ACCIDENT REPORT

Report on the investigation of the

failure of the controllable pitch propeller of the cargo ship

Saffier

resulting in heavy contact with a berthed tug

in Immingham harbour

25 June 2011

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

LESS SERIOUS MARINE CASUALTY REPORT NO 9/2012 May 2012

Extract from

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2005 – Regulation 5:

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

NOTE

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

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ACM-E	-	Alphacomm monitoring - engine
ACM-GP	-	Alphacomm monitoring - gear and propeller
ACS	-	Alphacomm safety
AHD	-	Ahead
ASP12	-	Propeller pitch closed loop control unit
AST	-	Astern
AT2000 PCS	-	Alphatronic 2000 propulsion control system
BV	-	Bureau Veritas
CPP	-	Controllable pitch propeller
DP	-	Dynamic positioning
Hz	-	hertz
IACS	-	International Association of Classification Societies
kts	-	knots
kW	-	kilowatt
mA	-	milliampere
MAN	-	MAN Diesel & Turbo SE
PCS	-	Propulsion control system
PES	-	Programmable electronic systems
PSV	-	Platform supply vessel
rpm	-	Revolutions per minute
SMS	-	Safety management system
STCW	-	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
UR	-	Unified requirement

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

Saffier

SYNOPSIS

On 25 June 2011, the general cargo vessel *Saffier* made contact with the tug *Svitzer Ferriby*, which was berthed at quay 5 and was unmanned, when control of its controllable pitch propeller (CPP) system was lost while berthing in the port of Immingham. *Saffier's* stern was breached above the waterline at the starboard quarter, and the tug suffered minor damage.

Saffier's history of defects with its propulsion plant began after she suffered a serious engine room fire in January 2011. Although a significant number of the electronic components in the CPP control system were replaced during re-commissioning of the system, insufficient attention was paid to the adjustment and calibration of the controls for astern pitch. This resulted in large discrepancies between astern pitch demand and response. During the subsequent sea trial the full range of astern movements was not tested and the mismatch went undetected.

Almost immediately after the vessel recommenced trading, problems with the control of astern pitch began to occur. An investigation into the problems was conducted by the CPP system's manufacturer and timed pitch response tests carried out by the crew should have confirmed that there was a problem with astern pitch control. However, the manufacturer's investigation was not sufficiently detailed to allow the correct conclusions to be drawn. The crew were unable to reproduce the problem when service engineers visited the vessel and, without an obvious defect to repair, no checks were made on the CPP system that tested the astern pitch control response.

While berthing at Immingham the master ordered 'half astern', however the CPP pitch went to 'full astern'. The master's lack of familiarity with the pitch control system and his subsequent attempts to regain control of the pitch increased *Saffier*'s sternway and made the situation worse. The backup pitch control button did not stand out as an emergency control and, because the master was unfamiliar with its operation, the backup mode was not used. Subsequently, on the advice of the pilot, the master activated the engine emergency stop and ordered the anchor party forward to drop both anchors. Dropping one anchor was delayed by nearly 2 minutes, and the vessel made heavy contact with the tug *Svitzer Ferriby*.

Saffier's owner has been recommended to ensure that crew verify that they have full control of the CPP before the vessel sails from port or enters confined waters. The owner has also been recommended to improve the vessel's safety management procedures, to improve crew training and to conduct drills to prepare crew for responding to engine control system failures. The CPP system's manufacturer, MAN Diesel & Turbo SE, has taken actions to improve the quality of checks carried out when commissioning CPP control systems. A recommendation has been made to Bureau Veritas, *Saffier*'s classification society, to make a submission to the International Association of Classification Societies (IACS) for the control of CPP systems to be verified throughout the whole range of ahead and astern movements during commissioning and sea trials.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *SAFFIER* AND ACCIDENT

SHIP PARTICULARS

Vessel's Name	*Saffier*
Flag	The Netherlands
Classification society	Bureau Veritas
IMO number	9357511
Type	General cargo ship
Registered owner	De Bock Maritiem B.V.
Manager(s)	De Bock Maritiem B.V.
Construction	Steel
Length overall	99.99m
Registered length	95.00m
Gross Tonnage	3970
Minimum safe manning	6
Authorised cargo	Dry cargo

VOYAGE PARTICULARS

Port of departure	Riga, Latvia
Port of arrival	Immingham, UK
Type of voyage	Short international
Cargo information	5000 metric tonnes of Urea (fertiliser)
Manning	7

MARINE CASUALTY INFORMATION

Date and time	25 June 2011, 0735 UTC
Type of marine casualty or incident	Less Serious Marine Casualty
Location of incident	Immingham harbour
Place on board	Starboard quarter
Injuries/fatalities	Nil
Damage/environmental impact	Breach above water line; minor damage to tug *Svitzer Ferriby*
Ship operation	Manoeuvring to berth
Voyage segment	Arrival
External & internal environment	Light airs, no rain, daylight
Persons on board	7

1.2 BACKGROUND

Saffier's main propulsion system consisted of a medium speed diesel engine driving a CPP. The main engine also drove a shaft alternator which was required to run at constant speed.

On 28 January 2011, the vessel suffered a major engine room fire, caused by fuel from a ruptured pipe spraying onto the turbocharger. During the fire many of the cables and electronic components in the propulsion control system were damaged. Extensive repairs were carried out and sea trials were conducted on 24 and 25 March. *Saffier* returned to regular service on 26 March 2011. Within a few days, the vessel's crew reported problems when applying astern pitch to the CPP. Although the equipment manufacturer's service engineers attended the vessel, they were unable to diagnose the fault as the crew could not reproduce the problem.

1.3 NARRATIVE

On 21 June 2011, *Saffier* sailed from Riga, Latvia to Immingham, UK. Prior to departure, small movements of the CPP were made ahead and astern to test the system. As the normal practice was to test the pitch with the main engine running at normal speed, the pitch applied was slight and brief to avoid putting excessive tension on the mooring lines.

At 0532 on 25 June the Immingham pilot boarded for *Saffier*'s entry into port. Although required by the vessel's safety management system (SMS), pre-arrival engine tests were not carried out and the chief officer, who was on watch, told the pilot that there were no known defects with the ship. The chief engineer entered the engine room shortly after 0600 and the master arrived on the bridge at 0638.

At mooring stations, the chief officer and an ordinary seaman manned the forecastle and an able bodied seaman was stationed aft. The crew on the forecastle prepared the anchors for letting go; they disengaged the clutch between the windlass motor and drum on both the anchor windlasses, but did not lift the cable stopper[1] bars.

At 0726, prior to *Saffier* entering the harbour lock gate, the master took the conn of the vessel from the pilot, and by 0832 he started the final approaches to berth starboard side alongside at quay 3 **(Figure 1)**. The master of the tug *Valiant,* which was secured at the far end of quay 2, offered his tug to assist in berthing, but *Saffier*'s master declined. A forward spring line was secured on the quay and the vessel approached the berth at an angle of approximately 45º with a speed of 0.7 knot.

On the forecastle, the chief officer relayed the closing distances between *Saffier*'s bow and *Valiant* at frequent intervals. At 0832:39, when the closest point of approach was less than 10m, the master moved the bridge lever for propeller pitch control to 'half astern'. Within a few seconds, noticing that the forward motion had not been fully arrested, he put the lever to 'full astern'. As the vessel picked up speed astern, he pulled the bridge lever back to a very slight pitch astern. The pitch indicator continued to display 100% astern and did not appear to respond to the pitch reduction command.

[1] Also known as 'guillotine bars'

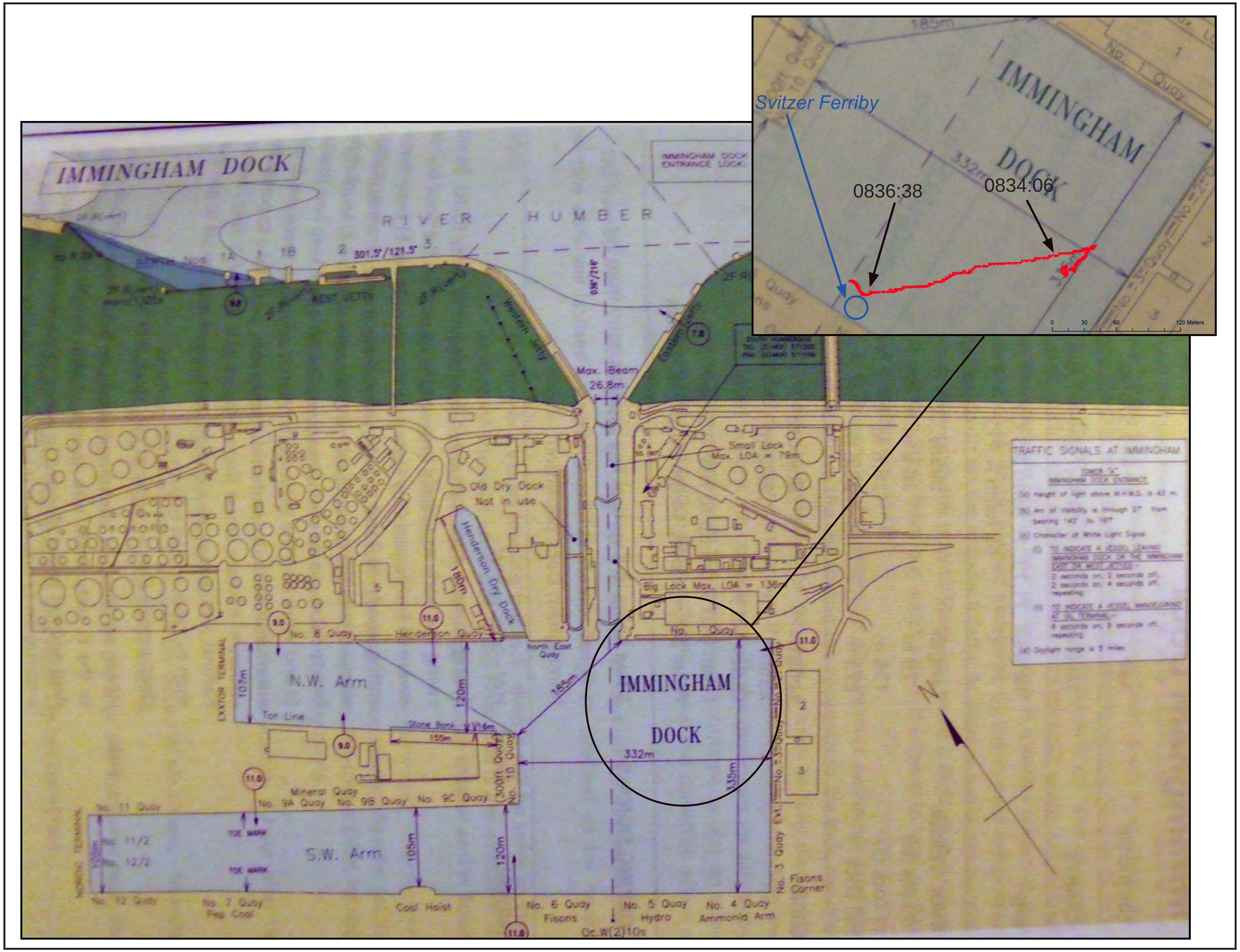

Figure 1: Immingham harbour (Inset: movement of *Saffier* during the incident)

Time	Demand [%]	Response [%]	Speed (knots)
0832:18	61 AHD	65 AHD	0.3 AHD
0832:39	49 AST	77 AST	0.7 AHD
0832:43	64 AST	104 AST	0.7 AHD
0832:57	97 AST	154 AST	0.3 AHD
0833:25	6 AST	80 AST	1.2 AST
0833:28	36 AST	57AST	1.3 AST
0833:37	72 AST	124 AST	1.6 AST
0833:41	113 AST	142 AST	1.7 AST
0833:47	50 AST	148 AST	2.0 AST
0833:54	132 AST	156 AST	2.2 AST
0834:06	118 AST	157 AST	2.6 AST

Table 1:CPP demand and response with the corresponding ship's speed over ground ahead (AHD) and astern (AST) (extracted from the vessel's voyage data recorder)

Over the next 41 seconds, the master gave several astern movements including 'full astern' **(Table 1)** with the intention of synchronising the bridge lever with the physical position of the pitch indicator in order to try and regain control; no stop or ahead movements were given. During this period, *Saffier*'s speed astern increased rapidly to about 2.6 knots.

The pilot had been looking out from the starboard wing position. Noticing the increase in astern speed, he hurried towards the central control where he found the master in an apparent state of panic; the master informed the pilot that the propeller pitch was stuck in the 'full astern' position. *Saffier* was by this time approximately 185m from the tug *Svitzer Ferriby* alongside berth 5. At 0834:06, following the pilot's advice, the master activated the engine emergency stop and ordered the chief officer on the forecastle to drop both the anchors. The master made no attempt to contact the chief engineer who was near the engine room propulsion control system (PCS) panel, which was one platform above the main engine local manoeuvring station. The general alarm was not sounded at any time during the incident.

The starboard anchor was dropped at 0834:25. There was a delay of nearly 2 minutes before the port anchor could be dropped because its stopper bar had jammed on the anchor cable and the crew had to engage the windlass to take the tension off the cable before it could be released. Immediately after the second anchor was dropped, the spring line parted. At 0836:38, *Saffier*'s starboard quarter made heavy contact with the starboard shoulder of *Svitzer Ferriby,* which was unmanned at the time, parting her mooring lines.

At 0848, *Saffier*'s main engine was restarted and she was safely moored at quay 3 by 0910. She was assisted by the tug *Valiant,* which also pushed *Svitzer Ferriby* back alongside to be re-secured.

The area around *Saffier*'s starboard quarter was split approximately 1m above the waterline. The damage penetrated into the workshop area and the afterpeak ballast tank **(Figure 2)**. The tug *Svitzer Ferriby* suffered minor damage to its fender ring and a bracket holding the fender ring to the hull was distorted **(Figure 3)**.

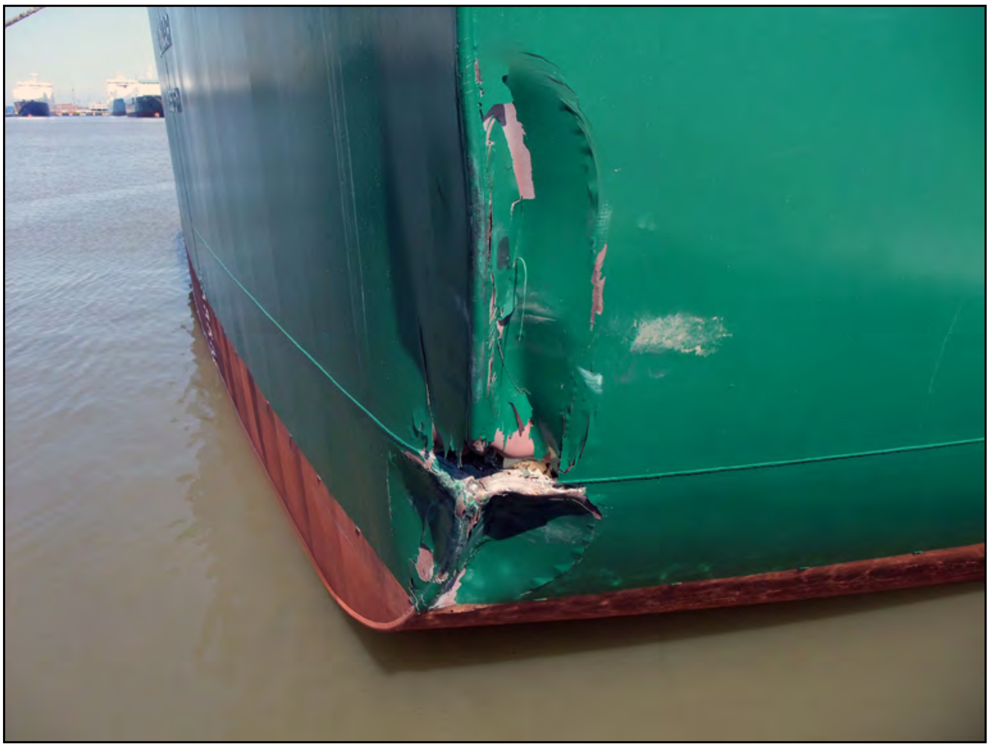

Figure 2: Damage to *Saffier*

Figure 3: Damage to *Svitzer Ferriby*

1.4 COMPANY AND SAFETY MANAGEMENT

1.4.1 Company

De Bock Maritiem B.V. was based in the Netherlands and owned three vessels including *Saffier.* All three vessels were small bulk carriers trading within Europe and West Africa. Management of the company was carried out by a group of four people, one of whom was the owner (who also acted as the designated person ashore); the other three worked part-time.

1.4.2 Safety management system

Saffier's SMS did not require that the emergency operation of the propulsion system be tested or that drills be conducted to prepare crew in case it should fail. There were no records on board of any tests or drills involving the propulsion system.

The SMS required a document called '*Checklist Voyage Preparation*' to be completed prior to port arrivals and departures. In total there were 68 items in the checklist, one of which was '*Main Engine*'*.* There were two tick boxes against each item: one marked positive and the other negative. A footnote on the checklist stated that any questions that had been answered negatively had to be explained. Checklists for the departure from Riga and the arrival at Immingham were completed with marks in the positive tick box for all items.

The SMS contained a section '*INSTRUCTIONS AT EMERGENCY SITUATIONS'* with specific instructions for situations such as collision, grounding , fire/explosion, contamination and shifting of cargo, black out, failure of steering and '*FAILING OF BRIDGECONTROL CPP INSTALLATION'*. The emergency response procedure for this contingency stated:

- *Give general alarm*
- *Engineer or Mate operates emergency controls*
- *Engineer finds defect*
- *Go at anchor to solve the problem if needed* [sic]
- *Inform designated person*
- *Fill out Non-conformity report* [sic]

There were no instructions in the SMS relating to anchor operations or anchor readiness when entering/leaving port.

1.5 CREW

There were three deck officers on board *Saffier*: the master, chief officer and second officer. The engine department consisted of only the chief engineer. The master was Russian and the other two deck officers were Dutch. The three remaining crew members (two deck ratings and a cook) were Indonesians. The official working language on board was English.

The master joined *Saffier* on 8 June 2011. He held an unlimited STCW II/2 certificate of competency issued by the Russian Federation and endorsed by the government of The Netherlands. He joined De Bock Maritiem in 2008, had worked a total of 12 months on *Saffier* as chief officer, and was promoted to the rank of master in September 2010. He had no previous experience of dealing with CPP failures.

The chief officer held an STCW II/2 certificate of competency, which allowed him to work without limitation on any vessel as chief officer, and a limited III/2 certificate of competency (second engineer on ships with propulsion power less than 3000kW). He was not required to use the engineering part of his qualification on *Saffier*. At sea, the three deck officers kept a 4 hours on / 8 hours off watchkeeping routine.

The chief engineer held a III/1 certificate of competency which was limited to ships of propulsion power less than 3000kW. He had been employed ashore in an engineering firm for nearly 22 years, before he returned to sea in 2010. He joined *Saffier* in the last week of April 2011, his first contract with De Bock Maritiem. He worked during the day and the machinery space was unmanned at night. He always manned the engine room during standby periods and usually stayed near the aft entrance to the engine room when the vessel was being moored. He often helped the AB at the aft mooring station.

1.6 COMMUNICATION SYSTEM

Normal communications between *Saffier*'s wheelhouse and engine room was via telephone; *Saffier* did not have a separate engine control room. The telephone system had a distinct ring tone which was distinguishable from the engine room alarm. There was one telephone in the engine room next to the PCS panel; another was located in the steering compartment. A set of headphones, with a microphone activated by a talk back button, was used to answer or make telephone calls. The headphone was attached to a long cable, which allowed it to be used anywhere within the engine room, including the local control station for the engine and CPP system.

The chief engineer who was on board at the time of the accident had an understanding with the deck officers that if they required to talk to him, they should dial the engine room number, let it ring twice and then disconnect. He would then go to the steering gear compartment to return their call as that compartment was quieter so making it easier to communicate.

1.7 MAIN PROPULSION ENGINE, GEARBOX AND CPP

1.7.1 Engine, gear box and CPP servo system

The main propulsion engine, gear box, CPP, monitoring and control systems were supplied as a complete package by MAN B&W Diesel A/S (now known as MAN Diesel & Turbo SE). The propeller shaft and a shaft alternator were driven through a common gear train. Consequently, the engine speed was maintained at a constant 800 revolutions per minute (rpm) in order to maintain a shaft alternator speed of 1500rpm and a corresponding propeller shaft speed of 190rpm. There was no clutch between the engine and gearbox; therefore, the engine could not be turned without also turning the shaft alternator and propeller.

The oil for gearbox lubrication and CPP servo actuation was part of a common system, supplied by an engine-driven gear pump. An electric motor-driven pump was also provided, which could be used in port to test the pitch without starting the engine or, in an emergency, if the engine-driven pump failed. The CPP servo system was supplied with oil at a pressure of 30bars. A spool valve, actuated by ahead and astern solenoid controlled valves, directed oil under pressure to the servo system in order to adjust the pitch of the propeller blades. The solenoid valves received their control signal from the propeller pitch closed loop control system, known as the ASP12 unit. The solenoid valves kept the spool valve in the ahead or astern position until the actual propeller pitch matched what had been demanded.

The physical travel of the propeller blade servo actuating mechanism could be measured on a graduated scale which was accessed by opening an inspection window on the gearcase. The nominal position on the graduated scale for full ahead pitch was 52mm aft of the zero position and the position for full astern pitch was 40mm forward of zero position **(Figure 4)**.

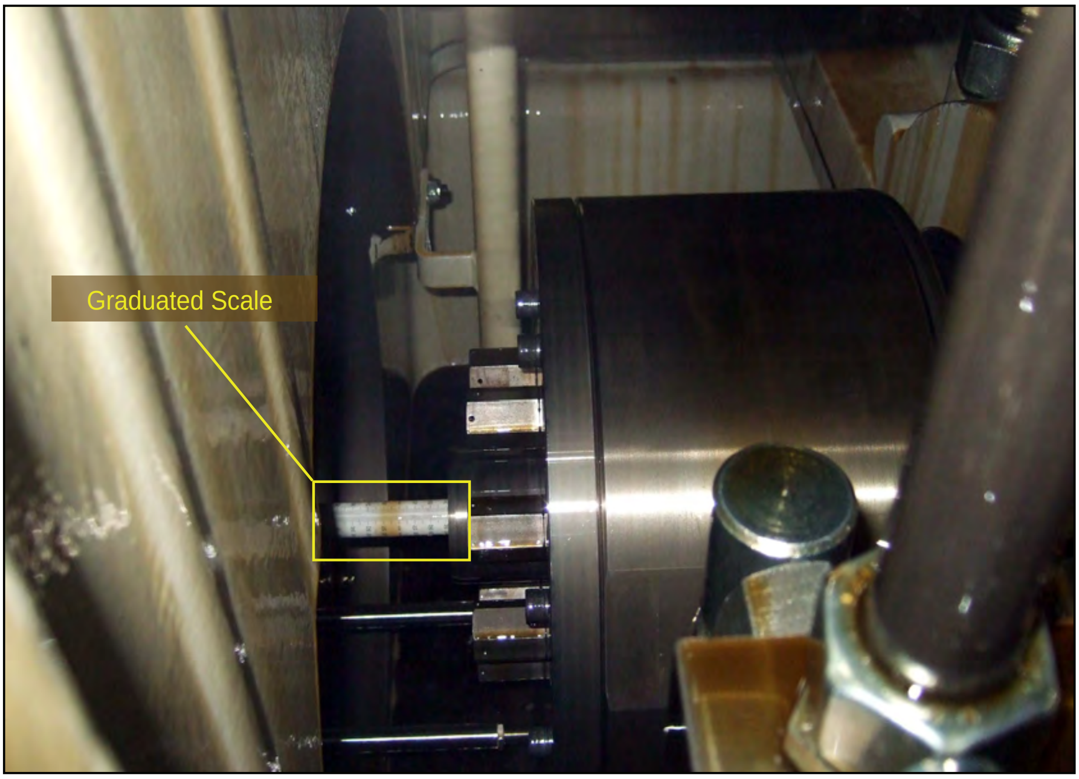

Figure 4: Graduated scale indicated CPP servo travel

1.7.2 Alphatronic 2000 propulsion control system

The ship's propulsion equipment was controlled by MAN's Alphatronic 2000 propulsion control system (AT2000 PCS) **(Figure 5)**. It was integrated through a network with systems for engine safety (ACS), engine monitoring (ACM-E), and gearbox and propeller monitoring (ACM-GP). The AT2000 PCS was capable of several functions including: starting and stopping the main engine; operating the propulsion system in three different modes (combinator[2], constant speed and independent control); main engine load control; transfer of control between engine

[2] Combinator: A mode of CPP system operation where both the propeller pitch and shaft speed are controlled to produce the desired thrust.

room and bridge; bridge wing control selection; and alarm indication. At the time of the accident there were approximately 1100 vessels in service worldwide equipped with AT2000 PCS units.

Pitch and engine rpm indications were available on the bridge at the central control console and portable bridge wing control unit[3], at the operator panel in the engine room and at the main engine local control station.

[3] *Saffier* was provided with one portable control unit that could be carried from a central stowage position to either side of the bridge to allow the vessel to be manoeuvred from the bridge wings.

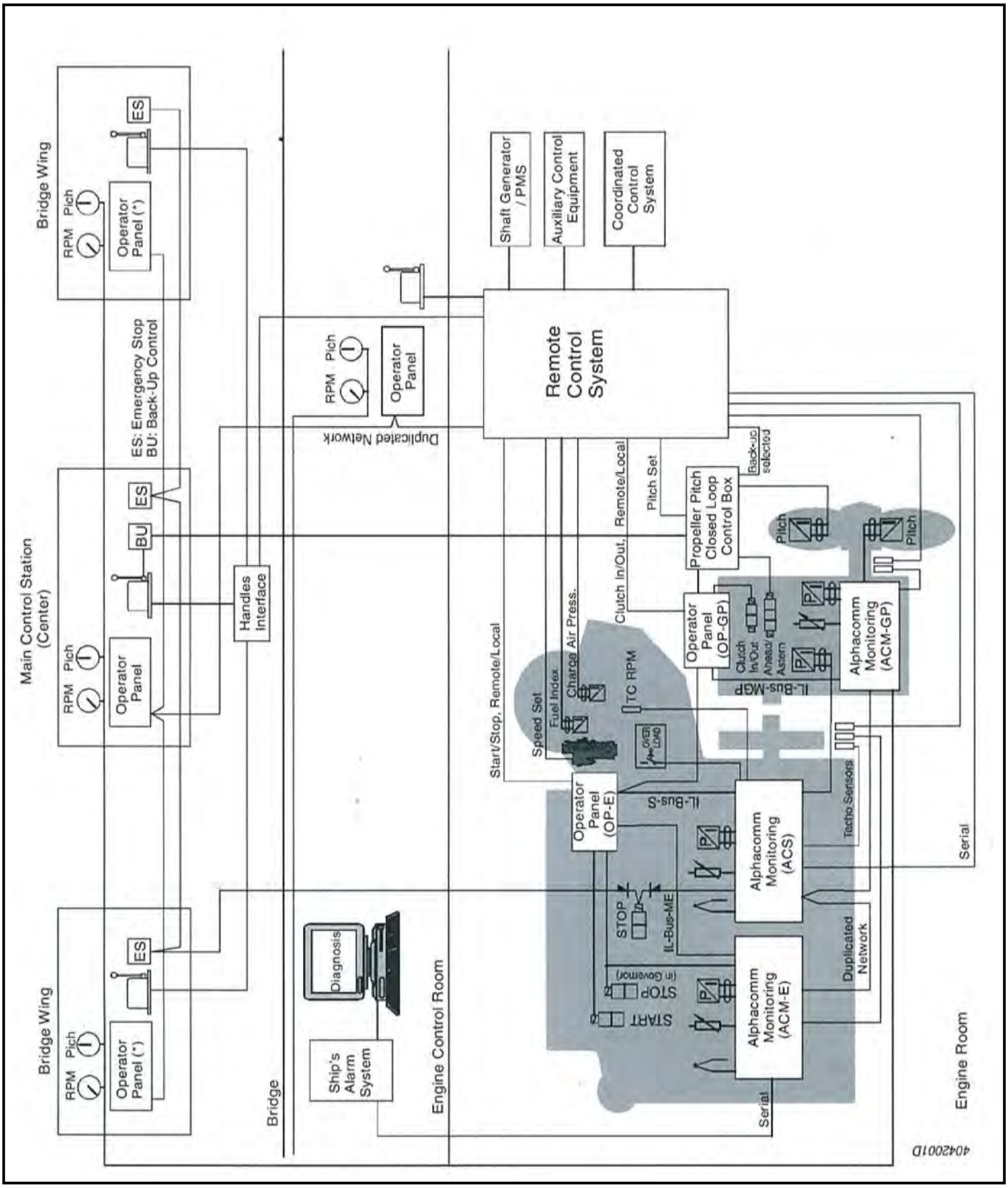

Figure 5: Propulsion control and monitoring system

1.7.3 Pitch control

Pitch control through the AT2000 PCS

The pitch control levers at both the central control console and portable console were connected to potentiometers, which communicated the amount of pitch required by the operator to the AT2000 PCS. A pitch demand signal, of between 4 and 20mA, was generated and fed into the ASP12 unit **(Figure 6)**, which then compared the demand and feedback position signals. The feedback signal represented the actual pitch of the propeller blades and was received from one of two position feedback transmitters.

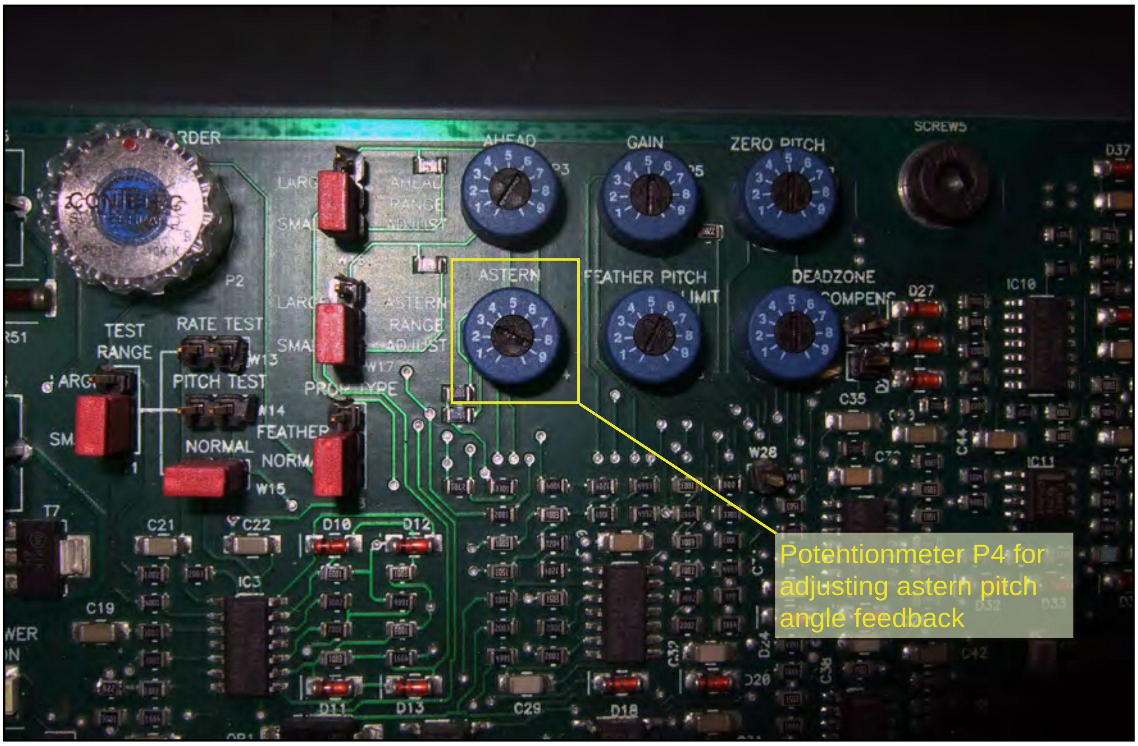

Figure 6: Closed loop control system ASP12

Pitch control in an emergency

It was possible to bypass the AT2000 PCS by pressing a button labelled 'BACK UP CONTROL' **(Figure 7)** at the central control station on the bridge. When backup control was in use, a second potentiometer, also connected to the pitch control lever, was used to control the pitch. The signal was fed directly into the ASP12 unit, bypassing the AT2000 PCS, to control the pitch.

In an emergency, the propeller pitch could also be controlled locally from the engine room by:

- setting a switch to the local control position and activating an ahead or astern switch which controlled the solenoid valves directly **(Figure 8)**
- activating the solenoid valves **(Figure 9)** directly using finger pressure.

In the local control mode, the closed loop pitch controller was bypassed.

Figure 7: Backup control to bypass the AT2000 PCS

Figure 8: Local control for main propulsion system

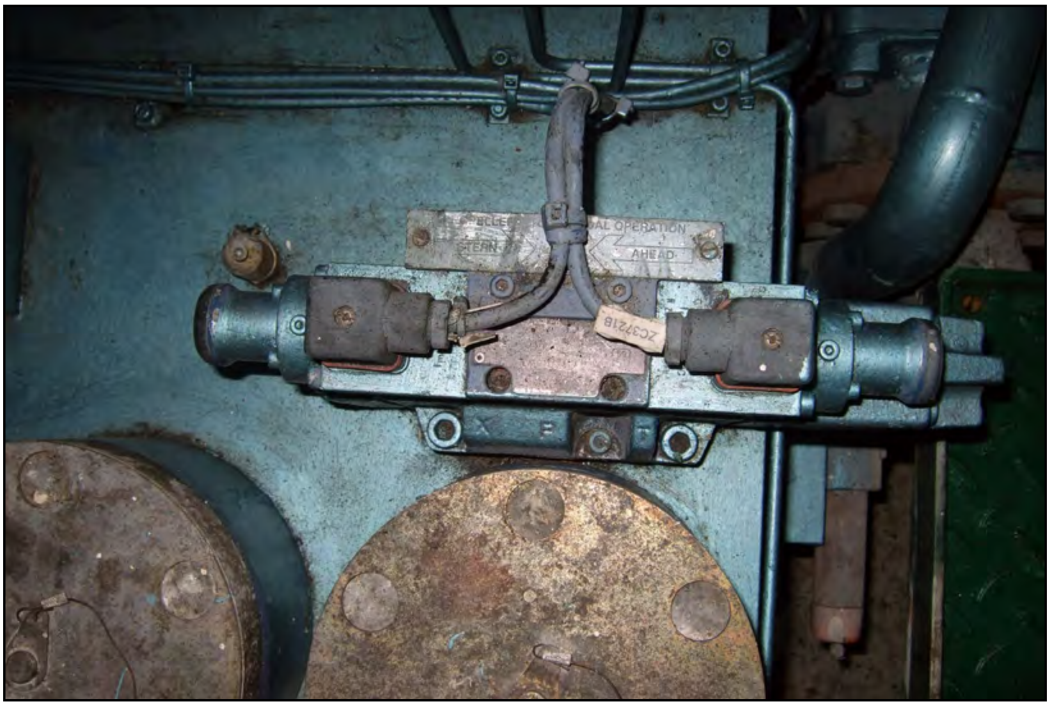

Figure 9: Solenoid valves for CPP pitch actuation

1.7.4 Feedback calibration

The closed loop control system (the ASP12 unit) was located next to the engine gearcase. It compared the pitch demand signal from the AT2000 PCS with the feedback from the pitch position indicating transmitter. The ASP12 unit contained six potentiometers, P3 to P8 **(Figure 6)**, which could be used to calibrate the pitch servo response to the demand and feedback signals. At the time of the accident, the potentiometers on *Saffier* were set to the following values:

- P3 (AHEAD) = 5.95
- P4 (ASTERN) = 3.00
- P5 (GAIN) = 5.00
- P6 (FEATHER PITCH LIMIT) = 5.95
- P7 (ZERO PITCH) = 5.10
- P8 (DEAD ZONE) = 5.00

The settings on potentiometers P3 and P4 adjusted the calibration of the feedback current that represented the ahead or astern pitch angle of the CPP blades.

During the sea trial that took place after the repairs in March 2011, MAN service engineers adjusted potentiometer P3 ('full ahead' feedback signal) to adjust the propeller pitch so that the engine was loaded to its maximum continuous rating when an operator set the pitch control lever to 100% ahead. They then adjusted potentiometer P4 to an approximate setting for the 'full astern' pitch position. The result of this setting was not verified by trials because the precise loading of the engine at 'full astern' pitch was not thought to be as critical as that for 'full ahead' pitch. Subsequently, the service engineers connected a laptop to the ASP12 unit to read the feedback currents that were generated at the 'full ahead', 'stop' and 'full astern' positions. These values were then entered into the AT2000 PCS unit in order to calibrate its output.

1.7.5 Fault simulation

In October 2011, at the request of MAIB, MAN staff reproduced the effect of *Saffier*'s propulsion control settings at the time of the accident on a simulator at MAN's facility in Frederikshavn. All the settings made by the service engineers during the sea trial were retrieved from archived data files and the post sea trial report. The simulator, consisting of control units identical to those on *Saffier*, was loaded with this data and the feedback currents corresponding to the ASP12 potentiometer settings were measured as follows:

- 15.27mA (corresponding to P3 = 5.95) at 100% ahead pitch
- 11.42mA (corresponding to P7 = 5.10) at zero pitch
- 9.75mA (corresponding to P4 = 3.00) at 100% astern pitch

The simulator gave the correct response for stop and ahead pitch commands, but reacted with an excessive astern pitch response when loaded with the settings from *Saffier*. MAN staff were able to confirm that setting potentiometer P4 to a position of about '3' (with a corresponding feedback current of 9.75mA) gave an astern pitch on the simulator equipment of 184% of the designed maximum astern position.

This resulted in the AT2000 PCS calibrating itself incorrectly, causing the propeller pitch to reach the designed 'full astern' position prematurely, when the pitch lever was in the 'half astern' position. When the setting of potentiometer P4 was reduced, both the ahead and astern pitch responses were found to be correct.

MAN staff were also able to confirm that the response times for pitch to be reduced should be the same from both ahead and astern directions.

1.8 POST-FIRE REPAIRS AND SEA TRIAL

1.8.1 Repairs

Following the engine room fire that occurred in January 2011, extensive repairs were made to *Saffier* between 11 and 24 March 2011 while the vessel was in Lisbon. All the fire-damaged cables in the area between the engine and gearbox were renewed. Fire damage had caused a large number of short circuits in the propulsion control system; several of the printed circuit boards were changed and the remaining cards were cleaned by a specialist company.

1.8.2 Sea trial

The sea trial took place from 1600 on 24 March to 1930 on 25 March 2011. Those present during the trial included the owner of the vessel, two service engineers from MAN and a surveyor from the vessel's classification society Bureau Veritas (BV). The owner had prepared a detailed plan **(Figure 10)** for the sea trial in consultation with all the parties represented. The plan made provisions for adjusting the 'full ahead' pitch to set the maximum load on the engine, and included a 'crash stop' test. The ‘crash stop’ was intended to show that astern pitch could be used to bring the vessel to a stop in the water. The astern pitch response was not required to be recorded, and there were no other tests to verify that the astern pitch functioned correctly.

Although MAN service engineers were required to follow a comprehensive checklist to commission and test new installations, the work on *Saffier* was regarded as a repair - for which there were no checklists, regardless of the complexity of the task.

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Sea trails mv. “Saffier” after repairs Setubal & Lisbon.

Date: Thursday 24th / Friday 25th of March 2011.

Sea trail leader : [redacted]
Captain : [redacted]
Departure from : Lisbon, Naval Rocha shipyard.

Present:
Crew: 8. / Owner: 1.
Bureau Veritas: 1. [redacted]
MAN diesel: 2. [redacted]
Alewijnse: 2. [redacted]
Total: 14 persons on board.

Programme:

14:30 - 15:30	Everybody on board, report on the bridge, take drafts. (when vessel is afloat) As soon as vessel afloat, take crankshaft web deflection.	MAN
15:30	Pilot on board, make fast tug boat.	
15:30 - 16:00	Dock out. Pump full ballast.	Crew Ch. Off.
16:00 - 16:30	Start up all systems and test shutdown alarms.	MAN
16:30 - 17:00	Sailing to open water at 20% load with 2 tugs.	
17:00 - 17:30	Sailing to open water at 30% load with 1 tug. (1 tug stand by)	
17:30	Drop of pilot / let go tug.	
17:30 - 18:00	Sailing at 40% load.	
18:00 - 18:30	Pitch adjustments 0%.	MAN
18:30 - 19:30	Sailing at 50% load. Shaft generator on main switch board.	Alewijnse
19:30 - 20:30	Sailing at 60% load.	
20:30 - 21:30	Sailing at 70% load. / Switch over to heavy fuel oil.	
21:30 - 22:30	Sailing at 80% load.	
22:30 - 23:30	Sailing at 90% load.	
23:30 - 00:30	Sailing at 100% load. / Pitch adjustment 100%. Measuring pressure, temp. ME / fuel system / cooling water.	Ch. Eng.
00:30 - 00:45	Crash-stop with shaft generator on switch board. (Fixed Speed)	BV/Alewijnse /MAN
00:45 - 01:15	Main engine stopped for check ups.	MAN
01:15 - 01:45	Start up / Bow thruster test.	MAN / Alewijnse
01:45 - 03:00	Over rule of ME Auto stop alarms. Auto stop auxiliary engine. Black Out test Take over ER - Bridge Auto reduces (LO pressure / CW temp / Exhaust Temp) Reduced pitch at fixed speed and in combinator mode Main engine Emergency Stop from Bridge (with shaft generator)	BV/Alewijnse/MAN BV/Alewijnse BV/Alewijnse BV/Alewijnse/MAN BV/MAN BV/Alewijnse/ MAN BV/Alewijnse/MAN
3:30	Pilot on board.	
4:30	Arrival Setubal.	
	After arrival: take crankshaft web deflection.	MAN

- Lifejackets are located on the bridge. / In case of emergency follow instructions of the captain.

Bankrek. nr: 68.03.68.922
BTW nr: 8084.24385.B.01
KvK Alkmaar nr: 37087436 0000

Figure 10: Sea trial tests protocol

1.9 CPP FAULTS

1.9.1 History of CPP faults on Saffier

On 7 April 2011, while *Saffier* was manoeuvring at Gemlick in Turkey, the master reported a problem after he applied 70% astern pitch and then reduced the pitch to 0%. He reported that the CPP continued to maintain astern pitch and did not return to 0% as he expected. The master was using the portable control panel at one of the bridge wings at the time. After approximately 1 minute, he changed control to the central console and put the pitch handle to zero. It was reported that the pitch then came down to 0%.

On 10 April 2011 the master carried out a test in the open sea using the portable control unit to set the astern pitch to 70%. He noticed that it took around 8 seconds for the pitch to return to 0% after he had set the pitch control lever to stop. He reported that when operating from the central control, the problem did not recur; however, he had applied only 20% ahead and astern pitch movements from the central control console. In a letter to the owner of the vessel, he concluded that there must be a fault in the portable control unit.

De Bock Maritiem staff, in consultation with MAN staff, asked the master to carry out several tests to record the time taken for the propeller pitch to come back to 0% from 70% ahead and astern settings. The master carried out the tests at sea with the engine running. The results **(Table 2)** were forwarded to MAN, who responded that these were normal and as expected.

70% ahead – 0% (central control console) [seconds]	70% astern – 0% (central control console) [seconds]	70% ahead – 0% (portable control unit) [seconds]	70% astern – 0% (portable control unit) [seconds]
4	13	4	15
3	24	4	11
4	18	5	12
4	9	4	15
4	11	4	11

Table 2: Time taken for the pitch to return to 0% after having been set at 70% in both ahead and astern directions (tested from both the central control and portable control consoles)

The problem with incorrect astern pitch response was noticed on two further occasions, the last of which was 17 April 2011, 2 days before the master signed off. In his handover notes to the next master he stated:

> *If this ever happens again push the backup control button in the wheelhouse near the telegraph.*

Between 19 April and 9 June 2011 it was reported that there were at least two more incidents of astern pitch malfunction, but these were not recorded in detail or reported to the company. The handover notes to the master who was in command during the accident in Immingham on 25 June, stated:

> *Bridgewing control is still working allright although I haven't used it the last weeks.* [sic]

In addition to the handover notes, the off-going master also told his relief about the backup control button, and advised him to use it if he had a problem with the engine pitch.

MAN service engineers were on board for various purposes while the vessel was in port on 9 April, 3 May, 29 May and 8 June 2011. During their first visit in May, the master attempted to reproduce the problem with the CPP controls, but was unsuccessful. The service engineers established that the portable control unit was not defective, but left the vessel without conducting any further investigation to see if there was an underlying problem.

1.9.2 Technical instruction manuals and maintenance

MAN had provided technical instructions for the CPP system in three manuals that referred to the gearbox, propeller and control system. In the gearbox instruction manual, under the heading 'Troubleshooting', three possible scenarios of propeller servo failure were described as:

- *pressure drops down*
- *the pitch moves to full ahead or full astern on its own*
- *when manoeuvring the pitch stops moving at a certain position*

For the two pitch-related faults, six possible reasons were mentioned; five of these suggested possible problems in the hydraulic system and one suggested an incorrect electric signal to the CPP activating solenoids. The CPP control system manual did not contain any troubleshooting tips for the control system. One possible anomaly that was described in the propeller manual was *Unstable pitch setting/ engine load* with the possible cause listed as *damaged feed-back transducer*.

1.9.3 Fault rectification after the accident

After the accident a MAN service engineer attended the vessel at Immingham port on 26 June. He reproduced the astern pitch control problem by setting the pitch control handle to the 'full astern' position, leaving it there for approximately 1 minute and then moving the handle to 'full ahead'. He reported:

> *We tested the system again, and it was correct that the pitch stayed in "astern" for approx 1 minute after giving order to "ahead".*

He found that when the pitch request was 100% astern, the pitch feedback indicated that it had attained 120% astern. Subsequently, even though the pitch control lever was moved to 0%, the pitch continued to increase till the feedback indicated 155%

astern. It took almost 1 minute to return to zero pitch. When the pitch control lever was set to 5.5 astern (approximately ‘half astern’), the pitch feedback indicated 100% astern. The service engineer’s report went on to state:

> *Contacted the automaton department at MAN who suggested that the CPP input adjust might be out of adjustment. Therefore the load control did not know what to do when feed-back was more than 100% to “astern”.* [sic]

The MAN service engineer readjusted the potentiometers in the ASP12 unit and confirmed that the pitch control responded correctly.

1.10 REGULATIONS AND REQUIREMENTS

1.10.1 Requirements of classification societies

BV’s rules for Steelships, Part C, Chapter 1, Section 15, Article 3 ‘Shipboard tests for machinery’, section 3.3.2 pertaining to astern trials during sea trials, state:

> *The ability of the machinery to reverse direction of thrust of the propeller in sufficient time, and so to bring the ship to rest within reasonable distance from maximum ahead service speed, shall be demonstrated and recorded.*

Neither BV nor any of the leading classification societies require the test of all astern movements during manoeuvring trials; BV reported that additional tests would only be requested by their surveyors if needed to verify compliance with existing rules.

IACS unified requirement (UR) E22 ‘On Board Use and Application of Programmable Electronic Systems’ was issued in 2006, with revision 1 issued in 2010. UR E22 was only applicable to vessels under construction where the services of IACS members had been contracted on or after 1 January 2008. *Saffier* was contracted for construction shortly before this date and, although the UR was not applicable, the underpinning technical and safety issues are relevant.

UR E22 categorises programmable electronic systems (PES) into three areas depending on the potential severity of the impact of a single failure within PES. Category III was defined as:

> *Those systems, failure of which could immediately lead to dangerous situations for human safety, safety of the vessel and / or threat to the environment.*

1.11 PREVIOUS CPP RELATED ACCIDENTS

From 1991 to 2010, a total of 90 incidents directly related to CPP failures have been reported to the MAIB. Of these, 75 were caused directly as a result of control failure.

The safety issues found by the MAIB’s investigations into four of these accidents are considered to be the most pertinent:

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 its port CPP. 180 passengers and 29 crew were injured, including 5 with bone fractures and several who were rendered unconscious.

The recommendations made by the MAIB to the vessel's managers 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.*

On 29 December 2004, the ferry *Isle of Mull* struck the ferry *Lord of the Isles*, while manoeuvring in Oban harbour. One of the safety issues identified in the subsequent MAIB investigation report was that insufficient checks were carried out to ensure CPP control had been transferred to the bridge wing.

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 38 persons 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 its approach to the berth, resulting in *Isle of Arran* landing heavily on the linkspan.

On 26 February 2011, the platform supply vessel (PSV) *SBS Typhoon* was undertaking functional trials of a newly installed dynamic positioning (DP) system while alongside in Aberdeen Harbour. Full ahead pitch was inadvertently applied to the port and starboard CPPs, causing the ship to move along the quay. Contact was made with the standby safety vessel *Vos Scout* and the PSV *Ocean Searcher,* causing structural and deck equipment damage. Ahead pitch was applied to the CPPs because an incorrect pitch command signal was generated by the DP system signal modules. The error was not identified during factory tests or during the pre-trial checks despite the system documentation specifying the correct signal values.

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 THE ACCIDENT

Saffier's history of propulsion plant defects began after she suffered a serious engine room fire in January 2011. Although a large number of electronic components in the CPP control system were replaced, insufficient attention was paid to the adjustment and calibration of the controls for astern pitch. This resulted in large discrepancies between astern pitch demand and response. During the sea trial, the full range of astern movements was not tested and the mismatch went undetected.

Almost immediately after the vessel recommenced trading, problems with the control of astern pitch began to occur. Timed pitch response tests carried out by the crew should have confirmed that there was a problem with astern pitch control. However, the manufacturer's investigation was not sufficiently detailed to allow the correct conclusions to be drawn. The crew were unable to reproduce the problem when MAN's service engineers visited the vessel and, without an obvious defect to repair, they did not carry out any other system checks that tested the astern pitch control response.

The underlying cause of the astern pitch demand discrepancies remained undiagnosed. Unfortunately, while berthing at Immingham, the astern pitch control problem, which had lain unresolved for many weeks, combined with a poor emergency response from the crew, led *Saffier* to make heavy contact with a berthed tug. The accident could easily have caused more severe consequences, such as injury to personnel, flooding or pollution.

2.3 SEA TRIALS

2.3.1 Commissioning

The service engineers who made the adjustments to the ASP12 potentiometers during *Saffier*'s sea trials in March 2011 were very experienced individuals who had carried out many installation and commissioning jobs; they were part of a small team and, at the time of the accident, there were over 1100 vessels worldwide fitted with the AT2000 PCS. Nevertheless, the work required on *Saffier* was complex; it was understandable, once MAIB inspectors had studied the complicated commissioning sequence, to see why the service engineers could misadjust the potentiometer affecting the astern pitch response. The mistake could have been quickly and easily corrected, however, there were insufficient cross-checks to detect the error.

The checklist used for new installations comprised a series of logical steps and counterchecks to guide MAN staff through the commissioning work. Unfortunately, the repair to *Saffier*'s propulsion control system after the fire was not considered as a new installation, and therefore the checklist was not used. Had a similar checklist for post-repair commissioning been used, the discrepancy in the setting of the astern position feedback potentiometer was much more likely to have been identified.

The commissioning error could have been detected by comparing the servo travel indication scale with the expected (as designed) travel for the full ahead and full astern pitch positions. However, the scale was inside the gearcase and was impossible to read while the engine was running. On completion of the sea trial, the MAN service engineers left the vessel as soon as it berthed without verifying the astern pitch adjustments with the engine stopped.

Propeller pitch feedback was also displayed on the local control panel next to the engine. If this display had been monitored while the propeller was operated throughout its full range of travel, it would have shown that the amount of astern pitch movement was too great.

2.3.2 Protocol

The protocol for the sea trial was drawn up by the owner and agreed by the participants of the trial, including the attending class surveyor and MAN service engineers. Although the crash stop test demonstrated the effectiveness of the astern pitch, its main focus was to measure the time for the ship to stop in the water from normal sea speed. There was no requirement to monitor the actual astern pitch response during this test, and it is quite possible that the commissioning error would not have been noticed because the observers' attention was focused elsewhere.

Major repairs had been carried out on the main propulsion control system; one of the most critical machinery systems on board. The trial was conducted with the vessel in open sea and with no potential hazards from weather or traffic conditions. Yet no one present during the trial thought it necessary to do a full range of tests to verify the ahead and astern pitch response. Such a test would have been straightforward and taken only a few minutes to achieve. Indeed, it would have been good practice to have done a pitch response test, using the electrically-driven pump, to ensure that there was control of the CPP before the main engine was started and *Saffier* left its berth. If the sea trials team had done such a test, the mismatch between demand and response would almost certainly have become apparent and the MAN service engineers would have had the opportunity to check and correct the astern pitch control settings.

BV's current rules do not explicitly require the full range of ahead and astern propulsion control movements to be tested during commissioning trials, because the rules only require that astern propulsion be used to bring the ship to rest from maximum ahead service speed within a reasonable distance. While BV's attending surveyors can require further tests if they think they are necessary, without detailed knowledge of how the system operates, or specific requirements from the vessel's owner, the surveyor has to rely on advice from the equipment manufacturers' representatives for what tests need to be done. In turn, the vessel owners and equipment manufacturers' representatives refer back to the classification society's requirements to define what performance checks are needed in order to gain the relevant certificates required to approve the equipment and allow the vessel to start trading. The consequence of this situation is that trials become focused on demonstrating compliance with the classification society's rules.

During the trials on *Saffier*, none of those present identified that what looked to be a comprehensive trials plan, which met BV's requirements, had completely overlooked the fundamental safety issue of whether there was full control of astern propulsion. The trials plan and tests performed on *Saffier* complied with the requirements of

BV's existing rules, and therefore the obligations of the society and its surveyor were perceived to have been fully met. Nevertheless, control of astern propulsion had not been adequately tested and a potentially dangerous underlying defect was left undetected. This demonstrates that more detailed guidance from classification societies is needed to ensure that all propulsion control system trials are conducted to an adequate and uniform standard.

The sustained frequency of CPP-related accidents over the last 20 years is concerning. Guidance from IACS in UR E22 should help address this trend by improving the standard of critical control systems. However, as UR E22 applies only to vessels contracted for construction after 1 January 2008, it will not affect the significant number of vessels in service that precede this requirement. This reinforces the need for classification societies to insist that CPP control systems are tested throughout their full range of operation.

2.4 FAULT

2.4.1 Fault mechanism

It was conclusively demonstrated from the tests conducted on the simulator at MAN's Frederikshavn facility that the mismatch between astern pitch demand and response was caused by the incorrect adjustment of potentiometer P4, representing the astern pitch feedback. While the ahead pitch feedback adjustment was set in a methodical way in order to load the engine correctly, there was no opportunity to adjust the astern pitch feedback as the propeller pitch response was not verified in the full astern position. Unfortunately, the service engineers' approximate setting of potentiometer P4 resulted in a feedback current of 9.75mA, which equated to an astern pitch of 155%.

When the AT2000 PCS was 'taught' that a 100% pitch demand was expected to produce a feedback of 9.75mA, it calibrated itself to expect that a value of 9.75mA represented when 100% astern pitch had been achieved. Consequently, when 'full astern' pitch was demanded, the net effect was for the propeller blades to be driven to 155%. Even a 'half astern' pitch demand resulted in the blades' pitch being set to more than 100% astern **(Figure 11** and **Figure 12)**. As a consequence, it took far longer for the blades to return from 155% astern to 0% pitch, giving the false impression that the blades had 'stuck' at 100%.

2.4.2 Fault diagnosis

The anomalies caused by the incorrect astern pitch control adjustment manifested themselves shortly after the vessel went back into service. The timed tests carried out on board followed the instructions from MAN staff and clearly indicated that the average response time for pitch reduction from 70% astern to zero was approximately four times greater than for a similar amount of ahead pitch reduction. The discrepancy was apparent when both the central and portable control consoles were used. Even though this information was relayed back to MAN staff, it is disappointing that it did not trigger a more detailed technical inquiry from their side. It is particularly concerning that MAN staff dismissed the results of the timed tests as being 'normal'.

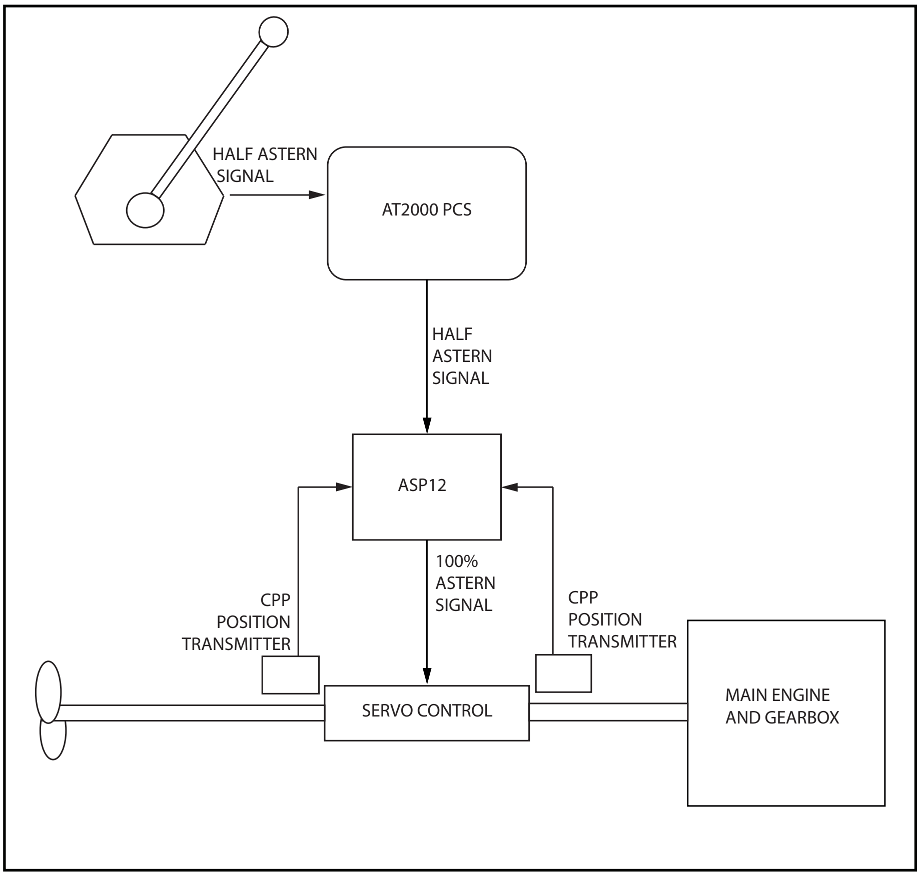

Figure 11: Half astern demand translated to full astern by AT2000 PCS

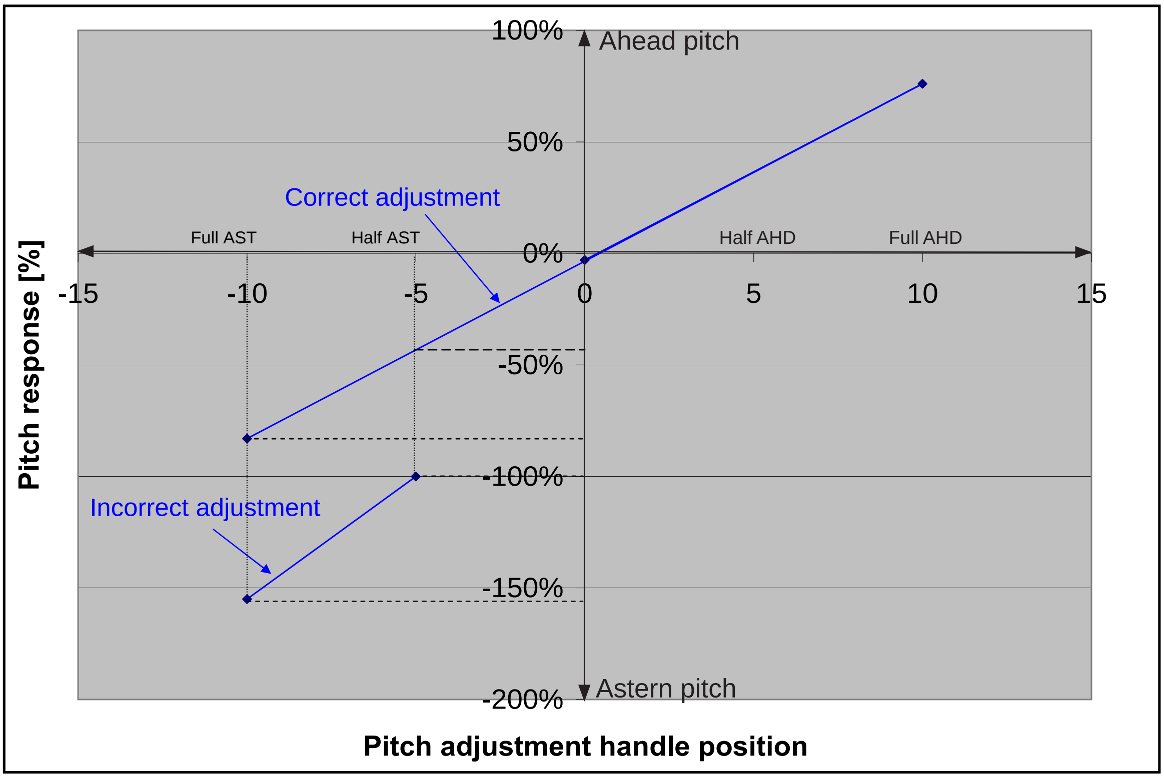

Figure 12: CPP behaviour with correct and incorrect adjustments demonstrating how the pitch supplied could significantly exceed pitch demanded due to incorrect adjustment

Although MAN's service engineers attended *Saffier* on four different occasions, their attendance was not specifically to solve the CPP problem. When newly joined crew were unable to reproduce the fault, the service engineers left the vessel without persevering. It is rare for control systems to malfunction randomly and without reason, and the technical manuals did little to contribute to the crew's understanding of the problems they were experiencing. The failure modes of the system were beyond the comprehension of the operators; therefore it was difficult, if not impossible, for the crew to replicate the conditions which led to a failure. In contrast, equipment manufacturers have an intimate knowledge of their systems and are often the only ones able to trace the root cause of a problem. This capability was made amply evident when MAN staff, at the request of the MAIB, were able to precisely simulate the astern pitch malfunction and clearly identify the reason for the problem.

2.5 EMERGENCY RESPONSE

2.5.1 Pitch recovery attempts

When *Saffier*'s master initially ordered the astern propeller pitch, his primary focus was to arrest the forward movement of the vessel in order to avoid a potential contact with the tug *Valiant*, that was moored ahead of his vessel's intended berth. The astern pitch response, as shown in **Table 1**, was consistently in excess of that demanded. It is likely that the master would only have noticed that there was a problem with the pitch response when he reduced the pitch demand to 6% astern. As the actual pitch that had been achieved before this order was 154% astern, and as the pitch indicator dial was mechanically restricted to display a maximum of 100% astern, it is understandable why the master thought that the pitch appeared to be 'stuck' at 100% astern. The reason for this illusion was that not enough time had passed in order for the pitch to reduce from 154% to below 100%.

From his subsequent actions, it is likely that the master did not see the pitch indicator eventually reduce to 80% astern, because instead of pulling the lever back to stop, or even applying ahead pitch, he gave a series of further astern movements. This was in the hope that by realigning the pitch demanded with the response, he could somehow regain control and then be able to reduce the pitch.

It is of serious concern that the master's familiarity with the propulsion system was so inadequate that he believed that by synchronising the pitch control lever with the pitch indication needle, he could recover the situation. Had he placed the pitch control lever in the full ahead position or even the stop position the amount of astern pitch would have reduced and the collision could have been avoided. This demonstrates the importance of ensuring that bridge watch keeping officers are sufficiently familiar with the equipment they operate so that they can react effectively in an emergency situation.

2.5.2 Backup control

Saffier's master was aware of the backup control button, yet during the crisis that developed he did not remember to use it. Had it been activated, it would have bypassed the AT2000 PCS and restricted effective pitch control.

The appearance and positioning of the backup control button did little to distinguish it from other controls. It was not readily identifiable as an emergency backup control. In the absence of a prominent visual reminder and with the master's lack of familiarity, it is not surprising that it was not used.

Emergency backup controls must be prominent and easily identifiable so that operators can use them quickly when required. Similarly, operators must have sufficient system knowledge and have practised the use of emergency controls during drills, so that their use becomes an instinctive option during the stressful circumstances of an emergency.

2.5.3 Emergency stop

It is more difficult to understand why the activation of the emergency stop button was delayed until the pilot prompted the master to do so. This control was more accessible and clearly identified than the backup control button. Considering that the vessel's speed was increasing, it would have been good judgment to stop the main engine by any means possible. However, it was apparent that the master's attention was focused on regaining control of the CPP, which required him to keep the main engine running instead of activating the emergency stop.

It would have taken more than 2 minutes for *Saffier* to cover the 185m to *Svitzer Ferriby* at a speed of 2.6 knots. If the main engine had been stopped and the anchors dropped promptly, it is possible that contact between the two vessels could have been avoided. Bridge teams must take prompt and decisive action to limit the potential for damage if control system failures occur.

2.5.4 Anchor readiness

Saffier's chief officer did not remove the anchor stopper bars as part of his preparations for mooring stations. When the master ordered both anchors to be let go, the port anchor could not be released as the stopper bar had jammed against the cable. The windlass motor then had to be started and clutched in to take the tension off the cable so that the stopper bar could be released. This took time, delaying the release of the port anchor and reducing the chances of stopping *Saffier* before she made contact with *Svitzer Ferriby*.

Saffier was in sheltered waters within a harbour and there was no need to keep the anchor securing bars in place. It might be unrealistic for the SMS to contain a detailed procedure on the exact meaning of anchor readiness; however, in the light of this accident it would be prudent for this to be included in local instructions posted near the windlasses on vessels operated by De Bock Maritiem.

2.5.5 Communication

During the time that the engine pitch appeared to be stuck at 100%, *Saffier*'s master did not contact the engine room to seek help from the chief engineer. It is considered most likely that he was dissuaded from this action because he knew that the chief engineer did not answer the phone immediately, but called back from the steering compartment after he had heard the engine room phone ring. The master knew that he did not have sufficient time for this process. The master might also have thought that the chief engineer was helping at the aft mooring station as was often the case. In either event, it was a reasonable assumption that the chief engineer might not respond quickly enough to be of any real help.

The telephone link between the bridge and the engine room was provided to enable quick and effective communication. It was not acceptable for the chief engineer to introduce a delay by his preference to call back from the steering compartment after hearing the telephone ring in the engine room. This practice should have been challenged and corrected.

It is understandable in a vessel with very few crew members that, individuals may have to assist in activities not directly related to their departmental specialism. However, as the only member of the engine department, and as the nominated engineer in charge of all the machinery, the chief engineer's undivided attention should always be devoted to the engine room during critical operations such as berthing or unberthing.

The master did not activate *Saffier*'s general alarm or alert the crew in any other way. Consequently they had limited warning to prepare for, or react to, the subsequent damage.

2.5.6 Summary

There were several factors that contributed to the situation going out of control after the CPP system malfunctioned. These were:

- The master's unfamiliarity with the operation of the main propulsion system, his failure to activate the backup control to bypass the AT2000 PCS and delay in stopping the engine using the emergency stop button
- The delay on the forecastle in dropping the second anchor
- The master's decision not to contact the chief engineer during the emergency.

2.6 SAFETY MANAGEMENT

2.6.1 Propulsion system checks

The pre-departure and pre-arrival checklist on board *Saffier* did not explicitly require the crew to test that the CPP system was functioning reliably. Although it was possible to check the pitch response throughout its whole range without starting the engine, they chose not to; the checklist only prompted them to test the engine. With the vessel's movements being predominantly in the ahead direction, it was not surprising that during the few astern movements which may have been required during manoeuvring, the mismatch between the demand and response of astern pitch was not detected more often. Pre-departure and pre-arrival checklists should be amended to require a proper test to prove that operators have full control throughout the whole range of ahead and astern pitch movement.

2.6.2 Propulsion failure drills

There were no records on board of the emergency backup control of the main propulsion system ever having been tested during the life of the vessel. The crew on board at the time of the accident had not practised any such tests. Therefore, even if the crew had considered using the emergency backup controls during the incident, it is unlikely they would have been successful.

While the SMS identified various emergency scenarios and provided a bulleted list of actions for dealing with each, it stopped short of requiring the crew to carry out drills to practise these actions. Frequent drills help to hone a crew's reactions in an emergency; in the absence of such drills they can only revert to the actions they took during other similar incidents. Unfortunately, *Saffier*'s master had no previous experience of CPP control failure; consequently, his response during this accident was poor. Instead of informing the chief engineer or even sounding the general alarm to alert other crew members, the master attempted to resolve the situation on his own. Had the pilot not asked the master to stop the engine and drop anchors, he might have delayed these actions further and the consequences of the accident could have been much worse. It is imperative that periodic drills are carried out by the crew so they can learn how to react to a propulsion control system failure correctly and help prevent similar accidents in the future.

SECTION 3 - CONCLUSIONS

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

1. The accident was caused by a combination of an undiagnosed fault in *Saffier'*s propeller pitch control system and a poor emergency response from the crew. [2.2]

2. Although the service engineers who made the adjustments to the propulsion control system were very experienced individuals, who had carried out several installation and commissioning jobs, they made an error in the astern pitch adjustment. There were insufficient confirmatory checks to detect that an adjustment error had been made. [2.3.1]

3. The checklist used for new CPP system installations comprised a series of logical steps and counterchecks to aid MAN engineers in the commissioning work. Had a similar checklist for post-repair commissioning been used, the discrepancy in calibrating the astern position feedback should have been identified. [2.3.1]

4. The protocol for *Saffier'*s post repair sea trial was drawn up by the owner and agreed by the participants of the trial, including the attending class surveyor and MAN's service engineers. As tests of astern movements were not included in the plan, except for an indirect test during the crash stop test, the effect of the incorrect adjustment of astern pitch feedback did not become apparent during the sea trial. [2.3.2]

5. Classification societies' do not explicitly require that control throughout the whole range of ahead and astern propeller pitch is verified during commissioning trials. This accident, and many others involving CPP control failures, demonstrates the need for classification societies to insist that CPP control systems are tested throughout their full range of operation. [2.3.2]

6. A mismatch between the amount of astern pitch demand and response was caused by the incorrect adjustment of potentiometer P4 in the ASP12 unit. This resulted in the incorrect calibration of the control system with the net effect that, when 100% astern pitch was demanded, the propeller blades were driven to 155% astern. [2.4.1]

7. *Saffier*'s crew were unable to replicate the problems with the CPP control system to MAN's service engineers, and MAN staff did not investigate the problem sufficiently in order to diagnose and correct it. [2.4.2]

8. The master's lack of familiarity with the pitch control system and his subsequent attempts to regain control of the pitch increased *Saffier*'s sternway and made the situation worse. [2.5.1]

9. The backup pitch control button did not stand out as an emergency control and, because *Saffier'*s master was unfamiliar with its operation, the backup mode was not used. [2.5.2]

10. *Saffier*'s master did not activate the engine emergency stop until prompted to do so by the pilot. This delay contributed to *Saffier* making contact with *Svitzer Ferriby.* It is essential that bridge teams take prompt and decisive action to limit the potential for damage if control systems fail. [2.5.3]

11. *Saffier's* port anchor could not be released immediately when ordered because it jammed against the stopper bar. It would be good practice to define to crew exactly how anchoring equipment should be configured when it is required for immediate readiness. [2.5.4]

12. The common pre-departure and pre-arrival checklist did not explicitly require the crew to verify that the CPP system was functioning correctly. The checklist should be amended to require a test of the full range of ahead and astern pitch. [2.6.1]

13. There was no requirement in *Saffier*'s SMS to test the correct functioning of the propulsion system emergency backup controls, or for crew to conduct drills to practise the correct emergency response. This reduced the crew's effectiveness in responding to the pitch control failure. [2.6.2]

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

1. Limited communication from the master to his crew during the accident restricted their ability to prepare for, or react to, the subsequent damage. [2.5.5]

SECTION 4 - ACTION TAKEN

4.1 MAN DIESEL & TURBO SE

MAN Diesel & Turbo has:

- Adopted the use of its commissioning checklists for new installations when conducting major in-service repairs of existing propulsion control systems. The checklist has been enhanced to include additional confirmatory tests on the propulsion system.

- Informed its service engineers about the *Saffier* accident and emphasised the importance of making accurate adjustments to the propulsion system settings and conducting extensive trials in both ahead and astern directions.

- Replaced all remaining electronic components and internal cables of the control system cabinet on board *Saffier*, to eliminate any possibility of latent failures due to heat damage.

SECTION 5 - RECOMMENDATIONS

De Bock Maritiem B.V. is recommended to:

2012/111 Review *Saffier*'s safety management system in order to:

- Improve ship's officers' induction procedures and training for the main propulsion system and its manoeuvring controls.
- Ensure a full range of ahead and astern pitch tests are carried out prior to port departure and arrival.
- Clarify anchoring and anchor readiness procedures.
- Require ship's crew to carry out periodic drills to practise the correct response to propulsion system failures.
- Regularly test the arrangements provided for the operation of propulsion systems in an emergency.

MAN Diesel & Turbo SE is recommended to:

2012/112 Enhance the appearance and labelling of the backup control button on Alphatronic 2000 Propulsion Control Systems so that during an emergency its function is more readily apparent.

Bureau Veritas is recommended to:

2012/113 Make a submission to IACS to introduce a unified requirement for controllable pitch propeller systems to be subjected to a full range of tests in both ahead and astern directions during commissioning trials of new and existing systems.

Marine Accident Investigation Branch
May 2012

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

Marine Accident Report

INVESTORS IN PEOPLE