management Team are considered to be a **maintenance event** and should be recorded in the appropriate planned maintenance record as an unplanned event.*

*A **Notifiable Defect** is the failure in the operation of a part of the ship's structure or its machinery, equipment or fittings that does not affect the safety of personnel, vessel or impact on the environment that has been dealt with by the onboard Management Team but is the subject of the following:-*

- *Vessel casualty report that requires Further Corrective Action. Further Corrective Action shall be detailed on a Defect Report….*

No instructions or guidance was provided on how to use the flowchart. There was a common understanding among the vessel's officers and shore management that the chart should only be entered at its top-left corner.

1.13.2 Responsibilities

Individual responsibilities for defect reporting were laid down in the MVOM and included:

*The relevant **Technical Manager** shall be responsible for:-*

- *Ensuring the requirements of the reporting of defects are complied with;*
- *Ensuring the root cause of a defect is established as appropriate;*
- *Evaluating the effectiveness of corrective action;*
- *Disseminating relevant information to other vessels, managers and departments, as appropriate;*

*The **Chief Engineer and Chief Officer as appropriate** are responsible for:-*

- *Assessing the effectiveness of repairs;*
- *Establishing the category of the defect, …*
- *Ensuring a Defect Report (…) is raised as required;*
- *Identifying the root cause, if possible;*

1.14 INTERNATIONAL SAFETY MANAGEMENT (ISM CODE) AND CLASSIFICATION SOCIETY REQUIREMENTS

1.14.1 ISM Code

Section 10.3 of the ISM Code states:

The Company should identify equipment and technical systems the sudden operational failure of which may result in hazardous situations. The safety management system should provide for specific measures aimed at promoting the reliability of such equipment or systems. These measures should include the regular testing of stand-by arrangements and equipment or technical systems that are not in continuous use.

To meet this requirement, CFL had referred to the primary systems and equipment on board its vessels in its MVOM. With regard to *Isle of Arran* this included:

> *The main engines and reduction gearboxes and variable pitch propellers have been identified as machinery, which by their failure, would place the vessel in a hazardous situation.*
>
> *The maintenance system in place onboard the vessel shall ensure the reliability of the systems.*

1.14.2 Classification Society

LR Rules state:

> *Any damage, defect, breakdown grounding, serious deficiency, detention or arrest which could invalidate the conditions for which a class has been assigned, is to be reported to LR without delay.*
>
> *All repairs to hull, equipment and machinery which may be required in order that a ship may retain her class…., are to be carried out to the satisfaction of the Surveyors. When repairs are effected at a port, terminal or location where the services of a Surveyor to LR are not available, the repairs are to be surveyed by one of the Surveyors at the earliest opportunity thereafter.*

1.15 PREVIOUS ACCIDENTS

1.15.1 Accidents involving CFL vessels

On 29 December 2004, *Isle of Mull* struck *Lord of the Isles*, another Caledonian MacBrayne ferry, while manoeuvring in Oban harbour. The safety issues identified in the subsequent MAIB investigation report[2], included:

- The monitoring of the master's actions and decisions by the OOW were not effective.
- Insufficient checks were carried out to ensure propulsion control had been transferred to the bridge wing.
- It was not possible to make any safety announcement when contact with the pier was inevitable, and it was fortunate that there were no passengers on board at the time of the accident.
- Routine and over-familiarity possibly contributed to a decline in the standard of bridge procedures and awareness of potential emergencies.
- Internal audits of navigational practice had not highlighted any particular concerns about harbour arrival routines.

[2] Report on the investigation of the contact between ***Isle of Mull*** and ***Lord of the Isles*** and subsequent contact with Oban Railway Pier Oban Bay 29 December 2004; Report No 13/2005 (http://www.maib.gov.uk/publications/investigation_reports/2005/isle_of_mull.cfm)

The report also noted the following actions taken by CFL:

- *All Caledonian MacBrayne vessels have reviewed their arrival and departure routines, and updated instructions and checklists where required. Passage plans are being updated to include a specified point by which the arrival checklist is to be completed, or the approach aborted. Mooring teams now also have to report to the bridge that they are in position.*

- *The technical director has instructed all officers (irrespective of discipline) of the need to ensure, not assume, that the master was informed when any operation is undertaken that will affect the operation of the vessel.*

- *The internal audit practice in respect of navigation has been revised by Caledonian MacBrayne in light of this accident. The marine managers have been instructed to look closely at passage planning and navigation practices during ship visits.*

- *Emergency collision drills are being reviewed and revised to ensure a safety announcement is made to crew and passengers.*

On 30 March 2009, *Isle of Arran* grounded on a reef while departing Oban and suffered considerable damage. Action taken by CFL included the issue of a safety alert to its fleet **(Annex F)**.

1.15.2 Similar accidents occurring to other ro-ro passenger vessels

On 27 April 2000, the cross-Channel ro-ro passenger ferry *P&OSL Aquitaine* struck No 7 berth in Calais at 7kts after a loss of control to her port CPP. 180 passengers and 29 crew were injured, including 5 with bone fractures and several who were rendered unconscious.

Recommendations to the vessel managers resulting from the MAIB investigation[3] included:

- *Review its fleet regulations to ensure that the CPP bridge control systems are operating satisfactorily before leaving and entering port.*

- *Circulate throughout the fleet a reminder of the importance of fleet regulations being followed with regard to monitoring correct pitch orders.*

- *Consider what appropriate announcement may be made to the passengers before the vessel enters a port so that, in the event of an accident, the majority of passengers will still be seated. Hopefully, the number of those injured and the extent of their injuries can be minimised if this is achieved.*

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[3] 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_aquataine.cfm)

On 10 March 2006, the ro-ro passenger-vehicle ferry *Red Falcon* made heavy contact with the linkspan in Southampton. The two propulsion units had been de-synchronised due to a problem with one main engine, and had not been re-synchronised prior to arrival at the berth. Consequently, one engine was still thrusting ahead. Eleven people were injured. A previous similar accident had occurred to the vessel in 1994.

One of the safety issues highlighted in the MAIB investigation report[4] was speed of approach. Following the accident, the Southampton harbourmaster re-introduced a requirement for the *Red Falcon* and her sister vessels to observe a 6 knot speed limit when approaching the linkspan.

[4] Report on the investigation of *Red Falcon*'s contact with the linkspan at Town Quay, Southampton 10 March 2006; Report No 26/2006.
(http://www.maib.gov.uk/publications/investigation_reports/2006/red_falcon.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 OD BOX FAILURE

It is evident from the metallurgical analysis of the failed components, together with the service agent's inspection report, that the failures of the output piston rod-end of the starboard OD box in September 2009 and on 6 February 2010 were caused by an unintended bending moment. It is also evident that the bending moment was induced by the incorrect adjustment of the clevis linkage on the servomotor's output piston rod-end, causing the clevis link adjusting thread to foul on the pitch-shedding piston rod.

The failure on 6 February could have occurred at any time during the passage from Port Askaig to Kennacraig. The combinator levers were set on full ahead for most of the voyage, and full or near full ahead pitch would have remained on the starboard propeller when the OD box failed. The failure would only have been apparent when the combinator lever was set to below '3' which occurred after the master had moved to the bridge wing.

2.3 SERVOMOTOR REPLACEMENT AND ADJUSTMENT

2.3.1 May 2009

The pilot valve spindle in the servomotor fitted in May 2009 was 13mm longer than the corresponding spindle in the original component. The consequence of the longer pilot valve was significant as it would have displaced the start and end point of the output piston, thereby increasing the pitch on the starboard propeller. In turn, this would have increased the likelihood of the starboard engine becoming overloaded.

To reduce the frequency of this occurring, the ship's engineers would have had to adjust the clevis linkage on the rod-end of the servomotor output piston, thereby reducing the gap between the end of the adjusting screw and the top of the pitch-shedding piston rod. Consequently, on the occasions when the pitch-shedding piston operated, such as when the vessel was in rough seas, the two moving components would have been forced against each other.

Following the installation of the servomotor in May 2009, it is unclear exactly when, or how often, the clevis linkage was altered. Although only a small amount of the screw thread was initially protruding into the clevis link space, by September 2009 the adjustments made had resulted in a sufficient length of screw thread within the clevis linkage to cause a failure.

2.3.2 September 2009

When the spherical rod-end from the servomotor was replaced in September 2009, the screw thread at the end of the output piston rod was cut to the same size as the failed component and the clevis linkage was adjusted to its previous setting. Consequently, the gap between the end of the adjusting screw and the top of the pitch-shedding piston rod within the clevis link space would have been the same as at the time of the failure. In the absence of any adjustment to increase this gap, which was unlikely given that this would have increased the loading on the engine, it was inevitable that the two components would again come into contact during the intermittent operation of the pitch-shedding piston. Therefore, it was only a matter of time before the failure of the starboard OD box was repeated.

2.4 REPAIR PROCEDURE

The conditions that led to the failures of the starboard OD box in September 2009, and before the vessel hit the linkspan at Kennacraig, originated in the replacement of the servomotor earlier in the year. Several factors were contributory:

First, although neither the replacement servomotor nor its packaging was marked, it appeared to be identical to the original component. The differing lengths of the pilot valve spindles could only have been identified by measuring the length of their stroke or by dismantling both servomotors and comparing the spindle lengths. Also, when the replacement servomotor was fitted, no comparison appears to have been made with the corresponding linkage on the port OD box.

Second, the contact between the adjusting screw and the pitch-shedding piston rod was not identified following repair or adjustment because the full range of the propeller pitch was not tested in conjunction with the operation of the pitch-shedding piston cylinder. This test was feasible as the operation of the pitch-shedding cylinder could have been controlled from a switch on the engine fuel rack.

Third, adjustment of the clevis linkage would have altered the movement of the propeller pitch in relation to the position of the combinator lever. This was evident by the difference following the re-commissioning of the starboard OD box following this accident when the propeller pitch operated between settings ‘0’ and ‘5.5’ on the combinator lever compared to the settings of ‘0’ and ‘3’ prior to the accident. Therefore, it is almost certain that the adjustments made following the replacement of the servomotor in May 2009, would also have changed the settings required. However, the vessel’s crew did not recognise the significance of this change.

Finally, the information provided in the Berg manual held on board did not provide sufficient detail or guidance to assist the ship's engineers replace the servomotor or to adjust the clevis linkage correctly. Consequently, although the engineers had previously sought guidance from visiting service agents and had produced their own drawings, they were unaware of the potential dangers resulting from the incorrect adjustment of the clevis linkage.

It is evident that although the vessel's propulsion system had been identified as a 'primary system' within the CFL's MVOM in accordance with the requirements of the ISM Code, the significance of the OD boxes as key components of the propulsion system had not been recognised. Consequently, no additional specific measures were in place to ensure that the provision of spare parts, the maintenance regime adopted, and the technical information available was commensurate with the importance of the OD boxes to the vessel's operation and safety.

2.5 DEFECT RESPONSE

Following the failure of the starboard OD box during pre-departure checks in September 2009, the fractured linkage was assessed by the ship's engineers to have been caused by metal fatigue, and the failed component was replaced. This 'can do' and practical approach to defect rectification is commonplace among ships' engineers, and enables vessels to remain operational even when spare parts or detailed guidance are not available. Therefore, the attempted repair of the starboard OD box was not unreasonable.

However, as the failure of the clevis linkage had resulted in the temporary loss of the starboard propulsion system, it was clearly a 'critical defect' as defined in the MVOM (paragraph 1.13.1). This was partially recognised by the chief engineer, who did not initiate a defect report but did inform the ship's technical manager of the problem. The technical manager accepted the chief engineer's repair and took no further action. This was an opportunity missed. Metallurgical tests on the failed component, together with advice from Berg or its service agents, would have quickly highlighted the nature of the failure and allowed action to be taken in time to prevent its recurrence.

The purpose of the flowchart at **Annex E** was to assist ship's engineers in their decision-making and to ensure consistency in defect reporting. However, no guidance on its use was provided, and by entering the chart at its top left hand corner in accordance with normal practice, the sub sections within the chart, including *'critical defects*' were ignored. Consequently, as the repair of the starboard OD box did not require external assistance, it was treated only as a '*maintenance event'* and a defect report was not raised. It is possible that a defect report would have highlighted the adjustments required over the previous 4 months, and that the overhaul of the OD box was overdue. In turn, this might have prompted a more robust investigation by the technical manager.

Although there is some uncertainty within the shipping industry regarding which defects and repairs must be reported to classification societies, in view of the importance of the OD boxes and the non-routine nature of the repair required, a report to the classification society was probably warranted on this occasion. It is possible that the subsequent scrutiny of the repair by an independent surveyor would have at least identified the lack of technical information available and the need for further investigation, if not the unsafe condition within the clevis linkage.

2.6 BRIDGE PROCEDURES

2.6.1 Reaction time

The master realised that he did not have control of starboard propeller pitch at the port wing console when *Isle of Arran* was about 250m from the pier. At a speed of 10kts, this meant that the master and the rest of the bridge team had less than 1 minute to take remedial or avoiding action. This was an unnecessarily short time frame, which could have been lengthened by several precautions.

2.6.2 Transfer of pitch control

Given the short distance of the bow from the bridge and the resulting difficulty in assessing the vessel's rate of turn, the practice of the masters to move to the port wing on completion of the final turn towards the berth (paragraph 1.9.3) was understandable. A consequence of this action was that the requirement of the arrival checklist (Annex A) to transfer the control of the propeller pitch to the port wing before the vessel passed Black Rocks (Figure 2) was not met on this occasion. Indeed, this requirement is unlikely to have been completed until the vessel was heading towards the berth on the majority of occasions the vessel arrived in Kennacraig.

However, there was no reason why the control of the pitch could not have been transferred to, and tested from the port wing console before the vessel reached Black Rocks, and then transferred back to the centre console. Although this action would not have guaranteed a smooth transfer of control to the port wing console following the final turn, it would have provided assurance that the port wing console was working correctly immediately before it was required for use. As the starboard OD box failed during the passage, such a check would have identified the loss of control of the starboard propeller pitch before the approach to the linkspan was commenced. Consequently, more time and safe water would have been available to allow the entry to be aborted.

2.6.3 Monitoring of the pitch indicators

The pitch indicators were listed as primary equipment and had therefore been identified as necessary for the safe operation of the vessel, but they were not monitored by the master or the bridge team when transferring control or when manoeuvring. It is highly likely that this was partly due to the very coarse nature of the information provided by these indicators. In this case, even though any change in pitch would not have been indicated until the starboard combinator lever setting was reduced to below ‘3’, the lack of movement on the starboard pitch indicator when the master set the combinator levers to ‘1.5’ ahead during the approach to the berth would have immediately alerted him. Instead, the master only became aware of the loss of control when he realised that the vessel was not slowing as expected. By then, valuable time had been lost.

2.6.4 Speed of approach

A vessel’s speed of approach to a berth is generally determined by several factors including weather conditions, tidal conditions, the manoeuvrability of the vessel, the proximity of other vessels, and the safe water available. In this case, given the 10 knot wind at the linkspan, the negligible tidal stream, the perpendicular approach required, and the fact that *Isle of Arran* was on schedule, her speed of about 12kts as she steadied on her approach course was unnecessarily fast. A more conservative approach, following the procedure usually adopted by one of the vessel’s regular masters (paragraph 1.9.3), would not only have identified the loss of control of the starboard propeller pitch as soon as the vessel had steadied on course, it would also have allowed more time for corrective action to be taken.

Although the master used maximum astern power on both combinator levers, let go the starboard anchor and eventually ordered the starboard engine to be stopped, these actions were ineffective in preventing contact because of the relatively fast speed of the vessel so close to the pier. Furthermore, as the pitch on the starboard propeller had failed at its maximum ahead, the use of full astern on its combinator lever would only have increased the engine speed. Therefore, the starboard propeller was at full ahead and, as the port propeller was at full astern, it was not surprising that the vessel’s bow sheared to port and made contact with the pier, and that the vessel’s headway was not significantly reduced.

2.7 EMERGENCY RESPONSE

As soon as the master realised that the starboard propeller pitch was not responding, he immediately relayed the problem to the chief officer, who quickly confirmed that pitch control had been transferred to the port wing. To try and resolve the situation, control of the propulsion was transferred between the port wing and centre consoles and the second officer informed the chief engineer in the ECR.

However, the message to the chief engineer that the starboard engine was not responding was inaccurate and misleading, and resulted in the chief and second engineers focusing on the starboard engine rather than the starboard propeller pitch. Again valuable time was lost as scrutiny of the pitch control air pressure gauge (“From Bridge Control”) and the propeller pitch indicator would have quickly highlighted that the loss of control was due to a mechanical failure.

Communication between the master, chief officer, second officer and the ship's engineers was timely. However, the failure of the master to tell the chief officer which propeller pitch he was unable to control, the inaccurate information passed to the ECR, the lack of a warning announcement to the passengers, and the use of full astern on the starboard combinator lever indicates that the bridge team were not adequately prepared to cope with a mechanical failure of this nature.

This was possibly due to the restricted nature and frequency of the machinery failure drills conducted on board and the limitations of the indicators provided. It is also of note that, although various emergency scenarios had been considered on board, these did not include the vessel making heavy contact with a linkspan or berth, despite her regular and routine exposure to this risk.

2.8 SAFETY CULTURE

CFL operates many ferries over many challenging routes, making its operation unique within UK waters. Nevertheless, in common with all other ferry operators, it faces the difficult challenge of ensuring that its crews not only comply with company and vessel procedures, but also carefully consider each and every entry and departure on its own merit.

Complacency is a natural human behaviour in response to repeated exposure to situations in which no adverse consequences are experienced. This inevitably results in people feeling comfortable, and induces an attitude of 'it won't happen to me'. In turn, this leads to shortcuts and risks being taken and procedures being ignored. As ferries inevitably operate regularly and routinely between the same ports, their crews are particularly susceptible to this type of behaviour.

In this case, possible consequences of complacency were the failure to: test the pitch control from the port wing, monitor the pitch indicators and investigate the failure of the OD box in September 2009. There was also a lack of awareness of potential emergencies and the speed of the vessel's approach to the berth. Similar issues were identified following the contact involving *Isle of Mull* in 2004 (paragraph 1.15.1) and, although CFL subsequently introduced measures to prevent their recurrence, it is evident that further action is required.

The development and promulgation of written procedures and checklists plays an important role in helping to ensure that best practice is followed and that important precautions are not overlooked. However, it is essential that procedures and checklists are fully supported by masters and do not dampen a master's initiative to assess and react to the differing risks and challenges encountered. Likewise, crew training in resource management improves communication and teamwork, but the benefits of this training in emergency situations must be maintained through realistic drills. Other measures such as ship visits and audits, crew selection and rotation, masters' reviews, and senior officer seminars also have a role to play.

Combating complacency is a significant managerial challenge for all ferry owners and operators, for which there is no simple solution. Therefore, it would probably be beneficial to passenger safety for ferry owners and operators to share their experiences and understanding of complacency, as well as measures which have been found to be successful in preventing its occurrence.

SECTION 3 - CONCLUSIONS

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

1. It is possible that the failure to test the pitch control from the port wing, monitor the pitch indicators, investigate the failure of the OD box in September 2009, the lack of awareness of potential emergencies, and the speed of the vessel's approach to the berth resulted from complacency. [2.8]

2. Combating complacency is a significant managerial challenge for all ferry owners and operators, for which there is no simple solution. [2.8]

3.2 SAFETY ISSUES IDENTIFIED DURING THE INVESTIGATION WHICH HAVE NOT RESULTED IN RECOMMENDATIONS BUT HAVE BEEN ADDRESSED

1. In May 2009, the ship's engineers did not notice that there was a difference between the original and replacement servomotors. The pilot valve spindle in the replacement servomotor was 13mm longer than the corresponding spindle in the original component and increased the likelihood of the starboard engine becoming overloaded. [2.3.1, 2.4]

2. The technical information held on board did not provide sufficient detail or guidance to assist the ship's engineers replace the servomotor or to adjust the clevis linkage correctly, and no comparison appears to have been made with the corresponding linkage in the port OD box. [2.4]

3. Contact between the adjusting screw and the pitch-shedding piston rod was not identified following repair or adjustment because the full range of the propeller pitch was not tested in conjunction with the operation of the pitch-shedding piston cylinder. [2.4]

4. The failure of the starboard OD box in September 2009 was not fully investigated. Following repair, the clevis linkage was again adjusted to a position in which the adjustment screw and the pitch-shedding piston rod came into contact when the starboard engine became overloaded. It was only a matter of time before the failure was repeated. [2.3.2, 2.5]

5. No guidance was provided regarding the use of the vessel's defect reporting flowchart. Consequently, a defect report was probably not raised in September 2009 because the repair of the OD was treated as a *'maintenance event'* rather than a '*critical defect'*. [2.5]

6. The bridge team had an unnecessarily short timeframe following discovery that the starboard CPP was not responding to demands in which to take action to avoid hitting the pier and the linkspan. [2.6.1]

7. The control of the pitch was not tested from the port wing console before the vessel started her final approach to the linkspan. [2.6.2]

8. The pitch indicators would have provided an immediate indication of the OD box failure as soon as the combinator was set to ‘1.5’. However, they were not monitored by the master or the bridge team when transferring control or when manoeuvring. [2.6.3]

9. In the prevailing conditions, the vessel’s initial approach speed was unnecessarily fast. [2.6.4]

10. The failure of the master to tell the chief officer which propeller pitch he was unable to control, the inaccurate information passed to the ECR and the lack of a warning announcement to the passengers indicates that the bridge team were not adequately prepared to cope with a mechanical failure of this nature. [2.7]

SECTION 4 - ACTIONS TAKEN

4.1 ACTION TAKEN BY CALMAC FERRIES LTD

CFL has:

- Conducted a technical investigation into the failure of the starboard OD box.
- Issued a technical bulletin to its vessels advising that spare parts should be checked prior to fitting to ensure that the part is fit for purpose and that the source of spare parts (ie supplier) is recorded.
- Reviewed:
  - Section 1 of its MVOM with regard to the reporting of defects.
  - The arrival/departure checklists on board its vessels
  - The vessel's passage plan with regard to the appropriateness of the established abort positions.
  - The frequency and scenarios for the vessel's emergency drills.
- Undertaken:
  - To review the effectiveness of crew resource management (CRM) training and to arrange for an independent party to monitor its effectiveness through ship visits.
  - To convene meetings with masters and chief engineers to discuss the lessons learned from recent accidents and to canvass for suggestions to prevent similar accidents occurring in the future.
  - To review its internal investigation report and issue a bulletin to its masters and officers highlighting the lessons learned and actions required to be taken to prevent a similar accident on other vessels.
- Started a comprehensive review of its safety management under the direction of the managing director to ensure that it reflects industry best practice.

SECTION 5 - RECOMMENDATIONS

The **UK Chamber of Shipping** is recommended to:

2010/131 Encourage and facilitate the regular sharing of experiences and initiatives between its UK ferry membership, with particular emphasis placed on the prevention of complacency during routine and repetitive operations.

October 2010
Marine Accident Investigation Branch

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