ACCIDENT REPORT

MAIB MARINE ACCIDENT INVESTIGATION BRANCH

Report on the investigation of the contact of the chemical tanker *Ali Ka* with Oikos Jetty 2 on the River Thames at Canvey Island, England on 25 October 2022

SERIOUS MARINE CASUALTY REPORT NO 6/2024 JULY 2024

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2012 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 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 14(14) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

Front cover image courtesy of Sakis Antoniou (MarineTraffic.com).

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CONTENTS

FIGURES

TABLES

ANNEXES

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

°	-	degrees
2/O	-	second officer
BRM	-	Bridge Resource Management
BSSS	-	Baines Simmons Safety Services
BST	-	British Summer Time (Greenwich Mean Time +1 hour)
CEO	-	chief executive officer
C/O	-	chief officer
CCTV	-	closed-circuit television
CHM	-	chief harbour master
COMAH	-	Control of Major Accident Hazards Regulations 2015
COVID-19	-	coronavirus
DPC	-	duty port controller
ECDIS	-	Electronic Chart Display and Information System
ENC	-	electronic navigational chart
EU	-	European Union
EUWTD	-	European Working Time Directive 2003/88/EC
GBRf	-	GB Railfreight Limited
GRT	-	gross registered tonnage
HM	-	harbour master
HM SMS&VTS		harbour master responsible for SMS and VTS
HSEQ	-	health, safety, environmental and quality
HSE	-	Health and Safety Executive
HSG	-	health and safety guidance
HSG256	-	Managing shiftwork
ICS	-	International Chamber of Shipping
IMO	-	International Maritime Organization
ISM Code	-	International Safety Management Code
kts	-	knots
LOA	-	length overall
m	-	metre
MAPP	-	major accident prevention policy

MCA	-	Maritime and Coastguard Agency
MGN	-	Marine Guidance Note
MGN 505 (M)	-	Human Element Guidance – Part 1: Fatigue and Fitness for Duty
mm	-	millimetres
MMM	-	Chief Harbour Master's Marine Management Meeting
MPM	-	marine pilotage manager
MPX	-	master/pilot exchange
MSC.1/Circ.1598	-	IMO Maritime Safety Committee Circular: Guidelines on Fatigue
MSMS	-	marine safety management system
MSN	-	Merchant Shipping Notice
PCC	-	Port Control Centre
PD op letter	-	pilotage department operational letter
PISCES	-	Port Information System for End-to-end Services
PLA	-	Port of London Authority
PMSC	-	Port Marine Safety Code
Polaris	-	Port of London Authority reporting and information system
Polaris Lite	-	Reduced variant of Polaris, accessible on a pilot's tablet
RAIB	-	Rail Accident Investigation Branch
Resolver	-	independent commercial issue resolution platform
SEAiq	-	A commercial multi-platform piloting software
SHA	-	Statutory Harbour Authority
SharePoint	-	Microsoft web-based collaboration software
SHM	-	senior harbour master
SMCP	-	IMO Standard Marine Communication Phrases
SMS	-	safety management system
UKC	-	under keel clearance
UTC	-	universal time coordinated
VHF	-	very high frequency
VTS	-	vessel traffic services
VTSO	-	vessel traffic services officer

TIMES: all times used in this report are BST (UTC+1) unless otherwise stated.

Image courtesy of Sakis Antoniou (MarineTraffic.com)

Ali Ka

SYNOPSIS

On 25 October 2022, the 129.5m oil/chemical tanker *Ali Ka* departed from the Oikos fuel storage facility, Canvey Island, Essex in the early morning. While manoeuvring off the berth under pilotage, control of the ship was lost and it made contact with another fuel jetty at the site. *Ali Ka*'s starboard aft quarter was damaged in the accident but there were no injuries. The resulting damage to the westernmost dolphin, and a walkway, at Oikos Jetty 2 caused the jetty to be taken out of commission for 2 months before being returned to service at reduced capacity until repairs were completed in September 2023.The investigation concluded that it was highly likely that the pilot was fatigued, was unfamilar with the berth, and had elected to sail without the support of a tug. It also concluded:

- The Port of London Authority documentation on tug use had not been comprehensively updated to include a mandatory tug requirement for the Oikos berth, which was subject to the Control of Major Accident Hazard Regulations 2015.

- *Ali Ka*'s bridge team roles and responsibilities had not been allocated to best support the pilot during the manoeuvre.

- The pre-departure master/pilot exchange was ineffective and unsuccessful, and challenges to decision-making did not result in changes to the departure plan.

- Parts of the Port of London Authority's marine safety management system lacked clarity and the management of pilot fatigue did not identify and control the risk of fatigue.

- The Port of London Authority had identifed lessons from previous incidents but these had not resulted in fully updated procedures and opportunities for capitalising on learning had therefore been lost.

The Port of London Authority has taken numerous actions as a result of this accident that have included revisions to its safety management system, the withdrawal of out of date guidance and the introduction of qualitative reviews of pilotage plans.

Recommendations have been made to the Port of London Authority to conduct risk assessments of high-risk berths (in conjunction with Oikos for its berths); review the risk and management of pilot fatigue; implement stop procedures; and highlight, to pilots, the practices contained in the International Chamber of Shipping Bridge Procedures Guide.

Ali Ka's operator, Trans Ka Tankers, has been recommended to revise its fleetwide training in Bridge Resource Management and review the use of aids to navigation during pilotage.

The International Chamber of Shipping has been recommended to update its Bridge Procedures Guide with regard to the assignment of roles and responsibilities during the master/pilot exchange.

SECTION 1 – FACTUAL INFORMATION

1.1 PARTICULARS OF *ALI KA* AND ACCIDENT

SHIP PARTICULARS	
Vessel's name	*Ali Ka*
Flag	Malta
Classification society	Bureau Veritas
IMO number/fishing numbers	9451226
Type	Oil/chemical tanker (IMO type 2)
Registered owner	North Star Tankers Limited
Manager(s)	Trans Ka Tankers
Construction	Steel
Year of build	2020
Length overall	129.5m
Registered length	122.7m
Gross tonnage	7324
Minimum safe manning	13
Authorised cargo	Oils and chemicals

VOYAGE PARTICULARS	
Port of departure	Oikos Storage Limited, Canvey Island, Port of London, England
Port of arrival	Eastham, Merseyside, England (intended)
Type of voyage	International
Cargo information	Hydrogenated vegetable oil
Manning	18

MARINE CASUALTY INFORMATION	
Date and time	25 October 2022 at 0436 UTC+1
Type of marine casualty or incident	Serious Marine Casualty
Location of incident	Canvey Island, Port of London, England
Place on board	Starboard quarter
Injuries/fatalities	None
Damage/environmental impact	Damage to starboard quarter of *Ali Ka*; serious damage to westernmost dolphin and walkway of Oikos Jetty 2; no pollution.
Ship operation	Manoeuvring under pilotage
Voyage segment	Departure
External & internal environment	Wind from south-west at 15kts, sea state 1, tidal stream ebbing at 1.7kts, good visibility, dark night, no moon.
Persons on board	19

1.2 BACKGROUND

The Port of London Authority (PLA) was the statutory and competent harbour authority for 95 miles of the River Thames from Teddington Obelisk to the North Sea **(Figure 1)**. The PLA had a statutory duty to provide a pilotage service throughout its area of authority as described by the Pilotage Act 1987[1]. In 2022, the PLA handled 54.9 million tonnes of cargo and carried out 13,699 pilotage acts[2]. The port was the UK's largest by volume of goods handled.

Oikos Storage Limited (Oikos) operated a 70-acre bulk liquid storage facility on Canvey Island, Essex, England **(Figure 2)**. The facility had a tank storage capacity of 300,000 cubic metres and supplied road and aviation fuels to industry and national airports, including Heathrow, Gatwick and Stanstead. It also contributed to the national fuel distribution pipeline network and connected the UK to the European fuel supply distribution network[3]. The Oikos facility was classified as a critical piece of national infrastructure and was regulated by the Health and Safety Executive (HSE) under the Control of Major Accident Hazards Regulations (COMAH) 2015. Oikos operated two jetties: Jetty 1 (Oikos 1) and Jetty 2 (Oikos 2).

Image courtesy of the Port of London Authority

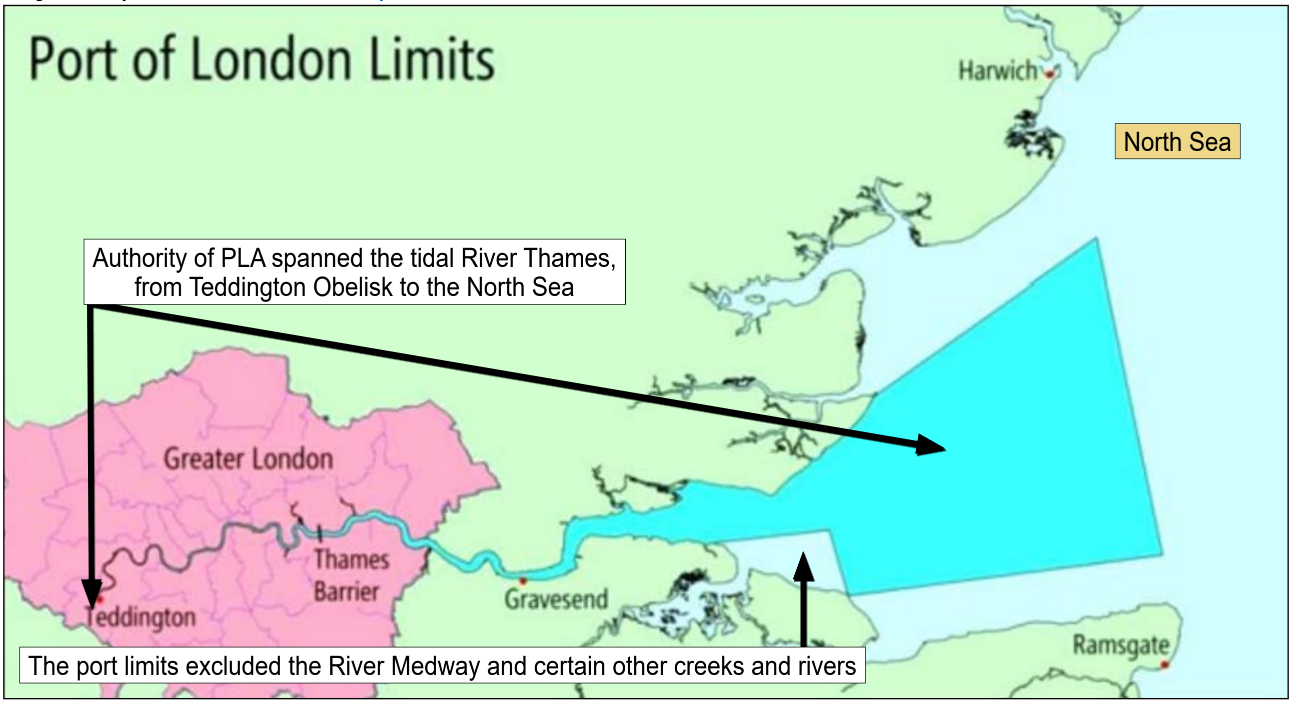

Figure 1: Port of London Authority limits

[1] As defined in Part I: Pilotage Functions of Competent Harbour Authorities https://www.legislation.gov.uk/ukpga/1987/21/contents

[2] https://pla.co.uk/annual-report-and-accounts-2022

[3] https://www.oikos.co.uk/

Image courtesy of Storage Terminals Magazine

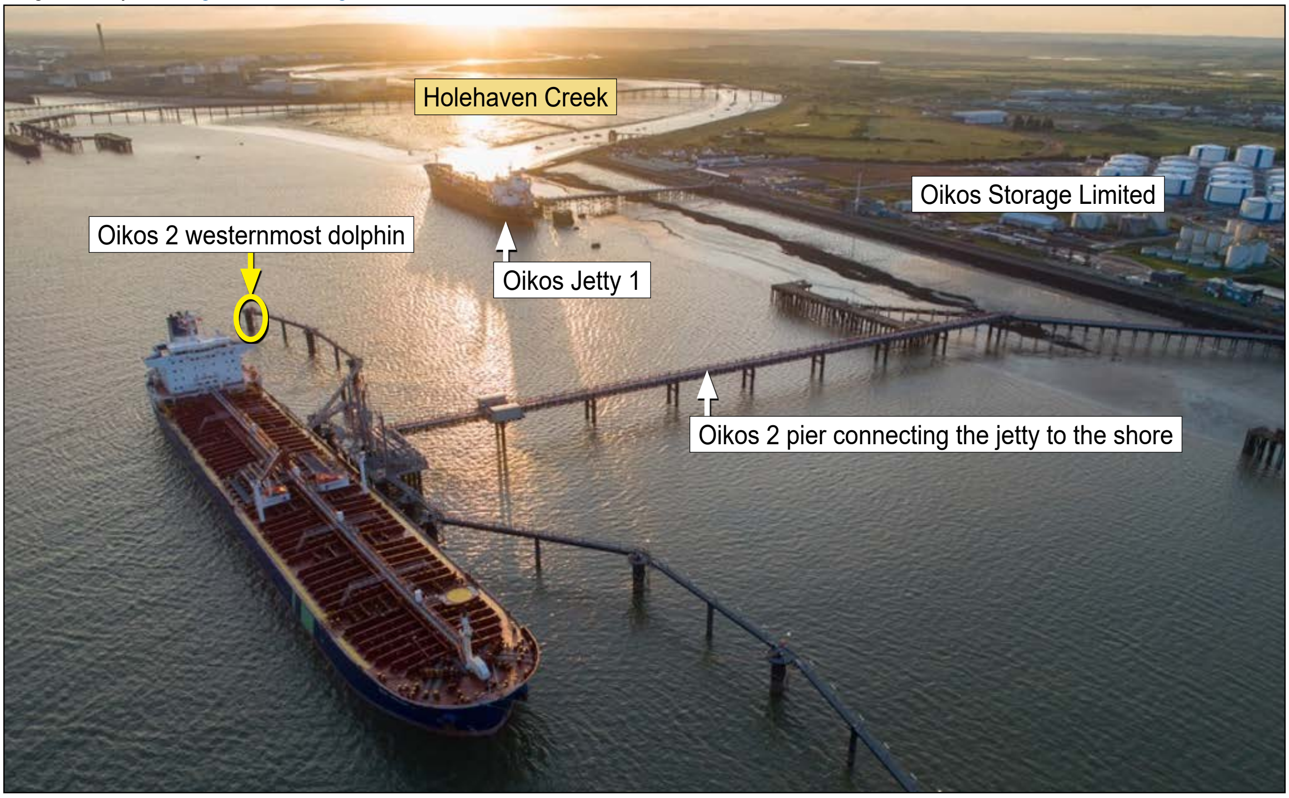

Figure 2: Oikos Storage Limited site

1.3 NARRATIVE

1.3.1 Arrival and cargo operations

On 23 October 2022, *Ali Ka* **(Figure 3)** sailed from Antwerp, Belgium bound for the River Thames, England, loaded with 7,956 cubic metres of hydrogenated vegetable oil. At 0800 on 24 October 2022, two PLA pilots, one of whom was a trainee, boarded *Ali Ka* for the transit upriver to Oikos 1, Canvey Island **(Figure 4)**. *Ali Ka* arrived at Oikos 1 at 1118. The wind was 15 knots (kts) from the south-west on arrival, the tidal height was 4.6m and the flood tide was 0.5kts and weakening. The pilot berthed *Ali Ka* port side to the berth, bows downstream (or head-down). No tugs were used for the move. The pilot discussed tug use for *Ali Ka*'s departure and annotated the ship's bell book[4], informing the master that if the ship was to sail on the ebb tide then use of a tug for the move was mandatory. The pilot also made a note in Polaris (see section 1.8.3.1) that *Ali Ka* had *weak astern power*.

Image courtesy of Bettina Rohbrecht (MarineTraffic.com)

Figure 3: *Ali Ka*

[4] An official book used to record vital information about the ship's movements.

Image courtesy of Google Earth

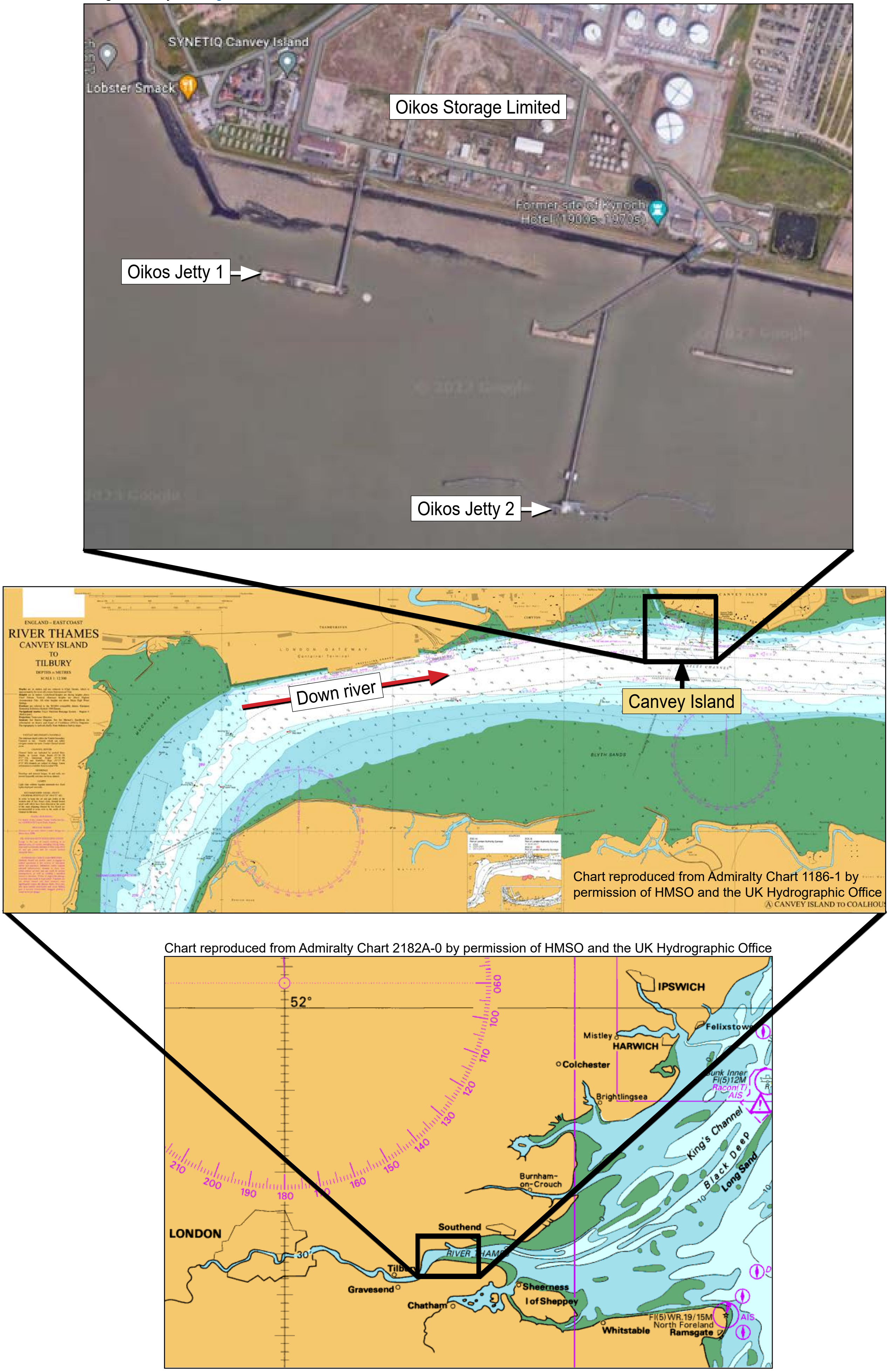

Figure 4: Location of the accident

At 1442, *Ali Ka* started discharging approximately half of its cargo. It was expected that cargo work would be completed by approximately 0100 on 25 October 2022, and the ship's agent was notified so that the vessel's departure could be organised. *Ali Ka*'s next planned port of call was Eastham, Merseyside, England to offload the remaining cargo. By 1500, the passage plan (voyage number 29[5]) had been produced by *Ali Ka*'s second officer (2/O) and checked by the master; both signed to indicate that their checks had been completed. The passage plan noted that the estimated time of departure was 0300 on 25 October 2022.

1.3.2 Preparations for departure

At 2042, the pilot coordinator in the London Vessel Traffic Services (VTS) Port Control Centre (PCC) allocated the pilot (pilot A) for *Ali Ka*'s departure. Two minutes later, *Ali Ka*'s agent called the duty port controller (DPC) at London VTS PCC to discuss an 0400 sailing time. The agent enquired whether the DPC would advise booking a tug as none was required by the Code of Practice for Ship Towage Operations on the Thames[6]. The DPC advised that a tug should be booked as problems had previously been experienced at Oikos 1. The operators of *Ali Ka*, Trans Ka Tankers, had an account with Boluda Towage for the provision of tugs and the agent called the dispatcher at 2054 to request one. The Boluda Towage dispatcher could not guarantee a tug for 0400 due to an earlier departure of the ultra-large container carrier *Delaware Express*. The dispatcher informed the agent that a tug could be guaranteed for 0500; it was possible that tugs might be available at 0430 or earlier if *Delaware Express* sailed on time. Tug *VB Panther* was booked to assist *Ali Ka* to sail from Oikos 1 at 0500 on 25 October 2022.

At 2056, pilot A called the DPC to discuss the departure plan for *Ali Ka*. During the call pilot A noted that tug *VB Panther* had been booked and that the departure time was now set as 0500. At 2216, pilot A called the DPC again and highlighted some concerns about the height of tide at 0500. Pilot A asked if *Ali Ka* could sail at 0400 when the height of tide would be 3.29m compared to 2.16m at 0500. After some discussion pilot A said that they would be happier for *Ali Ka* to depart at 0400 without tug assistance than an hour later with a tug. The DPC then called *Ali Ka*'s agent and asked for the move to be brought forward to 0400 with the understanding that no tug was available for that time. At 2221, the DPC informed pilot A by telephone that the 0400 move had been confirmed and that there was no tug. *Ali Ka*'s agent called the Boluda Towage dispatcher and cancelled *VB Panther*. At 2228, the agent informed *Ali Ka*'s master that departure was confirmed for 0400 without a tug, and that line handlers and a pilot had been booked.

1.3.3 Departure and contact with jetty

At 0148 on 25 October 2022, all the required documentation had been completed on board *Ali Ka* in readiness to depart Oikos 1. At 0253, pilot A parked at PLA's Gravesend car park and walked to the pier to board the harbour services launch for transit to the Tilbury landing stage. From there, pilot A took a pre-booked taxi to Oikos 1. By 0300, the master and the helmsman had arrived on *Ali Ka*'s bridge and prepared for the departure. The Electronic Chart Display and Information System (ECDIS) had voyage 29 loaded; the ECDIS shallow contour was set to 10m; the safety contour to 11m; and the safety depth to 11m.

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[5] Voyage number 29 was the berth-to-berth passage plan prepared by the ship detailing the passage from Oikos 1 to Eastham.

[6] Provided for the guidance of masters, pilots and tug crews involved, or likely to be involved, in ship towage operations. Commonly referred to as the Towage Code.

At 0340, pilot A arrived and was escorted to *Ali Ka*'s bridge. Once there, pilot A started to discuss the departure with the master and talked through the manoeuvre off the berth. *Ali Ka* was head-down (bows east) on the jetty, with the ebb stream in full flow. Pilot A's plan was to let go all stern lines and then swing the vessel's stern 90° to the berth before letting go the remaining lines and going astern. Focused on the tidal height, pilot A explained the need to stay clear of the shoal water to the south-west of Oikos 1.

Ali Ka's master confirmed the vessel's maximum draught as 7.4m aft and the cargo as vegetable oil. Pilot A then discussed the fact that *Ali Ka*'s departure had been brought forward to 0400, from 0500, because of his concerns about the height of tide. The master then asked pilot A to check if a tug could be obtained for *Ali Ka*'s departure. At 0345, pilot A called London VTS, using the vessel's very high frequency (VHF) radio, to check on the live tidal readings, pass on *Ali Ka*'s maximum draught, and ask if a tug was available. While waiting for London VTS to reply, pilot A and the master once again discussed the manoeuvre and the state of tide. They also talked about how the bow thruster functioned.

At 0347, London VTS called *Ali Ka* to advise that no tug had been booked for the departure. Pilot A said that this was due to *Delaware Express* departing at the same time and then informed the master that there was no tug for their move. The master remained concerned about the lack of a tug, despite pilot A's reassurances. During this exchange pilot A talked through the plan to use the forward spring to control the turn off the jetty and asked that the anchor be kept at standby. At 0349, pilot A visited the toilet. Seconds later, the pilot on board *Delaware Express* called *Ali Ka* and asked if the pilot was there. The master replied that the pilot was on board. The master then discussed the sailing with the chief officer (C/O) over a handheld radio. On returning from the toilet, pilot A said that *Ali Ka* should sail.

Further discussions took place between pilot A and the master about fendering, transit marks and the manoeuvre off the jetty. At 0354, pilot A used the radio to brief the line handlers about the plan for departure. The discussion about the manoeuvre off the berth then continued between pilot A and the master. At 0358, the master highlighted that a -12 setting on *Ali Ka*'s propulsion control had a neutral effect and that a zero setting resulted in ahead propulsion. Pilot A was concerned that preparations for sailing were behind schedule and was making efforts to hurry the departure. At 0400, the master, speaking in Turkish on a handheld radio, instructed mooring parties not to untie the mooring lines. After a discussion about whether *Ali Ka*'s crew were ready at their stations pilot A emphasised the steadily reducing height of tide to the master.

At 0402, the pilot on board *Delaware Express* called London VTS on the VHF radio and asked to switch to a private channel. The bridge team of *Ali Ka* and pilot A listened to that conversation but could only hear London VTS respond that there was no tug for the move, and that it agreed with the pilot of *Delaware Express* and would speak to the DPC (see section 1.8.4.3 for complete conversation). At 0405, the master called the ship's agent on a mobile telephone to highlight concerns about sailing without a tug. This call became a heated three-way conversation between the agent, the master and pilot A, and ended with pilot A saying that 0500 was too late to conduct a safe move. At 0410, pilot A reiterated the predicted height of tide at 0500 and said that this was not enough. At 0412, using a handheld VHF radio, the master ordered the ship's lines to be singled up and briefed the ship's officers at the mooring stations.

At 0414, pilot A called London VTS on the VHF radio for clearance to sail. The master then briefed pilot A again about *Ali Ka*'s astern propulsion. At 0416, London VTS called back to say that there was no traffic to affect the move and, on request, stated that the height of tide was 3m at Thames Haven. By 0417, the mooring teams had slipped all lines other than the forward spring. Pilot A then manoeuvred *Ali Ka* off the berth **(Figure 5)** and, at 0423, all lines were ordered to be slipped. The forward spring snagged briefly but was cleared by 0425 and pilot A continued to manoeuvre *Ali Ka* to 90° off the berth. At 0429, pilot A ordered the master to stop the engine and then go ahead. During this period a bow thruster overload alarm sounded and was acknowledged and reset. *Ali Ka* was making way astern and, at just before 0431, pilot A requested dead slow astern and then slow astern. By 0432, the tidal stream was taking *Ali Ka* towards the westernmost dolphin of Oikos 2. Almost a minute later, pilot A attempted to kick the vessel's stern to port by ordering ahead power and full starboard rudder. At 0434, pilot A ordered the engine to full astern and, soon after, full thrust to starboard. At the same time, the VTS officer (VTSO) observed on radar that *Ali Ka* was nearing Oikos 2 and called on VHF to check if all was okay on board; the call was not heard on the bridge of *Ali Ka*. At 0435, and for the next 90 seconds, the master and pilot A both shouted a series of orders about the anchors. At the end of this it was stated that the anchors were just to be lowered to the waterline. At 0436, the VTSO called *Ali Ka* warning that the vessel was running close to the oil jetty at Oikos 2; this transmission was not heard on board. At 0436:40 pilot A ordered "*Hard starboard, kick ahead, kick ahead*". Twelve seconds later, *Ali Ka*'s starboard aft quarter collided with the westernmost dolphin of Oikos 2.

With the engine now full ahead and the wheel hard to starboard, *Ali Ka* scraped along the dolphin. By 0438, both anchors were down and the engine was set to stop. *Ali Ka*'s stern cleared the westernmost dolphin, but as the bows pushed into the soft mud of the riverbank the stern hit the walkway on Oikos 2 and dislodged a section of it. By 0439, *Ali Ka* was stuck, the vessel's bows partly held by the anchors now lying out to port and by the mud of the riverbank. *Ali Ka*'s bows were approximately 48m away from the pier of Oikos 2 and the stern was resting on the jetty.

1.3.4 Recovery and damage

At 0439, pilot A called London VTS and requested tug assistance as soon as was possible. At 0449, the tug *Craigleith* arrived, followed at 0504 by the tug *Svitzer Bootle*. Pilot A then arranged for the tugs to take the weight, recovered the anchors and, by 0630, had berthed *Ali Ka* alongside Oikos 1, starboard side to, head-up. Damage on board comprised some indentations, bent frames and deep scours along the starboard quarter; there were two 500mm x 500mm holes punched into the hull and some guardrails had been bent flat. All the damage was above the waterline **(Figure 6)**. Oikos 2 suffered damage to the westernmost dolphin, with power cables cut and the structural integrity of the dolphin in doubt. The walkway had fallen into the river where *Ali Ka*'s stern had struck it **(Figure 7)**. There were no injuries to personnel.

1.3.5 Post-accident actions

Pilot A was suspended from duty pending a PLA investigation. On 4 November, both pilot A and the DPC were placed under PLA's disciplinary processes. The DPC was cleared of all disciplinary charges on 6 January 2023. All disciplinary processes against pilot A ceased on 10 March 2023, when pilot A retired after 22 years' service with PLA.

Oikos 2 was returned to 75% operational capacity 2 months after the accident, then repaired and fully recommissioned in September 2023.

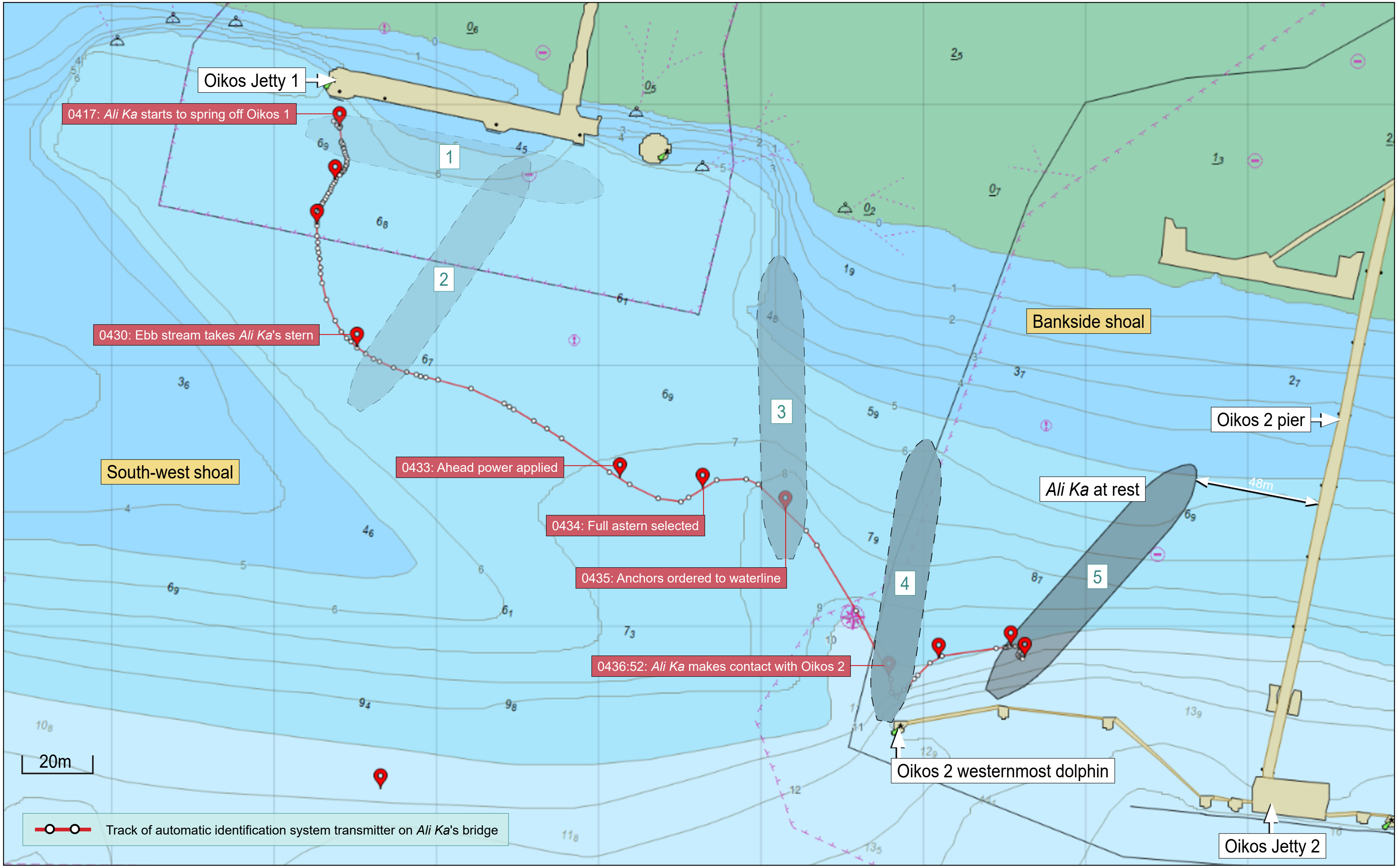

Figure 5: The sequence of events

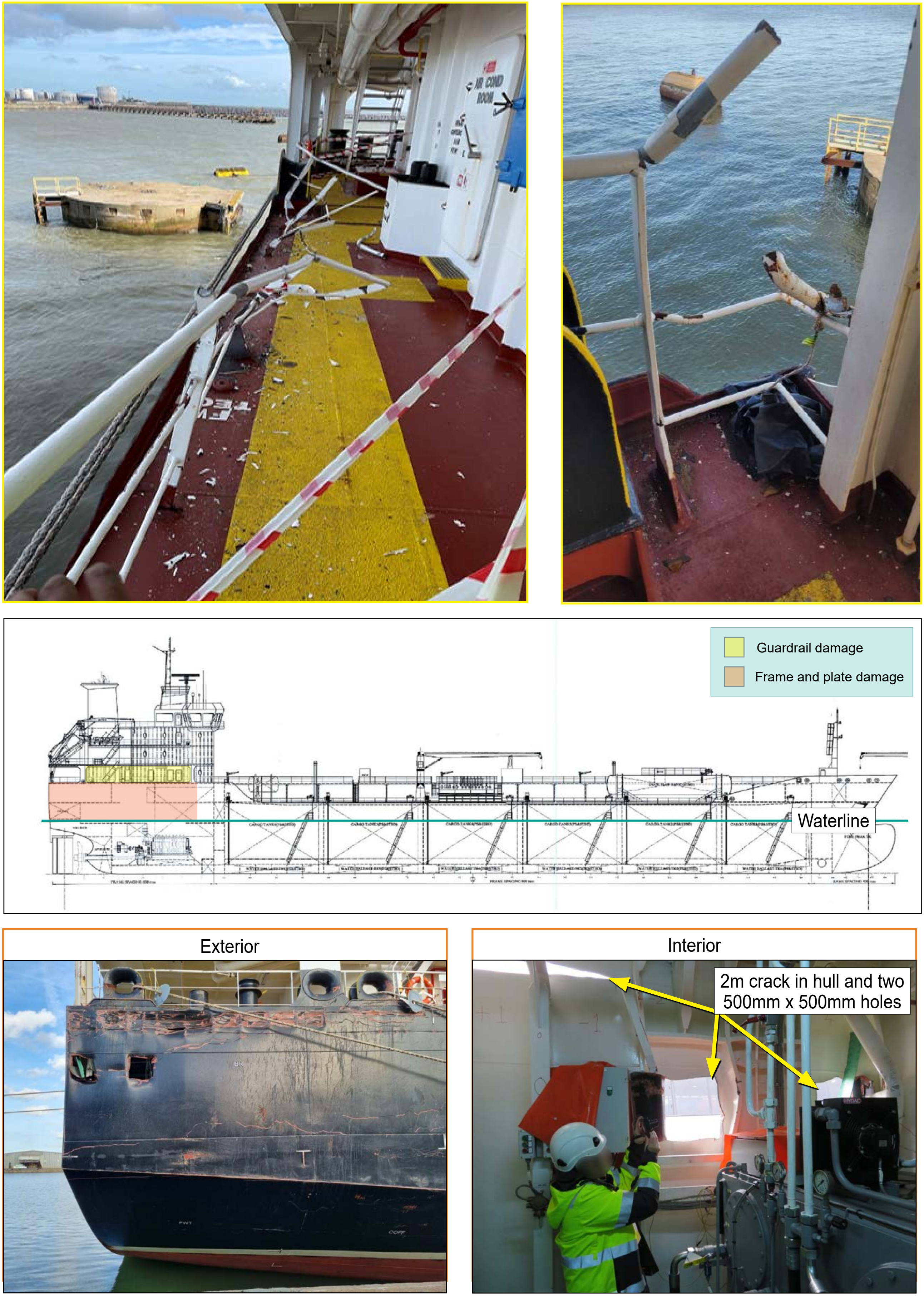

Figure 6: Damage to *Ali Ka*

Inset images courtesy of the Port of London Authority

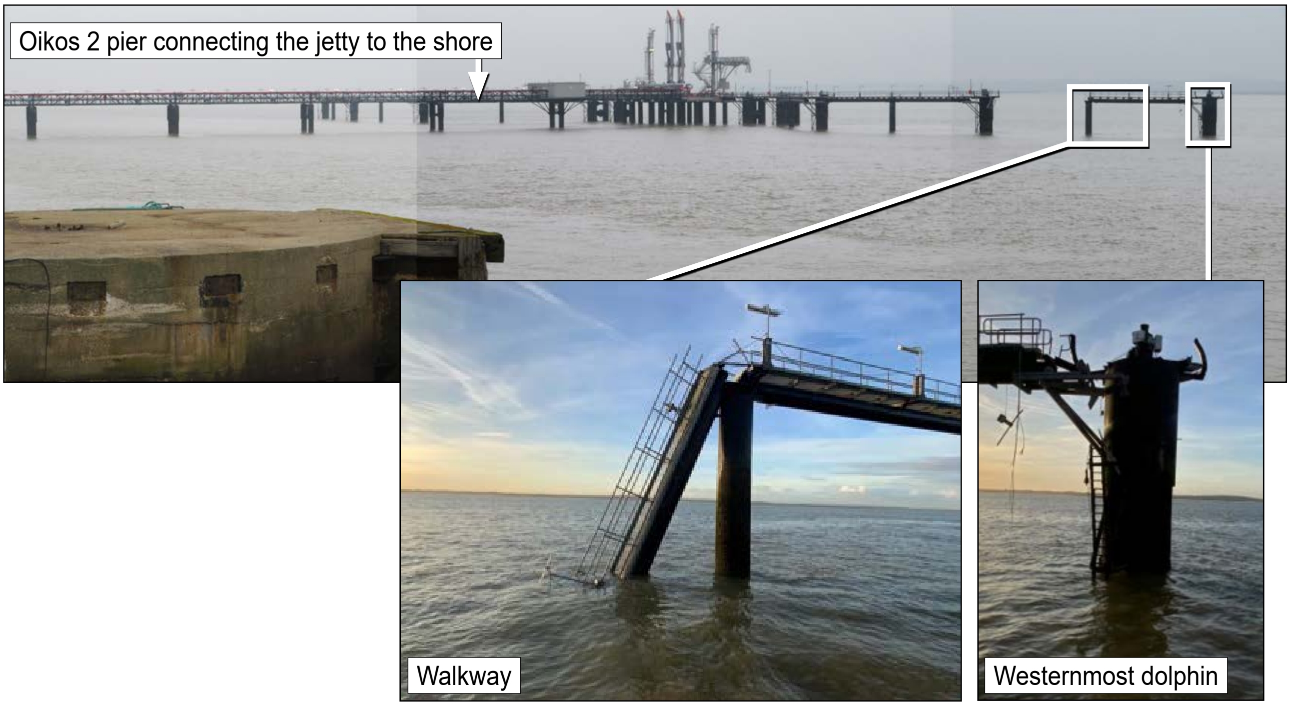

Figure 7: Oikos 2 and (inset) its walkway and damaged westernmost dolphin

1.4 ENVIRONMENTAL CONDITIONS

The night of 24/25 October 2022 was dark with moonrise occurring at 0727, and sunrise at 0738. Visibility was good. Predicted tidal heights at Coryton (adjacent to Oikos) were 3.29m at 0400 and 2.16m at 0500. The actual tidal heights observed on 25 October 2022 were approximately 0.1m above predictions. At 0400, the wind was 15kts from the south-west and it was just over 3 hours after high water at Thames Haven. The tidal stream was ebbing towards the east at approximately 0.5kts just off the berth at Oikos 1, increasing to over 3kts in the Yantlet Channel **(Figure 8)**.

Image courtesy of the Port of London Authority. The underpinning depth data was not to be used for navigation with the ENC containing up-to-date data

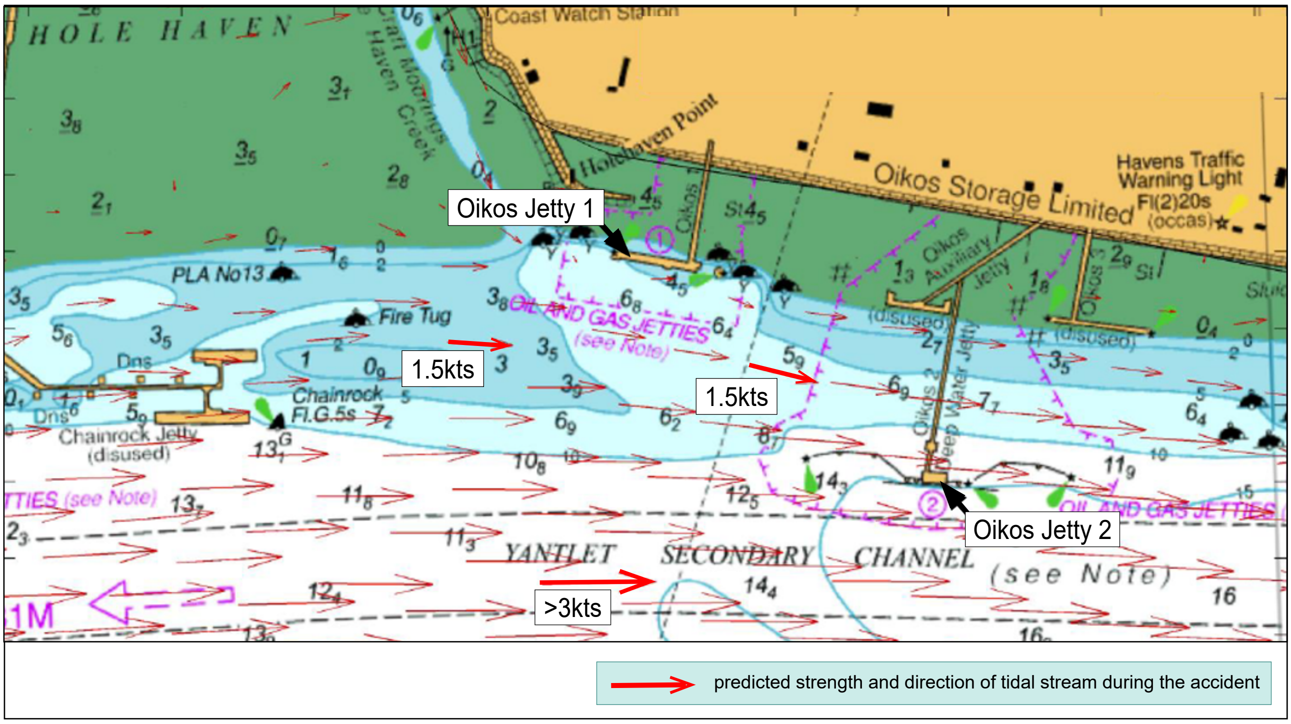

Figure 8: Tidal stream at Oikos on 25 October 2022 at 0427 UTC+1 (high water plus 3.5 hours)

1.5 APPROACHES TO OIKOS 1

The area off Oikos 1 was constrained by shallow water to the north, west and south-west of the jetty and also by the Oikos 2 jetty to the east and south-east. According to the latest PLA hydrographic surveys[7] the controlling depth on exit from Oikos 1 out to the Yantlett Channel was *6.6m* at the berth *and 6.7m on approach midway off the jetty*. The shallow water to the south-west of Oikos 1 was relatively steep-sided with depths of less than 2m at the top of the associated bank. The presence of this bank of shallow water resulted in a relatively confined space for manoeuvre off Oikos 1 and a narrow point of exit between the shallow water to the south-west and the westernmost dolphin of Oikos 2. The gap between the 6m contour on the south-eastern tip of the shallow water and the westernmost dolphin on Oikos 2 was 173m.

1.6 *ALI KA*

1.6.1 Vessel description

Ali Ka, was a 7,324 gross registered tonnage (GRT), double-hulled liquid oil/chemical tanker, primarily trading between European ports. *Ali Ka* had a four-bladed controllable pitch propeller and a 530 kilowatt bow thruster. The bridge centreline console comprised steering, propulsion and bow thruster controls flanked by a pair of radar displays and two individual ECDIS displays **(Figure 9)**. The bridge had enclosed bridge wings with consoles that also had steering, propulsion, and bow thruster controls.

At the time of the accident all the navigational equipment was operating correctly, and the ship was being steered by a helmsman at the centreline console. The ECDIS was loaded with a high-density electronic navigational chart (ENC) cell that allowed contours to be selected at 1m intervals.

The ship's top speed was 15kts and manoeuvring was normally conducted below 3.5kts as the bow thruster became ineffective above that speed. The master briefed pilot A that, when operating astern propulsion **(Figure 10)**, a setting of -12 produced a *neutral effect* and stated that astern propulsion was *lazy* and *very, very slow*. The bow thruster had three power level settings: 70%, 85% or 100%, to either port or starboard. The master also stated that the bow thruster might alarm if set to 100%.

1.6.2 Owners

Ali Ka was owned by North Star Tankers Limited of Valetta, Malta and managed by Trans Ka Tanker İşletmecılıgı Tıcaret Limited STI (Trans Ka) as part of Akbasoğlu Holdıng, Istanbul, Turkey.

Trans Ka's Document of Compliance confirmed that the company's safety management system (SMS) met the requirements of the International Safety Management (ISM) Code. It was issued on 24 May 2022 by the Government of Malta, as flag state, and was valid until 24 February 2023.

[7] The PLA approved comment from hydrographic department surveys, dated 9 September 2022.

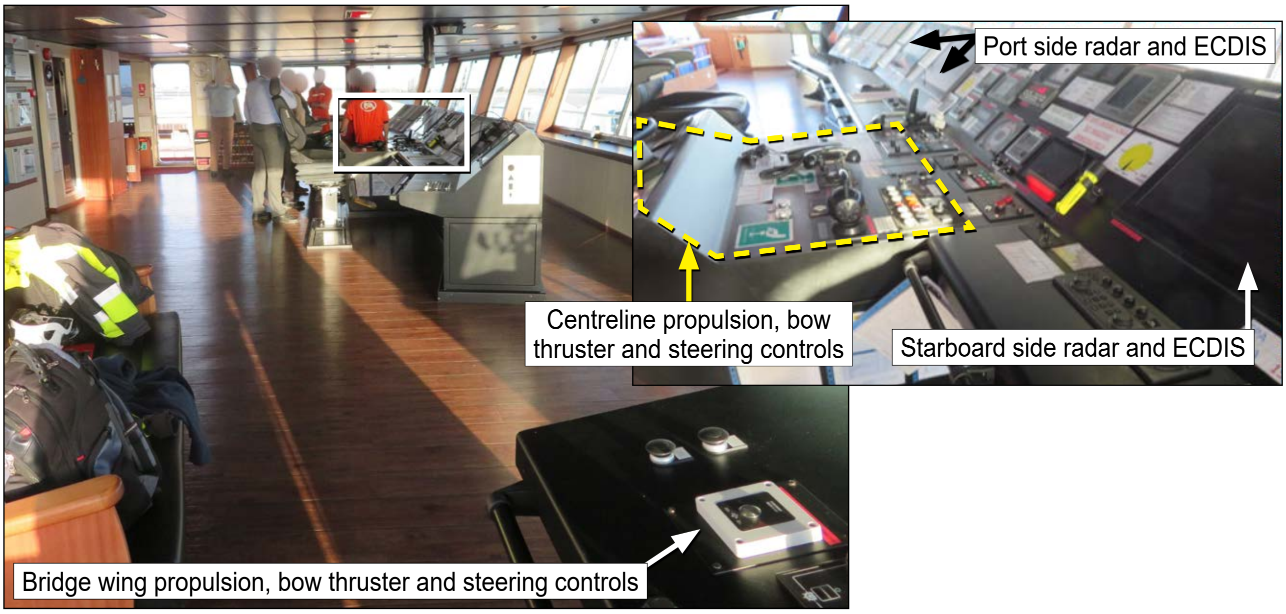

Figure 9: *Ali Ka* bridge layout

Figure 10: Propulsion control unit

1.6.3 Crew

Ali Ka's crew members were Turkish, as was the language used on board. Three crew members had joined the ship in early June, one in July, eight in September and the rest in October. The master had embarked on 9 October 2022 in Teesport, England and sailed *Ali Ka* to Antwerp on 10 October 2022, where the ship stayed until its departure for the UK on 23 October 2022, arriving at Oikos on 24 October 2022. *Ali Ka* was crewed in excess of its minimum safe manning of 13 and, in addition to the ship's permanent crew of 15, carried one deck cadet and two ordinary seamen in training positions.

The 62-year-old master had worked at sea for 39 years and had been a master with Trans Ka since 1998, serving as master of *Ali Ka* from the ship's build in 2020. The master did not keep sea watches. The C/O, 2/O and third officers kept a 1-in-3 watchkeeping schedule while *Ali Ka* was at sea. A full record of the hours of work and rest was available for the crew of *Ali Ka*.

1.7 TRANS KA SAFETY MANAGEMENT SYSTEM

1.7.1 General

The SMS was last updated in January 2019 and the onboard copy was written in Turkish; a translated copy was made available to the investigation. The SMS was not ship-specific though it was subject to routine audit. Section 7 of the SMS covered navigational safety and was further subdivided as follows:

- communications;
- bridge organisation (including preparations for sea, voyage planning, watchkeeping, anchoring and mooring); and
- engine room watchkeeping (including the relationship to bridge operations).

ECDIS use, pilotage and passage planning of relevance to managing safety in pilotage waters were all covered in the bridge organisation subsection.

The SMS did not specifically cover Bridge Resource Management (BRM) or challenge and response, though it did state that an effective bridge organisation would *manage efficiently all the resources that are available to the bridge and promote good communication and teamwork*.

1.7.2 Passage planning and ECDIS use

ECDIS was the primary means of navigation on board *Ali Ka*. Safety contours and safety depths were calculated as part of passage planning to a company formulation. The SMS also divided passage planning into four distinct stages; appraisal, planning, execution, and monitoring.

The SMS detailed minimum under keel clearance (UKC) and squat calculations for various scenarios. On manoeuvring, section N 7.2.1.3 of the SMS stated:

> *Once all dynamic factors have been taken into consideration, a margin of safety is at least 10% of the static draft* [sic] *that remains under the keel for vessels that are underway/ transiting to and from berth …*[8] [sic]

To calculate the safety contours to be applied in ECDIS the 2/O was required to apply squat[9] for the departure from Oikos 1. The 2/O was presented with several different values of squat to choose from. The detail in voyage number 29 used a block coefficient of 0.73[10], a squat value of 0.36m and a dynamic draught of 7.86m for transit *to and from the berth*. That voyage plan listed the calculated depths that included Trans Ka *safety parameters* and stated that the minimum depth for transit *to and from berth* was 8.65m with a minimum dynamic UKC of 0.79m. The 2/O set the ECDIS shallow contour at 10m, the safety depth and safety contour of 11m and the deep contour of 20m **(Figure 11)** and had uploaded the most up-to-date charts. These ECDIS settings indicated that the departure from Oikos 1 was in waters shallower than the calculated safety contours as the minimum charted depth between Oikos 1 and the entrance to the Yantlet Channel was 6.4m.

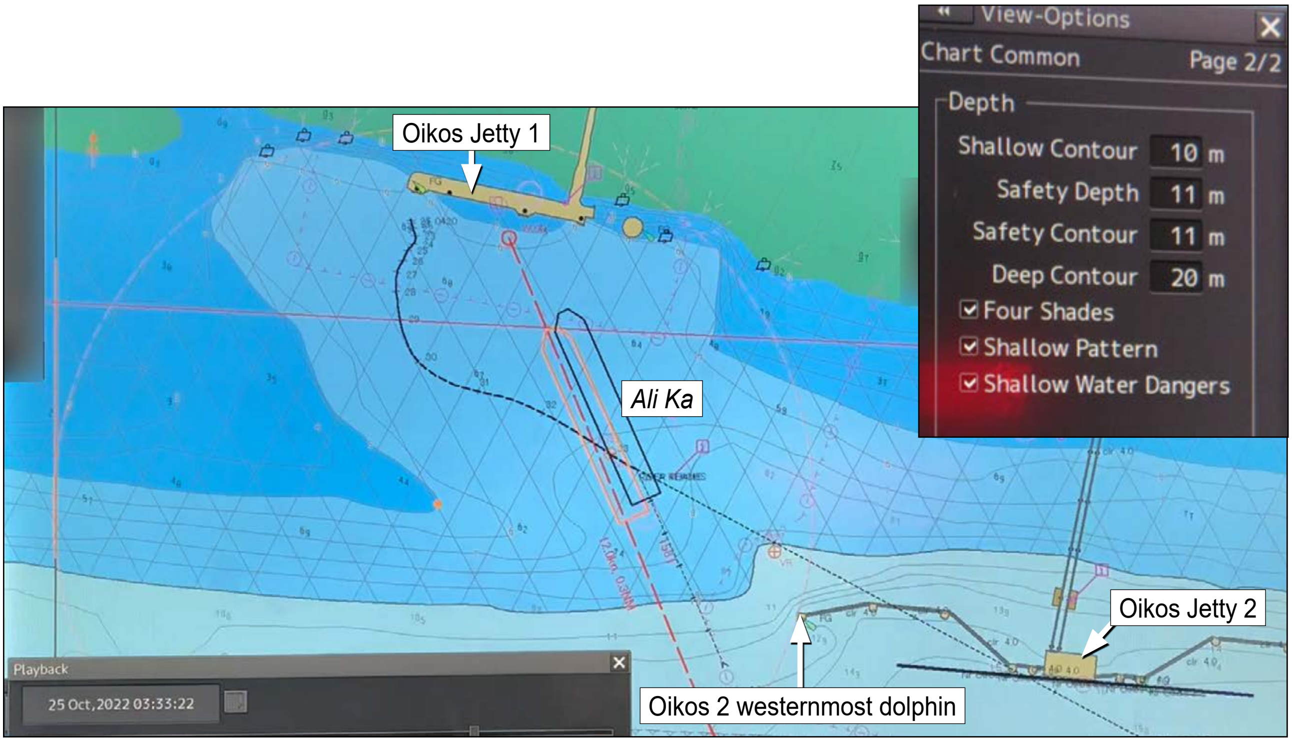

Figure 11: Safety contour used for the move and (inset) *Ali Ka*'s ECDIS settings

[8] Trans Ka Tankers Management Co. Ltd. Management Manual: Development of Plans for Shipboard Operations: Navigational Safety. 3rd Edition 25 January 2019.

[9] Squat is a hydrodynamic phenomenon causing a ship moving through shallow water to experience bodily sinkage towards the seabed. Values for squat can be predicted and vary with vessel (or water) speed and water depth. Squat for all vessels is zero when neither the vessel nor the water is in motion.

[10] The block coefficient of a ship is the ratio of underwater volume of the vessel compared to the volume of a rectangular block with the same length, breadth and depth. The closer the value of the block coefficient to 1 (maximum value) the more the ship will be affected by squat.

1.7.3 Pilots and conduct of pilotage

At section N 7.2.1 the SMS stated that:

Pilot, provides expert advice and guidance to the Master and the Bridge Team when navigating in pilotage waters.

The presence of pilot does not relieve the master and bridge team from their duties and responsibilities for ship safety and prevention of pollution. [sic]

At section N 7.2.4 the SMS stated that:

The Master shall inform the Pilot of the ship's manoeuvring characteristics and hand him on boarding, Company's "Master/Pilot Information Exchange" form and "Pilot Card" completed as directed by the Master. Any equipment's defect will be identified on the pilot card.

The Officer on watch should co-operate closely with the Pilot to assist him where possible and to maintain an accurate check on the ship's position and movement.

The Officer on watch should always seek clarification from the pilot when in any doubt as to the pilot's actions or intentions. If a satisfactory explanation is not given, the officer on watch should notify the master immediately, taking whatever actions is necessary before the master arrives.

The Master and his Officers must observe the Pilot's handling of the ship and must not hesitate to countermand his orders if they consider that safe navigation is at risk. [sic]

At section N 7.2.1.4 the SMS stated that:

Throughout the pilotage and berthing the Pilot should;

– Use the agreed working language and if necessary the IMO Standard Marine Communication Phrases (SMCP) when directing or advising the Bridge Team,

– Make use of the information provided during the Master / Pilot Information Exchange regarding manoeuvring characteristics,

– Respond to information, advice and questions from Bridge Team.

On berthing and unberthing with pilotage, section N 7.2.1.11.5 stated that:

The necessity of co-operation and a close working relationship between the master and pilot during berthing and unberthing operations is extremely important to the safety of the ship. In particular, both the pilot and the master should discuss and agree which one of them will be responsible for operating key equipment and controls (such as main engine, helm and thrusters).

The pilot should co-ordinate the efforts of all parties engaged in the berthing or unberthing operation (e.g. tug crews, linesmen, ship's crew). His intentions and actions should be explained immediately to the bridge management team, in the previously agreed appropriate language.

In supporting the pilot, the master and bridge personnel should:

– ensure that the pilot's directions are conveyed to the ship's crew and are correctly implemented;

– ensure that the ship's crew provides the bridge management team with relevant feedback information;

– advise the pilot once his directions have been complied with, where an omission has occurred or if a potential problem exists.

1.7.4 Pilot card and master/pilot exchange form

The pilot card and master/pilot exchange (MPX) forms prepared by *Ali Ka*'s crew included the following information: the safety contour was noted as 9.51m and the shallow contour as 8.92m; *Important details* were the ECDIS model, that NavTex warnings were updated automatically on ECDIS and that the ECDIS was in standard configuration and had no defects; the pilot card stated that there were no operational defects with equipment and that the bow thruster was not effective at speeds greater than 3.5kts. The MPX forms were signed by both the 2/O and the master. The master had added a handwritten note on the forms stating that they had been handed to the pilot but that pilot A had not signed them.

1.7.5 Anchor use

Section N 7.2.1.10 of the SMS covered anchoring in an emergency, although no mention was made of anchoring while manoeuvring or under pilotage as an emergency measure or contingency plan.

1.8 PORT OF LONDON AUTHORITY

1.8.1 Chief harbour master department

1.8.1.1 Organisation

The chief harbour master (CHM) was responsible to the chief executive officer (CEO) for all harbour services, VTS, safety management, pilotage and port security and contingency management. There were four elements to the CHM's department, each organised under a lead officer:

- The senior harbour master (SHM) was responsible for incident investigation, navigational safety, port security, the Towage Code, Thames resilience, berth liaison, emergency response and the risk register. This subdepartment covered both the Upper Thames (above Crayford Ness) and Lower Thames (below Crayford Ness) as two distinct subareas. Face to face liaison with berth operators had fallen into abeyance during the coronavirus (COVID-19) pandemic and was replaced by email contact and video meetings as required. The SHM line managed two other harbour masters, three deputy harbour masters, two assistant harbour masters and a marine superintendent. The SHM had joined the PLA in 2014.

- The harbour master SMS and VTS (HM SMS&VTS) was responsible for the management, organisation and control of the marine SMS and the safe running of VTS, including training and service continuity. A significant secondary duty was the delivery of a VTS refresh project that involved a new-build VTS PCC, colocation of the PCC and the Thames Barrier Navigation Centre, and redefined VTS roles and responsibilities. The HM SMS&VTS line managed the marine compliance manager and the VTS operations manager. The HM SMS&VTS had joined the PLA in 2014 and had been in post since 2016.

- The marine pilotage manager (MPM) was responsible for pilot recruitment, professional training (progression, professional development and the pilot training organisation), standards and safe delivery of pilotage. There were 119 pilots and 4 trainee pilots at the time of the accident. The MPM was supported by a deputy MPM, three pilotage support officers, an assistant pilotage support officer and five pilot coordinators. The MPM had joined the PLA in 2017.

- The Thames Tideway Tunnel harbour master was responsible for the major infrastructure project that was the Thames Tideway Tunnel.

1.8.1.2 Marine management meetings

The CHM held regular marine management meetings (MMM) to review the navigational safety policy and manage the content of the marine SMS. The MMMs were tasked with reviewing all marine accidents and incidents, reviewing hazards and risks, consulting with port users and berth operators, and reviewing reports from the pilotage management committee and pilotage training panel.

At the MMM on 23 September 2021, among other items discussed were the subjects of head-down ebb tide departures from Oikos 1 and tug provision for stern-to-tide moves. Oikos 1 departures had been raised before the meeting by one of the MMM pilot representatives[11] and they were awaiting an update. This pilot representative had been reviewing the MAIB report into *Sichem Melbourne*[12] concerning tug provision for head-down ebb tide departures and believed that if something went wrong during an Oikos 1 departure *you would end up potentially hitting Oikos 2… and if there was an incident on Oikos they would soon question why a tug was not used*. The MMM recorded that responses would be considered.

At the MMM on 25 November 2021, the item about tug provision for stern-to-tide moves was updated. The item had been noted as discussed at a risk assessment meeting and had been left open. There was a further comment that this would be addressed by the SHM in the *Tug Code* on return from leave and that, *as the code is now a live document it is straightforward to change*. The *Tug Code* referred to was the Towage Code.

This MMM also discussed Oikos 1 head-down ebb tide departures and the item was updated with a statement:

> *Agreed that it has not been identified as dangerous without a tug, but there are concerns which have been raised with Oikos. It's their decision as to whether they insist on a tug and as there has only been one stern to tide departure in the last two years there is not a great deal of evidence.*

---

[11] This pilot representative was the editor of the Berth Guide (see section 1.5.2) and was the pilot of *Delaware Express* on 25 October 2022. The pilot for *Ali Ka*'s arrival at Oikos 1 was also an MMM pilot representative.

[12] See section 1.13.6 of this report.

The evidence referred to was a piece of analysis, completed by one of the harbour masters in 2021, that identified nine vessel visits to Oikos 1 over a 2-year period. Of those nine visits, three used a tug on departure and six did not. With no recorded issues on departures PLA harbour masters formed the view that mandatory tug allocation for head-down ebb tide departures was not justified but that the matter would be raised with the berth operator. Oikos were consulted on 8 November 2021 and responded on 29 November 2021, agreeing to mandatory tug use for all departures from Oikos 1. The management of Oikos added that they believed tug use was mandatory following berthing simulations carried out for Oikos 1 in 2014.

A post-meeting minute was added to the records of the MMM held on 25 November 2021, noting that Oikos had accepted the requirement for a tug and that the item regarding Oikos 1 head-down ebb tide departures was now closed.

1.8.1.3 Simulator trials

The PLA carried out simulator trials on 23 October 2014 and 27 November 2014, to assess the impact on berthing and departures from Oikos 1 given the significant extension planned for Oikos 2[13]. Simulator trials were conducted for two model ships: *Baltic Captain* –182m length overall (LOA) and 11m draught; and *Sea Mariner* – 171m LOA and 7.5m draught. Several arrivals and departures were simulated over a range of tidal and wind conditions. All simulator runs were conducted with two attending tugs. The following conclusions were noted following the 27 November 2014 simulations, with conclusions 1 and 4 making specific reference to head-down ebb tide departures from Oikos 1:

> *Conclusions*
>
> 1. *Head down ebb tide departure could be problematic if after tug line fails, since the tug is doing most of the work in pulling the vessel out into the river.*
>
> 2. *Arrival and departure to/from number 1 jetty with number 2 occupied, in winds up to and including 35 knots, did not present any great difficulties with the tugs used. However, see number 4 below.*
>
> 3. *Traffic management issues were not part of the simulator exercises remit but will be addressed at the associated navigational risk assessment stage.*
>
> 4. *To allow vessels alongside number 1 jetty to depart at all states of tide, pending sufficient under keel clearance, only berthing starboard side alongside may need to be considered. Port side alongside ebb tide departures may require additional tug requirements for all vessels and an increased safety margin of wind parameters.*

On completion of the simulator trials, PLA convened a meeting with stakeholders on 30 January 2015 to produce an agreed navigational risk assessment for the berth. The SHM and HM SMS&VTS both attended this meeting, though in their previous PLA roles as deputy harbour masters; the duty DPC at the time of *Ali Ka*'s accident was also present. The review meeting examined the simulator trials of 23 October and 27 November 2014 and considered how the risk would change at Oikos 1 for

[13] This work extended the length of the Oikos 2 pier and changed Oikos 2 into a deepwater berth. The previous Oikos 2 jetty was similar to Oikos 1, and parts of the old structure could be seen to the east of Oikos 1. The extension work started at the end of 2017 and was delivered in December 2018. The associated tank farm work was eventually completed in June 2019.

vessel arrivals and departures there during and following the construction of the new Oikos 2 jetty, and whether changes to the risk would prevent further development work on Oikos 2. Six hazards were analysed:

1. *Collision – vessel/tugs manoeuvring in contact with passing vessel;*
2. *Contact – manoeuvring vessel/tug in contact with jetty due to collision avoidance;*
3. *Contact – passing traffic in contact with empty jetty;*
4. *Contact – passing vessel in contact with vessel on berth;*
5. *Mooring breakout; and*
6. *Parted moorings*

Hazards 5 and 6 were managed by Oikos shift supervisor checks whereas hazards 1 to 4 were predominantly controlled by PLA owned processes. No issues were identified *that might prevent further development work* on Oikos 2 and *no particular pilotage/manoeuvring issues or navigational safety concerns associated with berthing and unberthing* were highlighted. The hazard assessment and output from the review meeting were endorsed by PLA's navigational management team on 13 March 2015. Some managers at PLA believed that other simulator trials had been conducted, which had demonstrated that tugs were not always required, but evidence to support this was unforthcoming during the investigation.

1.8.1.4 Accident and incident investigation

The SHM's subdepartment investigated accidents and incidents reported to them on the Resolver system, which the HM SMS&VTS managed. PLA management encouraged wide use of Resolver by PLA staff, berth operators, river users and members of the public to report all accidents, near-misses, pilot ladder deficiencies, reports of dangerous wash, etc. Resolver reporting was widespread and popular. *Ali Ka*'s contact with Oikos 2 was raised as a Resolver report. Given the potential for these reports to impact vessel movements in real-time, all reports received wide distribution by email. This meant that PLA pilots, VTS staff and others would receive around 3 to 4 Resolver reports a day.

All Resolver incidents were triaged and investigated as necessary by the SHM's subdepartment. The compliance team used Resolver reports to produce risk heat maps of the river and identify themes and trends in risk.

PLA used Resolver reports to assess its risk management framework and was reliant on accurate, and complete, information being reported.

1.8.1.5 Audits

The CHM's department was subject to annual Port Marine Safety Code (PMSC) audits by external contractors. The audit cycle aimed to cover the entirety of PLA's marine safety organisation within a 3-year period. In July 2020, the audit examined the harbour master Upper Thames, VTS at the Thames Barrier Navigation Centre and risk management. In July 2021, the audit examined the harbour master

Lower Thames, VTS at Gravesend (the PCC/London VTS) and the marine SMS. In July 2022, it was the turn of port conservancy, marine services, pilotage, and governance.

The external audit concluded that the PLA was compliant with the PMSC and no nonconformities were noted. Multiple areas of *best practice* were noted during these audits including port conservancy, which contained the hydrographic function. The hydrographic department had published high-density ENCs for the River Thames, which covered Oikos and its immediate area. These high-density ENCs included contours at 1m intervals and allowed ships to define safety contours in ECDIS with good accuracy.

The PMSC external audit in 2022 identified the Towage Code, identified in the 2021 audit as a nonconformity with PLA policy because it was beyond its review date, and the incident reporting system as areas of *best practice*, although it was noted that there was no formal risk assessment in place for pilotage.

Fatigue was assessed at the Thames Barrier Navigation Centre in 2020 and at the PCC in 2021. The audits found that fatigue and working hours were managed in VTS, though this did not form part of a documented fatigue management system nor was fatigue management featured in policies or procedures. When fatigue in pilotage was examined in 2022, it was deemed satisfactory and highlighted the Sea Pilots Working Rules and Operational Guidelines[14], which detailed rostering, as delivering an effective pilot fatigue management system.

1.8.2 Documentation

1.8.2.1 Marine safety management system

The PLA's marine SMS was formed of many parts and focused *on the operational and administrative output of the following marine departments*:

- *Harbour Masters*
- *Pilotage*
- *Vessel Traffic Services*
- *Hydrographic including marine conservancy; and*
- *Marine Services.*

The exact boundaries of the marine SMS were diffuse and PLA's intranet site was used to house multiple documents, though as identified during the 2021 PMSC audit the document review and update process was neither efficient nor easy to use. Pilots found that documents were difficult to retrieve or discover and were unsure of whether certain documents were formally part of the marine SMS.

The marine SMS was stored within SharePoint and could be accessed via Polaris, the PLA reporting and information system. Polaris had two forms, the full system and a reduced version (Polaris Lite). Ship's agents could access elements of

[14] Sea Pilots Working Rules and Operational Guidelines (Sea Pilots Working Rules), version 8, issued 3 June 2021.

Polaris Lite remotely via the PLA's Port Information System for End-to-end Services (PISCES). The PISCES system allowed ship's agents to place pilotage requests and see pilotage allocations for relevant voyages. Pilots accessed information remotely on their tablet computers using a Citrix secure desktop visualisation link, although could not access everything via Polaris Lite. For example, the hyperlinks contained within the Berth Guide were inaccessible to pilots using Citrix to access Polaris Lite. Pilots could access work emails, Resolver reporting and notification, the berth guide and the pilot roster on their tablet computers. However, they needed to use PLA desktop computers to gain full access to the intranet site that stored everything related to the marine SMS and the Resolver incident reporting system. Dedicated workstations were available around the clock in Gravesend for pilots to conduct their planning.

Most documents had identifiable owners, though it was unclear how ownership worked in practice when documents were due to be updated. The PLA used a variety of ways[15] to rapidly highlight key matters to staff and external groups, although it was unclear how these letters correlated with the formal marine SMS.

The MPM distributed pilotage department operational letters (PD op letters) to pilots by email and recorded them on the PLA's intranet site. The investigation identified 240 extant PD op letters dating back to 5 August 1999. The topics of these letters included mobile phone use, access methods at various jetties, procedures for ordering taxis, billing procedures, security matters, fatigue and tug use.

There was no policy to describe how conflicts between directions delivered via PD op letters and procedures laid down in marine SMS documents were resolved. PD op letter 30/2021 stated that an *amendment to the "Code of Practice for Ship towage Operations on the Thames" will follow at the earliest next opportunity.*

1.8.2.2 The Code of Practice for Ship Towage Operations on the Thames

The Code of Practice for Ship Towage Operations on the Thames[16] (the Towage Code) was produced by the PLA to provide information to pilots, masters, tug crews and ship's agents; it was publicly available on the PLA website and to PLA staff via the PLA's intranet.

The Towage Code was split into two parts: part one, on safe working practices for ship towage operations, was for guidance only; part two, on the application of the guidelines, contained both guidance and mandatory requirements and included these statements:

> *The final decision on the number of tugs to be used must rest with the Master of the vessel, in consultation where appropriate, with the Pilot and/or the Port of London Authority (PLA) Duty Port Controller (DPC), who will take account of the particular exceptional circumstances, including the prevailing weather and tidal conditions.*

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[15] The PLA used General letters, VTS letters, Pilotage Department operational letters and Notices to Agents, Berths and Ship Operators. All of these impacted the management of safety.

[16] https://www.pla.co.uk/Safety/Regulations-and-Guidance/Code-of-Practice-for-Ship-Towage-Operations-on-the-Thames

It should be noted however, that in cases where the vessel Master refuses to accept the Pilot's, or in advance of the Pilot being embarked, the Duty Port Controller's advice in respect of the number of tugs required to facilitate a safe operation, the Harbour Master may impose the required number of tugs by Special Direction. These tugs will be for the owner's account.

The purpose of these Guidelines is to ensure, so far as possible, that the Master achieves safe ship manoeuvring operations.

The Towage Code in force on 25 October 2022 had last been updated on 29 April 2022. PD op letters 16/2008[17], 07/2017[18], 12/2019[19], 19/2019[20], and 30/2021 all discussed changes to tug requirements at various berths as a result of learning from accidents and near misses. PD op letter 30/2021, issued on 6 December 2021, was titled *Oikos no.1 berth – mandatory tug requirement for a head down, ebb tide departure*. This letter was issued on 29 November 2021, following agreement by Oikos to mandating tug use at Oikos 1. PD op letters 16/2008, 07/2017, 12/2019 and 30/2021 were not reflected in the 29 April 2022 update to the Towage Code, though PD op letter 19/2019 was partly reflected in the change. Despite the instruction to pilots making tugs mandatory for all head-down, ebb tide departures, the updated Towage Code indicated that, for a vessel of *Ali Ka*'s length, propulsion, draught and bow thruster capacity, no tug was required for a head-down, ebb tide departure from Oikos 1. No guidance was issued to resolve any apparent contradiction between the Towage Code and the PD op letters.

Harbour masters and VTSOs used the Towage Code as their guide to tug use and had no sight of PD op letters. Many pilots kept uncontrolled printed copies of the Towage Code for easy reference.

1.8.2.3 The Berth Guide

The Berth Guide[21] had been produced by one of the PLA pilots and was not part of PLA's marine SMS. The Berth Guide collated information relevant to berths on the River Thames and was hyperlinked to associated documents, such as all extant PD op letters and the Towage Code. The guide also contained information abstracted from other documents and included information about Oikos 1, which stated, in red lettering, *Mandatory Tug requirement for a Head Down, Ebb Tide Departure*.

The Berth Guide was accessible from PLA's intranet site, and required effort to keep it current and fully reflective of changes to the documents it cross-referred and linked to. The guide listed a controlling depth of 8.3m for Oikos 1, though it reminded users to check the latest hydrographic products in determining controlling depths.

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[17] Calor Jetty Tug Requirements – ships departing on the ebb tide when berthed head-down. Issued 29 October 2008.

[18] Esso Jetty – revised berthing arrangements. Issued 4 October 2017.

[19] Grays Terminal – berthing/unberthing limits and tug requirements. Issued 15 March 2019.

[20] VOPAK1 – revised berthing parameters – update. Issued 25 June 2019.

[21] Issue number 106. Updated 16 October 2022.

1.8.2.4 Management of fatigue

Version 8 of PLA's Sea Pilots Working Rules and Operational Guidelines (Sea Pilots Working Rules)[22] was used as the primary control document for managing the pilot roster and, as a result, fatigue among sea pilots. One specific rule aimed at managing fatigue was the *two nights out* rule, which PLA defined as[23]:

> *a fatigue management tool designed to protect pilots working consecutive night acts on roster and should not be compromised by work undertaking by the stand down period. After two consecutive "nights out", the pilot will not be called upon to work a third "night out". He/she may, however and dependent on the appropriate standard rest period as contained in Section 3.8*[24]*, be required to undertake a further act of pilotage if he/she is available and has reached the top of the roster, provided that the return to base time is anticipated to be before 2200 hours.* [sic]

It was the responsibility of the pilot, on completion of a second night out, to opt to take advantage of this rule. This would ensure that they were not allocated an act of pilotage between 2200 and 0600 the following morning.

On reporting fatigue, the Sea Pilots Working Rules stated that:

> *Pilots must report to the co-ordinator when their level of fatigue is such that they are not fit for duty. They should do this as soon as it becomes apparent to them that they are suffering from fatigue. The co-ordinator will remove them from the roster to allow the pilot a standard rest period and record that action in the daily log.*
>
> *If the pilot is conducting an act of pilotage and becomes aware that he is suffering from fatigue, he must advise the co-ordinator immediately and request a relief at the earliest opportunity.*
>
> *Pilots are expected to use their rest periods for quality rest such that they are in a fit state for their next act of pilotage.*

The investigation found no record that listed the number of reports of fatigue that had been made, although PLA management was aware of a handful of cases where fatigue had been reported and had accepted such claims. There was no process to treat fatigue issues as near misses.

PD op letter 04/2006, issued 10 February 2006, was titled *Tiredness Preventing Allocation* and reminded pilots to give the duty pilot coordinator adequate notice of any reason that would prevent their allocation. The letter stated:

> *All Sea Pilots have sufficient experience of the working roster for the Coordinator to assume they are able to order their lives* [to] *allow proper rest. The PLA accepts that there will be circumstances that interrupt this and therefore tiredness can occasionally be a reason for refusing a job.*

[22] Issued 3 June 2021.

[23] Sea Pilots Working Rules, version 8, issued 3 June 2021.

[24] Section 3.8 of the Sea Pilots Working Rules defined PLA's minimum standard rest periods for sea pilots after an act of pilotage as 8 hours. PLA fatigue management will be further described in sections 1.11.1 and 1.11.2 of this report.

When such a reason has been given once the job has been identified; the pilot will be asked for an explanation as a matter of record.

The circumstances are recorded to ensure they are genuine. Repeated incidences will attract attention. I hope you will appreciate that this is necessary to ensure that there is fair play to all on the Sea Roster.

PD op letter 25/2011, issued 4 August 2011, was titled *Use of Two Nights Rule* and instructed pilots that two nights out could not be claimed if one of those nights was performed as an act of overtime. The letter stated that *Pilots are expected to manage their own fatigue during stand-down,…always ensuring they have sufficient rest between overtime acts.*

PD op letter 09/2014, issued 19 February 2014, further discussed the claiming of two nights out and stated that pilots had to claim two nights out immediately after completing the second qualifying night or would otherwise lose the break. No retrospective claim was permitted. Neither of these letters was reflected in version 8 of the Sea Pilots Working Rules. No guidance was offered on the status of these letters following publication of version 8 of the Sea Pilots Working Rules.

Many PLA staff referred positively to the ‘stop work’ procedures at PLA and felt supported should they make such a call. The investigation noted that, on 27 June 2022 in one of their regular safety communications, PLA’s CEO had recorded that work to improve this procedure was in hand. The intent was to deliver greater clarity and empowerment of staff to stop work should they have a safety concern. The ‘stop work’ procedure was not in the marine SMS or associated documents available to the investigation.

1.8.3 Vessel traffic services

1.8.3.1 General

London VTS maintained a 24-hour watch over the River Thames and its base was the PCC **(Figure 12)** at PLA’s offices in Gravesend. The DPC at London VTS acted as both the CHM’s representative and as VTS supervisor for the control of all moves and activities downstream of Crayford Ness out to the seaward limits of PLA’s pilotage jurisdiction. This section was split into two subareas/sectors: the Estuary, from the seaward limits to Sea Reach No.4 light buoy; and the River, from Sea Reach No.4 light buoy to Crayford Ness). Oikos 1 was in the River sector.

The DPCs were senior class I pilots who kept 12-hour watches with changeovers at 0800 and 2000. They worked to a pilot roster for 10 weeks before spending 5 weeks dedicated to DPC duties. When acting as a DPC the normal rotation was a day watch, followed 24 hours later by a night watch, followed 24 hours later by another day watch. The on-watch DPC at the time of the accident had worked from 0800 to 2000 on 23 October and came back on watch at 2000 on 24 October, working until 0800 on 25 October. Individuals took regular breaks during each watch to manage their alertness levels. During night watches individuals were allowed to take extended breaks. These were managed by the DPC and were not documented.

The DPC managed three VTSOs, a pilot coordinator, a ship control officer (not between 0200 and 0600) and a river pilot. The VTSOs’ watch changeover times were 0700 and 1900; while on watch the VTSOs normally spent 2 hours at their desk followed by a 20-minute break before working on administration tasks then returning to their desk. The VTSOs also covered the ship control desk between 0200 and 0600. The VTSOs rotated between covering the Estuary, the River and administration. Overnight the VTSOs were allowed to take extended breaks to manage their alertness levels. The DPC and the VTSOs sat in one half of the VTS PCC, facing the river. Behind them sat the pilot coordinator, ship controller and river pilot.

The pilot coordinator allocated pilots to vessels according to their classification, arranged transport to deliver pilots to their acts and recovered pilots on completion. The pilot coordinator also called pilots 1 hour before base time to make sure they were awake and aware of the allocation. The ship control officer liaised with ship's agents to book moves on the river into Polaris and ensured any potential conflicts between moves were minimised.

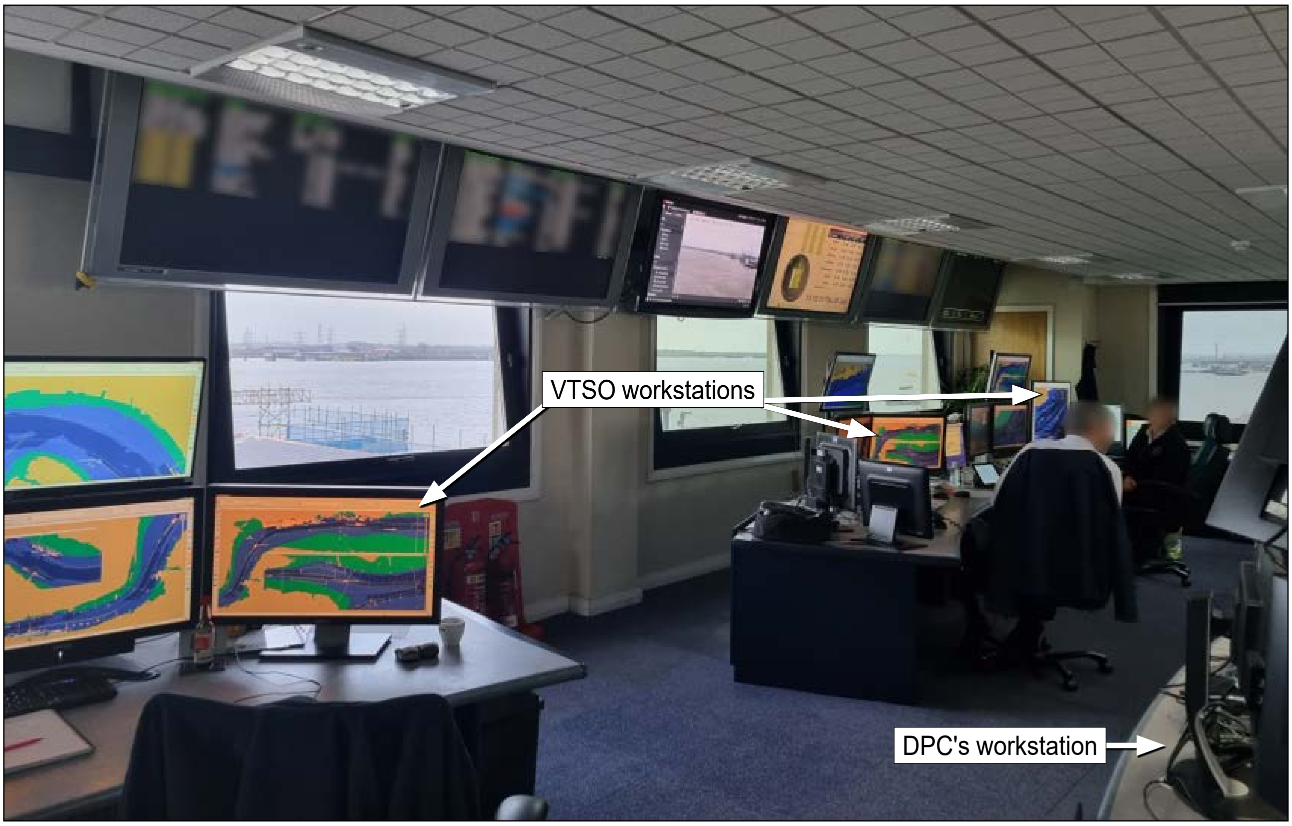

Figure 12: London VTS Port Control Centre

1.8.3.2 Procedures

London VTS operations were guided by its operational procedures. Part 2 of the VTS operational procedures was split into three sections: section 1 detailed common procedures such as general regulations, traffic management, communication, meteorological conditions, river closures, etc. that were relevant to the whole river; section 2 covered the sectors under the control of the PCC (London VTS at Gravesend); and section 3 was specific to Thames Barrier Navigation Centre operations. Section 2 included various procedures to be followed for activities such as passage planning, vessel programming, navigational safety, considerations for specific berths and abort procedures.

The VTSO was empowered to deny a vessel clearance to proceed if it was *clear that it is unsafe for the…vessel to leave the berth*[25]. Guidance on tug allocation was in the Towage Code. A VTS sailing plan was to be generated for all vessels with a draught of more than 7.5m. Tankers with draughts of less than 8.0m on a falling tide did not require any special programming. Oikos jetties did merit the following considerations at para 2.7.1 of the operational procedures:

> *Weather Parameters for Berthing Operations*
>
> *The maximum allowable wind speed for berthing at Oikos Jetty is 34 knots (17.5 m/s).*
>
> *If such a wind speed is expected, VTS is to seek confirmation from Oikos Jetty that they will be able to accept the vessel before the inward voyage commences and periodically thereafter with reference to the vessels options to safely abort her passage if required.*
>
> *Confirmation should be sought from the allocated boatmen that they will be able to undertake the mooring operation in the current or expected weather conditions taking into account their ability to safely run lines/wires from mooring boats to the buoys and work on them.*
>
> *Requirement for Vessels to Pass with Caution*
>
> *Whilst a vessel is alongside at Oikos No.1 Jetty a pass with caution should be issued for the period from one hour before low water to one hour after low water* [sic]

1.8.3.3 Vessel traffic services communications just before the accident

The VHF call from the pilot of *Delaware Express* to London VTS at 0402 on 25 October 2022 was answered by a VTSO; the DPC was on an extended break. The pilot of *Delaware Express* asked if *Ali Ka* had a tug for its departure. Further, the pilot stated that a tug was mandatory for all head-down, ebb tide departures from Oikos 1 and that this had been *agreed at an MMM* and was *in The Berth Guide*. The VTSO was unaware of this and said that the move had been discussed with the DPC, but that the VTSO would raise it with the DPC themselves. The pilot of *Delaware Express* expressed concern that if the move went ahead without a tug and if something went wrong then the pilot for the move would have put themselves into a very difficult position.

At about 0414, the VTSO phoned the DPC to discuss the radio conversation with the pilot of *Delaware Express*. The VTSO wanted to check that the DPC had not made a mistake regarding tug allocation. The VTSO informed the DPC that there was nothing about a mandatory tug in the *tug code* regarding Oikos 1. The DPC agreed and doubted that there was an *operational letter* about it. As a result the VTSO asked if it was okay to *let him* [*Ali Ka*] go…*if* [pilot A was] *happy to do it*. The DPC agreed and, at 0416, the VTSO gave *Ali Ka* river clearance for its move.

During this time *VB Panther*, having been released by *Delaware Express*, secured to a buoy and shut down, with no further jobs allocated for that morning.

[25] Paragraph 1.3.4 Movement Clearance Procedures; VTS Operational Procedures Part 2, version 1.5, published 13 October 2022.

1.8.4 Port of London Authority pilotage

1.8.4.1 Pilot training and equipment

Trainee PLA pilots followed a training programme on recruitment before qualifying as a Class IV pilot with authorisation to pilot vessels of 125m or less, and of 6m draught or less. Promotion to a Class I (unrestricted +) Havens level was possible in 5 to 6 years with continuous training and professional development; pilots at this level were authorised to pilot the largest ships on the river. There were seven pilot classifications above trainee **(Figure 13)**. *Ali Ka* required at least a Class III pilot when the ship was in its departure condition. The pilot for *Ali Ka*'s arrival was a Class II (unrestricted) pilot.

The PLA Marine Pilot Training Manual[26] was the governing document on pilot training and was based on various syllabi, standards and assessment criteria:

National Occupational Standards for Marine Pilotage

Assessment Criteria for Marine Pilotage National Occupational Standards

Port Marine Safety Code, and

International Maritime Organization Resolution A960[27] [sic]

The manual focused on trainee pilot progression and did not cover continuation training for experienced pilots. No record of any BRM training was noted for pilot A during the investigation. While many pilots believed that BRM training was a 5-yearly requirement, and had completed BRM training, this was not stated in the PLA Marine Pilot Training Manual[28].

Pilots were equipped with personal protective equipment, including a helmet, a coat with an integrated lifejacket, safety boots, and a VHF radio.

All pilots carried a PLA tablet computer fitted with a commercial pilotage navigation system that enabled passage planning and monitoring of manoeuvres. It also allowed for vessel movement prediction, displayed the marine automated identification system, and helped in collision avoidance. The tablet computers enabled partial access to Polaris Lite. It was not possible to access the hyperlinks in the Berth Guide via the tablet computers. Most pilots had accessed Polaris Lite from home while under COVID-19 restrictions and many had continued to do so during their planning, with few accessing Polaris from the office. Training was available from the PLA on the use of the applications housed on these tablet computers and pilots could request individual training from the pilotage support officer.

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[26] Version 3.1 issued 2 August 2022.

[27] IMO Resolution A.960(23) – Recommendations on Training and Certification and on Operational Procedures for Maritime Pilots other than Deep-Sea Pilots.

[28] Section 5 of the PLA Marine Pilot Training Manual did mention that trainee pilots were required to complete BRM-Pilots training. There was no mention in the progression steps listed at section 10 and beyond.

Image courtesy of the Port of London Authority

Figure 13: Port of London Authority pilot classifications

1.8.4.2 Pilotage plans

All PLA pilots were required to produce a pilot passage plan for any act of pilotage. PLA produced a *Master/pilot information and passage planning exchange* form (the MPX form) that pilots were encouraged to complete, though they could use other forms to fit their ways of working. The MPX form was split into routeing information, draught, planned speeds, critical depths, heights of tide and UKC, weather forecast data, abort contingency plans, a checklist of discussion items with the master, tug allocation, tidal stream, and passage notes. The final section was to be signed by both the pilot and the master.

To complete the MPX form pilots were required to access a wide range of safety critical information held variously on PLA systems.

Environmental data was available through the public PLA website and the PLA intranet site. All hydrographic charting and tidal stream data was provided on the PLA intranet site via the hydrographic department. This facility contained detailed predicted tides and associated tidal stream information in video and chartlet form. Real-time tides were also available with an assessment of whether the live readings were above or below prediction. Wind data was available on request from the VTS PCC or through commercial weather applications.

Notes on individual vessels were available on the Polaris database. A pilotage service order was generated when a ship's agent used PISCES to request an act of pilotage. The pilotage service orders contained several notes relevant to the act of pilotage, including whether Polaris notes existed for the vessel.

1.8.4.3 The master/pilot exchange

The PLA detailed some of the MPX information that pilots needed to be aware of in its Marine Pilot Training Manual[29], noting that:

> *The ships master is required by PLA General Direction to present his own passage plan for the passage. This should be compared with the pilot's PPP*[30] *so that a comprehensive passage plan is clearly understood and agreed by the master and the pilot.* [sic]
>
> *As the act of pilotage progresses, the passage plan may need to be reviewed and adjusted by the pilot; this process must be inclusive of the master and the bridge team.*

On bridge team integration, the Marine Pilot Training Manual further stated:

> *In order to ensure a safe and efficient passage, it is essential that there is close co-operation between the pilot and bridge personnel. This will necessitate an early exchange of information. It is vitally important that an interactive master/pilot relationship is clearly established.*
>
> *A further aspect for ensuring successful passage involves an ongoing assessment of the capabilities of other bridge personnel. The conduct of the master, the language in use and the general attitude and competence of bridge personnel all contribute to this assessment.*
>
> *The pilot will need to integrate fully with other personnel on the bridge and to work closely with the bridge team, taking into account any limitations and deficiencies observed along with respect for any national cultural peculiarities of the bridge team personnel.*

The Marine Pilot Training Manual covered passage planning and the MPX in its training syllabus for new pilots, making particular reference to the legal implications of the MPX process and that the MPX must be recorded as having been achieved.

Following the contact and grounding of the bulk carrier *Amber* on 15 November 2012 (see section 1.13.3), PLA's MPX form included a check box to indicate whether the individual roles and actions of the bridge team were understood.

PLA audited MPX forms to check whether an MPX form had been submitted following an act of pilotage. In June 2021, 53% of sea pilots had submitted their completed MPX forms and this had markedly improved by September 2022. Each month, PLA selected 2% of pilotage acts to check the MPX form for completeness, though not for content nor for the veracity of that content. Feedback to PLA management on these checks covered the percentage return rate. Feedback to pilots stated the need to submit these MPX forms, which would be thoroughly checked should an accident or incident occur.

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[29] Version 3.1 issued on 2 August 2022 was extant on 25 Oct 2022.

[30] Pilotage passage plan.

1.8.4.4 Pilot rostering

The PLA's sea pilots, like pilot A, were governed by PLA's Sea Pilots Working Rules. The sea pilot roster operated on a 15-watch system, each watch working 9 days on and 6 days off. A new watch started duty at 0800 each day.

Timings recorded by PLA were defined as follows:

- **Allocation time** – the time that the pilot was notified of the intended act of pilotage, commonly recorded as 1 hour before base time.
- **Base time** – the nominal time that was recorded to account for the pilot to have arrived at Gravesend. This time was set before the planned on board time to allow for passage planning and travel to the ship.
- **On board time** – the time the pilot set foot on board the ship.
- **Return time** – the time at which the pilot had returned to base, or home, on completion of the act of pilotage.
- **Act hours** – the period of elapsed time between the base time and the return time. This was used to inform the management response to control fatigue.

For moves of *Ali Ka*'s nature, pilots were given 1 hour to produce their passage plans within the base time.

1.9 PILOT A

1.9.1 Career and training

Pilot A had been a Class I (unrestricted) pilot, authorised to pilot vessels of up to 320m LOA and up to 13.5m draught, for 17 years and had worked at PLA for 21 years. Pilot A had served as master on oil and chemical tankers before becoming a pilot and had conducted over 2,000 successful pilotage acts that, latterly, primarily involved large vessels and tug support. Pilot A's last move at Oikos 1 before *Ali Ka* had been in 2017. While fluent in English, pilot A was not a native speaker of the language and used slow and measured tones in normal speech.

In 2018, pilot A had started training to become a Havens pilot[31]. On 15 February 2018, the simulator operator made the following notes:

> *Generally a good pilot. However, struggles to apply his normal skill set in unexpected circumstances on Havens size vessels.*

On 19 April 2018, during pilot A's five-yearly revalidation, the assessor noted that:

> *Berth of distinct familiarity ok. No issues with "Class 4" type berths. Requests table-top discussion when Oikos redevelopment complete. Just started Havens training. Nav Aids course in June. Advised to regularly check Pilot emails.*

[31] A Havens pilot could pilot the largest ships on the river. There were various authorisations for Havens pilots though ultimately a pilot could lead for container ships greater than 370m in length, and tankers of greater than 200m in length.

On 5 March 2020, pilot A attended simulator training without receiving any specific comments on their performance. Following a pilotage accident, pilot A underwent more simulator training on 28 May 2021, at which they demonstrated below par understanding of tug use, ebb tide departures, and the use of speed, bow thrusters and anchors. Despite a recommendation that pilot A be temporarily limited to Class I (restricted) moves, this was not imposed. Pilot A was required to conduct three trips on 29, 30 and 31 May 2021 with another Class I (unrestricted) pilot, who determined their performance as satisfactory. On 22 June 2021, pilot A was subsequently revalidated in the simulator and continued as a Class I (unrestricted) pilot.

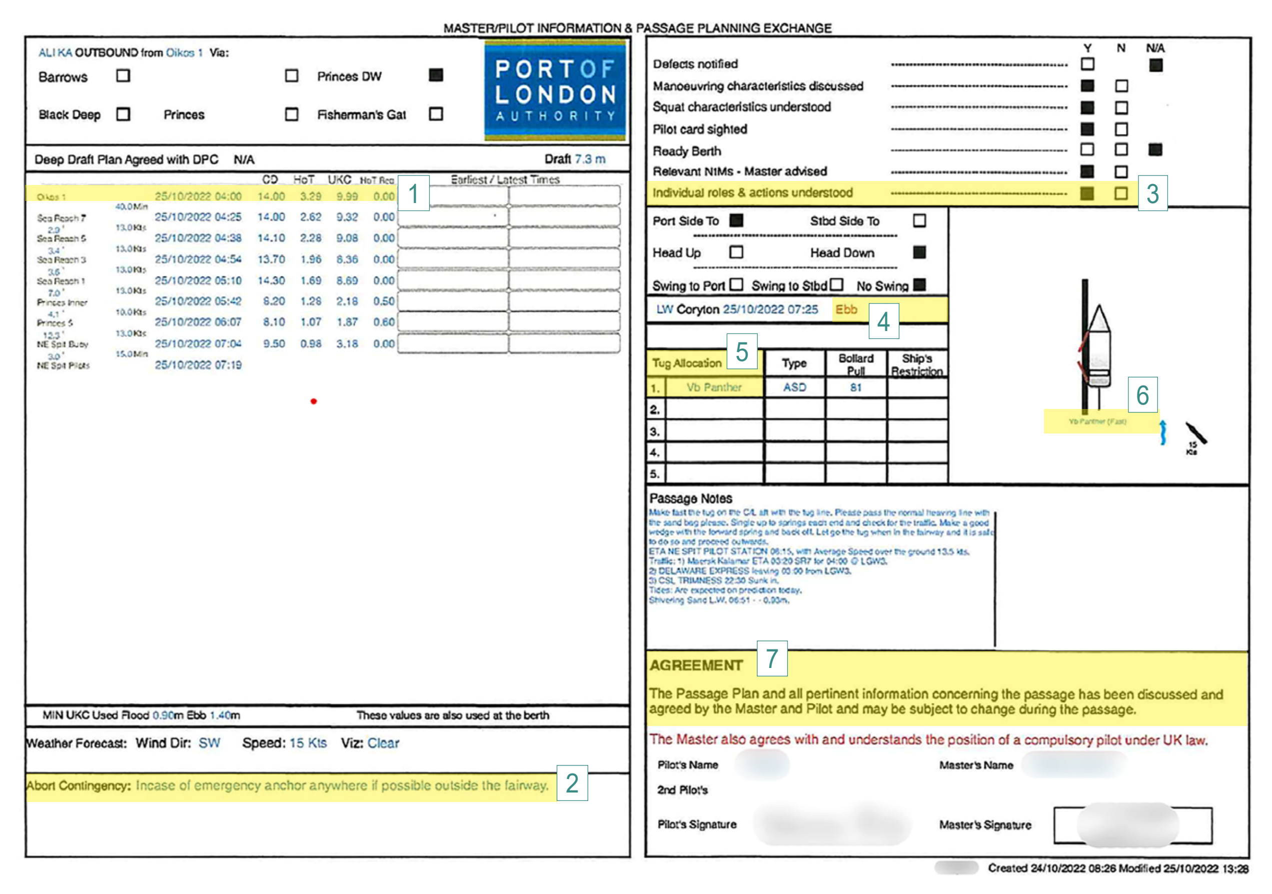
1.9.2 *Ali Ka* pilotage plan

The pilotage service order for *Ali Ka* indicated that Polaris notes were available, although pilot A did not access these in preparation for either the pilotage passage plan or MPX.

Pilot A used the PLA MPX form for the *Ali Ka* move **(Figure 14)**. The MPX form noted the intention to use the Princes deepwater channel; a draught of 7.3m for *Ali Ka*; charted depths of 14m between the berth at Oikos 1 and Sea Reach No.7 buoy; a minimum UKC of 1.4m during the ebb tidal stream; and wind from the south-west at 15kts. The MPX form further noted that there were no defects to affect the move and that *Ali Ka*'s manoeuvring characteristics had been discussed, the ship's pilot card sighted, and the bridge team's individual roles and actions understood. While these check boxes on the MPX form used for *Ali Ka* were marked as completed, it was not established when this was done. Roles and actions were not noted on the MPX form and there was no evidence that any discussion on these matters had taken place after pilot A boarded *Ali Ka*.

The MPX form had been annotated to indicate the tidal stream at the berth, though no comment had been added to indicate the strength of the tidal stream nor how this would vary throughout the manoeuvre off the berth. Tug *VB Panther* was listed as available, and the MPX form also included a comment that the tug was to be made fast on the centreline aft and only to be let go once *Ali Ka* was in the fairway and it was safe to do so. The MPX form included an emergency plan to *anchor anywhere if possible outside the fairway*.

Image courtesy of the Port of London Authority



1 Oikos 1 data showing incorrect controlling depth and UKC

2 The abort contingency plan

3 Individual roles and responsibilities marked as understood

4 Note added indicating ebb stream, no information on strength of ebb stream

5 Tug allocation of *VB Panther* retained despite the tug's cancellation

6 Tug plan and environmental conditions, no comment on strengthening tidal stream south of berth

7 The statement indicating plan has been discussed and agreed

Figure 14: Pilot passage plan and MPX form

1.9.3 Historic watch cycle

In 2021, pilot A conducted 136 acts of pilotage in approximately 20 blocks of time. On two occasions[32] pilot A worked 14 acts in 21 days with breaks of 2 days between blocks of activity and one 4-day break. In 2022, pilot A had conducted 118 acts of pilotage before *Ali Ka*. On one occasion pilot A conducted 34 acts in a 52-day period with only one 4-day break and one 3-day break, plus other shorter breaks in activity[33]. Each of these longer periods of activity was explained as pilot A using voluntary overtime during off-watch periods. The PLA management believed that pilots would normally conduct between four and five acts of pilotage in any 9-day period on watch. Pilot A undertook an average of 6.9 pilotage acts per duty period in 2021 and 6.4 pilotage acts per duty period in 2022[34].

[32] Occasion 1 was 15 March to 5 April 2021, occasion 2 was 11 September to 2 October 2021.

[33] 23 May 2022 to 14 July 2022 (inclusive) with a 4-day break between 2 and 7 June 2022 (exclusive), and the 3-day break between 3 and 7 July 2022 (exclusive).

[34] Approximate figures given the complications of overtime and that pilot A had worked for extended periods of duty, which meant it was difficult to make a definitive distinction between duty periods and off-watch periods mixed with overtime.

Pilot A undertook just one overtime act during the period between 1 September and 25 October 2022; all other acts were scheduled watch activities. Pilot A completed the watch cycle before the accident on 13 October 2022, returning from the last pilotage act at 2300.

1.9.4 Watch cycle up to the *Ali Ka* pilotage act

Pilot A's watch cycle started at 0800 on 20 October 2022, and the first pilotage act was allocated at 1753 **(Table 1)**. Pilot A completed night pilotage acts on 21 October and 22 October, then claimed for a break using PLA's 'two nights out rule' and achieved 7 hours' sleep overnight. On 23 October, pilot A was allocated to a 9-hour pilotage act and slept for 8 hours afterwards.

Act			Date (DD/MM/YY) and time				Act duration
Ship	**Berth**	**Class**	**Allocation**	**Base time**	**On board**	**Return**	
1	London Gateway (in)	I (R)	20/10/22 at 1753	21/10/22 at 0030	21/10/22 at 0345	21/10/22 at 0930	9 hours
2	London Gateway (in)	I (U)	21/10/22 at 1903	22/10/22 at 0130	22/10/22 at 0715	22/10/22 at 1245	11 hours, 15 minutes
3	London Gateway (in)	I (U)	23/10/22 at 0600	23/10/22 at 0700	23/10/22 at 1020	23/10/22 at 1600	9 hours
4	Gravesend to Grays 1 (in)	IV	24/10/22 at 0510	24/10/22 at 0515	24/10/22 at 0610	24/10/22 at 0830	3 hours, 15 minutes
Ali Ka	Oikos 1 to sea (out)	III	24/10/22 at 2042	25/10/22 at 0200	25/10/22 at 0340	25/10/22 at 1130	9 hours, 30 minutes

Key:	Class I (U) – 320m LOA x 13.5m draught
	Class I (R) – 215m LOA x 11m draught
	Class III – 145m LOA x 7.5m draught
	Class IV – 125m LOA x 6m draught

Table 1: PLA record of pilot A watch cycle pilotage acts up to the accident

On 24 October, pilot A returned home at 0830 following a pilotage act of 3 hours and 15 minutes and had breakfast and then completed some domestic tasks before attempting to nap for a couple of hours in the early afternoon. Unable to fall asleep, pilot A enjoyed some family time and then an evening meal. At 2042, the pilot coordinator informed pilot A that *Ali Ka* had been allocated as an act of pilotage and pilot A started planning the move. Pilot A had last undertaken an Oikos 1 departure on 8 December 2017 and completed the pilotage passage plan before resting in the belief that they would sleep more soundly as a result. Pilot A's planning had identified the constrained area of safe water around Oikos 1 and this raised concerns about the height of tide. Balancing this with the fact that the Towage Code did not require the use of a tug, pilot A opted for an 0400 move without a tug, though tug *VB Panther* was still noted on the MPX form. Pilot A was still awake when the DPC called at 2221 to finally confirm the move. Pilot A then tried to sleep but achieved little given their worries over the *Ali Ka* move, anxious whether they had made the right call about the time of departure and the dismissal of the tug. At 0200, pilot A got up, dressed, and gathered their things before heading to the Gravesend car park to catch the transport to *Ali Ka*.

1.9.5 Health

Pilot A was 60 years old, had high blood pressure, and had been undergoing long-term specialist treatment following the removal of a kidney in 2016. Pilot A also had an infected cyst on their back that affected their ability to sleep and often woke to visit the bathroom during periods of sleep. Pilot A believed that 6 hours of sleep a night was manageable and, while they found the duty roster tiring, had become used to this over the 22 years they had worked at PLA.

1.10 OIKOS STORAGE

1.10.1 Organisation

Oikos was organised into three main sections: operations; engineering; and health, safety, environmental and quality (HSEQ). Each section reported to the general manager on site.

The operations section employed five shifts to maintain 24-hour operational availability of the site. Each shift consisted of three workers and one shift supervisor. Line handling for ship departures was managed by a third-party contractor. The duty shift at Oikos was focused on the safe operation of equipment, tank management, vessel loading and unloading, and management of contractors on the site. The shift supervisor became the incident controller when *Ali Ka* collided with Oikos 2. Two security personnel were also on duty, one managing site access and egress and the other monitoring closed-circuit television (CCTV) for the site. The HSEQ manager maintained close liaison with the Health and Safety Executive (HSE) as the Oikos storage site was subject to COMAH.

In 2014, plans were put in place to extend Oikos 2 into the river to turn the jetty into a deepwater facility. The Oikos 2 extension underwent rigorous planning controls before being built and was fully commissioned into service in June 2019. The navigational risk assessment and PLA simulator work in 2014 was undertaken as part of the planning and approvals process. Oikos 2 became the most frequently used of the two Oikos jetties from July 2019.

1.10.2 Safety management system

Given the requirements of COMAH (see 1.10.3), Oikos had an SMS and associated major accident prevention policy (MAPP). Among the key elements of the MAPP and Oikos Storage Ltd Health, Safety and Environmental Policy was the evaluation of identified hazards and the requirement to hold up-to-date procedures for the maintenance and operation of the terminal. Responsibilities were defined in the SMS, though the duties of the incident controller appeared to focus on dealing with a fire, or the risks of fire, rather than a ship colliding with one of the jetties.

1.10.3 Control of Major Accident Hazards Regulations 2015

The HSEQ manager at Oikos was responsible for compiling the site's COMAH safety report. The last safety report had been submitted in 2021 and the next was due in 2026 unless, in the intervening period, any change to the site risk profile was identified. The requirements of the safety report were listed on the HSE website[35]. In the event of an oil spill into the River Thames, Oikos, as part of the Thames Oil Spill Clearance Association, would implement its part of the Port of London Oil Spill Contingency Plan.

1.10.4 Marine risk assessments

Hazard risk assessments[36] that covered tasks performed at Oikos were available to Oikos staff. The hazard risk assessments also linked the task analysis to a human reliability assessment for that task and included potential consequences of any failure and particular conditions that had been placed on the task. The risk assessments noted that Oikos 1 was used 8 to 10 times a year since the commissioning of Oikos 2.

The Oikos hazard risk assessments did not include marine risks, such as a collision into a vessel moored on either Oikos 1 or 2, or a vessel striking one of the two Oikos jetties. Such marine risks were viewed as being entirely managed by the PLA's risk control measures, for example by the provision of pilotage and the use of tugs.

1.10.5 Oversight of marine activities

Once cargo operations were completed, the main loading arms disconnected and radios returned[37], Oikos staff had no further responsibilities towards ships on their berths and exercised no oversight of marine activities. Oikos staff routinely remained on the jetty until ships had departed the berth. Departures were entirely under the control of the line handlers, the pilot, and tugs. Although Oikos staff believed that tug use was mandatory for Oikos 1, no assurance checks were conducted to confirm that these were in place before departure. No specific control measures to address accident scenarios of a marine origin were listed on the COMAH site for Oikos[38]. Security staff on 25 October 2022 did note that *Ali Ka*'s bows swung very close to Oikos 1 on departure and had focused CCTV cameras on the ship during the manoeuvre as this appeared to be unusual behaviour.

1.11 FATIGUE

1.11.1 Definition and impact of fatigue

The International Maritime Organization (IMO) Circular MSC.1/Circ.1598 – Guidelines on Fatigue – defined fatigue as:

> *A state of physical and/or mental impairment resulting from factors such as inadequate sleep, extended wakefulness, work/rest requirements out of sync with circadian rhythms and physical, mental or emotional exertion that can impair alertness and the ability to safely operate a ship or perform safety-related duties.*[39]

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35 https://www.hse.gov.uk/comah/background/comah15.htm#what

36 Appendix 3 to Oikos hazard risk assessment, revision 5, August 2021.

37 Visiting ships were provided with radios to allow for direct communications between Oikos staff and the ship.

38 https://notifications.hse.gov.uk/COMAH2015/PublicInformation.aspx?piid=3538

39 https://wwwcdn.imo.org/localresources/en/OurWork/HumanElement/Documents/MSC.1-Circ.1598.pdf

Further, MSC.1/Circ.1598 stated that *fatigue is a hazard because it may affect a seafarer's ability to do their job effectively and safely*. The Circular described causes, management factors, environmental factors and operational factors, and highlighted important basic concepts in understanding fatigue. The effects of fatigue were noted as being significant, and impairments *will occur in every aspect of human performance…such as in decision-making, response time, judgement, hand-eye coordination and countless other skills*[40]. Cognitive, physical and behavioural symptoms were also noted. It has been shown that *the effects of moderate sleep loss on performance are similar to moderate alcohol intoxication*.[41]

1.11.2 Fatigue regulations applicable to PLA pilots

Marine pilots are not treated as ship's crew for employment purposes so neither the IMO Guidelines on Fatigue nor the Maritime and Coastguard Agency (MCA) Marine Guidance Note (MGN) 505 (M) Amendment 1[42] applied. The regulations that did apply to marine pilots during the conduct of their PLA duties were contained in the European Working Time Directive (EUWTD) 2003/88/EC[43] and HSE requirements on managing the hazards associated with shift work.

1.11.3 European Working Time Directive

The EUWTD was part of retained EU law in the UK legal system and was in force on 25 October 2022. The EUWTD stated that all workers should have adequate rest periods, a maximum limit on weekly working hours, and account for, and limit, night and shift work, and specified that: the minimum daily rest period was 11 consecutive hours per 24-hour period[44]; the average working time for each 7-day period, including overtime, should not exceed 48 hours[45]; night workers whose work involved special hazards, or heavy physical or mental strain, should not work more than 8 hours in any period of 24 hours during which they performed night work[46]; and, an employer was to keep up-to-date records[47].

1.11.4 Health and Safety Executive fatigue guidance

The HSE noted that more than 3.5 million people in the UK were employed as shift workers[48] and that their working hour arrangements needed to balance the demands of work with time for rest and recovery to avoid fatigued workers who become exposed to accidents, injuries, and ill health. HSE Guidance (HSG) 256: *Managing shift work* (HSG256)[49] stated that it was insufficient to rely on the requirements of the EUWTD to meet the obligations for health and safety as regards shift work arrangements. The general duties noted under the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999 were

[40] IMO MSC.1/Circ.1598 Annex, page 15.

[41] Dawson, D., Reid, K. Fatigue, alcohol and performance impairment. Nature 388, 235 (1997). https://doi.org/10.1038/40775

[42] Human Element Guidance – Part 1: Fatigue and Fitness for Duty.

[43] https://www.legislation.gov.uk/eudr/2003/88/pdfs/eudr_20030088_adopted_en.pdf

[44] EUWTD article 3.

[45] EUWTD article 6.

[46] EUWTD article 8.

[47] EUWTD article 22.

[48] https://www.hse.gov.uk/humanfactors/topics/fatigue.htm

[49] https://www.hse.gov.uk/pubns/priced/hsg256.pdf

both applicable and explained the employer's duties to make an assessment of the risk to employees, including *the number of hours worked and how these hours are scheduled*[50].

HSG256 detailed how to consider the risks of shift work, how to establish systems to manage, assess and act on those risks, and how to check and review those arrangements on a regular basis (particularly the effectiveness of established controls). Worker consultation was considered crucial in the establishment of a fatigue risk management system under HSG256; it was also a requirement under the Safety Representatives and Safety Committees Regulations 1977 and the Health and Safety (Consultation with Employees) Regulations 1996.

The HSE used its human factors toolkit for inspectors[51] to guide employers in the checking of their fatigue management systems. This guide covered the management of fatigue risks and made a hard link between fatigue and the control of major accident hazards. The first question when examining the management of fatigue risks was:

> *Is there a policy that specifically addresses working hours, overtime and guards against fatigue?*

1.11.5 Fatigue risk management assessment

Given the performance of pilot A during the *Ali Ka* move and the presence of performance-shaping factors that might indicate that fatigue was an issue, the investigation commissioned a study from sleep and fatigue risk management experts.

Baines Simmons Safety Services (BSSS) examined fatigue associated with pilotage in this case and produced a report **(Annex A)**. The study sought to answer two key questions regarding fatigue:

1. Was there evidence that fatigue might have played a role in this specific case?

2. Was the fatigue management system in place compliant with regulation and best practice, and effective to control fatigue across PLA's pilot workforce?

In answering question 1 the study found that:

- *Pilot A's sleep/wake history made it highly likely that he was experiencing an elevated level of fatigue at the time of the accident.*

- *Pilot A demonstrated behaviours and performance consistent with a fatigued individual.*

- *It was highly probable that these behaviours and the performance played a direct role in the course of events leading to the accident.*

- *Fatigue was highly likely to have been a significant performance shaping factor in this accident.*

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[50] HSG 256 para 6.

[51] https://www.hse.gov.uk/humanfactors/assets/docs/toolkitintro.pdf

Pilot A's predicted fatigue levels were likely to have been at a moderate level during the planning stage and at either a high or severe level during the execution of the plan.

In answering question 2 the study found that:

- *There was a lack of regulation for specific fatigue risk management for Marine Pilots, but that the European Working Time Directive (EUWTD), 2003/88/EC and the Health and Safety at Work Act provided appropriate guidance to managing fatigue, as a hazard of shift work, through the risk assessment process.*

- *The Maritime Coastguard Agency (MCA) and IMO provided best practice respectively through their fatigue management plan and Company Responsibilities for managing fatigue risk.*

- *The lack of training in fatigue awareness amongst pilots, VTS staff and managers meant that, while personnel had the ability to report fatigue, most personnel did not report the signs and symptoms of fatigue. This limited organisational learning.*

- *PLA fatigue management arrangements were not following the above best practice and that the lack of training in fatigue, fatigue risk assessments, fatigue monitoring and fatigue assurance meant that PLA's approach to fatigue was not effective at identifying and controlling fatigue risk.* [sic]

1.12 OTHER REGULATIONS AND GUIDANCE

1.12.1 The Control of Major Accident Hazards Regulations 2015

The aim of these regulations was to *prevent and mitigate the effects on people and the environment of major accidents involving dangerous substances*[52].

Guidance from HSE was available[53] to anyone who had duties under the regulations and while focused on operators of COMAH establishments they also included others such as local authorities and emergency planners. Oikos was an upper tier establishment[54] and subject to these regulations. PLA had duties regarding emergency planning for accidents at COMAH sites on the river.

A major accident was defined as meeting three conditions:

(a) it results from uncontrolled developments at an establishment to which the Regulations apply; and

(b) it leads to serious danger to human health or to the environment, inside or outside the establishment; and

(c) it involves one or more dangerous substances defined in the Regulations, irrespective of the quantity involved.

52 https://www.hse.gov.uk/comah/

53 https://www.hse.gov.uk/pubns/priced/l111.pdf

54 An establishment where a dangerous substance is present in a quantity equal to, or in excess of, the quantity listed in the entry for that substance in the relevant schedule as part of HSE COMAH regulations.

HSE guidance expanded on the terms *uncontrolled development* and *serious danger*. An uncontrolled development could occur when an operator lost the opportunity or ability to control the internal or external factors affecting a hazardous situation. *Serious danger* was an occurrence that must have the potential to cause danger but need not result in harm or injury. Such serious danger pertained to persons, buildings or the environment, including *damage to the marine or aquatic environment*. The competent authority for Oikos was the HSE, which enforced these COMAH regulations. It was a general duty of these regulations to require every operator to *take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment*. Good practice was to be adopted and the guidance for these COMAH regulations asked an operator to consider first what more could be done to reduce the risks and, second, why the operator had not done this themselves. It included working with stakeholders in delivering proportionate action to control a given hazard.

1.12.2 Port Marine Safety Code

Before the accident, the Port Marine Safety Code (PMSC)[55] had last been updated by the MCA on 3 November 2016 and it applied to all UK harbour authorities and other marine facilities, berths and terminals. The PMSC was supplemented by the Guide to Good Practice on Port Marine Operations[56]. The PMSC was not mandatory but set out a national standard for every aspect of port marine safety and applied fully to PLA as a Statutory Harbour Authority (SHA). For berth operators such as Oikos, *proportionate compliance* with the PMSC was *strongly recommended*. In any event both parties were to *engage with one another to ascertain the scope and extent of the SHA's MSMS*[57] *and whether it incorporates any of the terminal's or jetty's marine operations. This engagement will help to define whether it is necessary for the terminal or jetty to develop their own MSMS*.

The PMSC laid out the key measures to secure marine safety and included the need to use formal risk assessments, have a marine SMS, report and investigate incidents, manage navigation, monitor performance, and monitor compliance. Audits commissioned by the PLA reported a legacy of satisfactory compliance with the PMSC. All observations were tracked by the PLA for action. The PLA used this information to evidence its compliance statements to the MCA. Pilots on the river were authorised and qualified, with pilotage directions being in place, as required by the PMSC. Oikos had not made any PMSC compliance statements and were not specifically aware of the provisions of this Code.

Section 8 of the Guide to Good Practice on Port Marine Operations contained detail on the management of navigation. This section detailed a range of topics, including on port passage plans, passage abort procedures, record keeping (for *incident investigation* purposes) and MPX. The Guide stated that the MPX needed *to be both detailed and structured, if the respective roles of the pilot and the master are to be integrated to best effect*. It detailed that the following *should* be included as a minimum:

- *The provision by the pilot of detailed local navigational information, including his recommended pilotage passage plan. Such details will assist the master to update his own plan and charts.*

[55] https://assets.publishing.service.gov.uk/media/5f63874d8fa8f51069100621/port-marine-safety-code.pdf

[56] https://www.gov.uk/government/publications/a-guide-to-good-practice-on-port-marine-operations

[57] Marine Safety Management System.

- *Details on how the bridge is managed, and who fulfils what functions will also assist the pilot to work effectively with the bridge team.*

- *Presentation by the master to the pilot of a completed standard Pilot Card. In addition, information should be provided on rate of turns at different speeds, turning circles, stopping distances and, if available, other appropriate data.*

- *Discussion of any special conditions such as weather, depth of water, tidal currents and marine traffic which may be expected during the passage.*

- *Discussion of any unusual ship-handling characteristics, machinery difficulties, navigational equipment problems or crew limitations which could affect the operation, handling or safe manoeuvring of the ship.*

- *Information on berthing arrangements; use, characteristics and number of tugs; mooring boats and other external facilities.*

- *Information on mooring arrangements.*

- *Confirmation of the language to be used on the bridge and with external parties.*

Section 9 of the Guide to Good Practice on Port Marine Operations contained detail on pilotage. It detailed how the bridge team and pilot were expected to work together and commented on pilot training and assessment:

- *Bridge procedures and bridge resource management principles still apply when a pilot is onboard. The bridge team must conduct a pre-passage briefing with the pilot to ensure a common understanding of the Passage Plan prior to its execution. Pilots, master and watch keepers must all participate fully, and in a mutually supportive manner.*

- *The master and bridge team have a duty to support the pilot and monitor his/her actions. This includes querying any actions or omissions by the pilot or any members of the bridge team, if inconsistent with the passage plan, or if the safety of the ship is in any doubt.*

- *In order to work effectively with the bridge team, the pilot should be trained in the principles of both Bridge Team Management (the focus being internal and external relationships and operational tasks of the Bridge Team) and Marine Resource Management (the focus being cultural issues and the role of the pilot).*

- *Pilots should be monitored and assessed in the effectiveness of work with the bridge team. This could be through peer review or other form of audit.*

1.12.3 Malta regulations

Ali Ka was registered in Valletta, Malta and Malta's Merchant Shipping Act therefore applied. The Malta flag state issued Merchant Shipping Notices (MSNs), Information Notices and Technical Notices. Technical Notice SLS.33 listed publications that were required to be carried on board. While the International Chamber of Shipping (ICS) Bridge Procedures Guide (Sixth Edition) was not included on this list, *Ali Ka* did carry a copy on the bridge to help ensure the bridge team were kept informed of best practice.

1.12.4 Marine Pilot National Occupational Standards

The Marine Pilot National Occupational Standards[58] had been used by PLA to establish its training standards for pilotage in its area of jurisdiction. Section 4 of these standards covered pilots working effectively with the bridge team, specifically that:

- *In order to ensure a safe passage, it is essential that there should be close co-operation between the Pilot and others in the bridge team. This will involve an early exchange of information. It is vitally important that the Master/Pilot relationship is clearly established.*

- *An integral aspect, which helps to ensure a successful passage, involves an ongoing assessment of the capabilities of the bridge team. The conduct of the Master, the language in use and the team's general willingness and competence all contribute to this.*

- *The Pilot will need to integrate fully within the bridge team, taking into account any deficiencies which may have been observed.*

The performance criteria for the exchange of relevant information when working effectively with the bridge crew required the pilot to *perform ongoing checks to ensure that the vessel's track and progress is effectively and frequently monitored*.

Section 8 covered the skills required to react and respond to problems and emergency situations:

> *A pilot must possess the ability to respond accurately and quickly to any problem, especially if it is a potential or actual emergency situation. This will require an ability to stay calm and make effective rapid decisions and convey them effectively to other members of the Bridge and to the Port.*

Section 9 stated that a *pilot should always be in a fit state to carry out their duties effectively*.

1.12.5 The Bridge Procedures Guide

The ICS published the Bridge Procedures Guide to reflect the best navigational practice for commercial ships and the guide was a carriage requirement for the vessels of several flag states. The Sixth Edition was published in 2022 with increased guidance on non-navigational procedures, new sections covering the human element and ECDIS safety settings, among many other improvements. While the Bridge Procedures Guide was a carriage requirement for UK ships, PLA pilots were not overly familiar with the contents of the Sixth Edition. On pilotage, chapter 1 of the guide stated that:

> *An effective master/pilot information exchange (MPX) is essential to confirm that the master, bridge team and pilot have appropriate levels of situational awareness and a common understanding before they start the pilotage, and this may show there is a need to amend the existing berth to berth passage plan.*

Additionally, that, *The presence of a pilot does not relieve the master or the bridge team of their duties and responsibilities for the safety of the ship*.

[58] https://www.portskillsandsafety.co.uk/skills/national-occupational-standards/

1.12.5.1 Bridge organisation and resource management

Chapter 2 covered effective bridge organisation and Bridge Resource Management and detailed challenge and response as a *leadership approach that fosters effective communication and teamwork*. There was a general encouragement to seek clarification from other team members to better understand decisions and to practise thinking aloud to facilitate a shared mental model and open discussion about intended actions.

1.12.5.2 Passage planning

Chapter 3 covered the principles of passage planning and described the four key stages of achieving a safe passage plan:

1. *Appraisal: collecting and assessing all relevant information required for the intended passage;*

2. *Planning: developing and approving a passage plan based on the outcome of the appraisal of all relevant information;*

3. *Execution: briefing the bridge team on the passage plan. Navigating the ship in accordance with the passage plan;*

4. *Monitoring: checking the progress of the ship against the passage plan.*

The production of a pilot passage plan followed a similar path, though new information could become available during the MPX.

Section 3.4.4 considered passage planning using ECDIS and how to use the various contours available. A shallow contour was to be equal to or more than the lowest draught of the ship as it was used to indicate the value of water depth below which the ship would run aground. The safety contour was an outline that marked the division between safe and unsafe waters. ECDIS prewarned the user of the anticipated crossing of a safety contour within a time set by that user. Use of the safety depth allowed the user to see spot soundings in black for depths shallower than the safety contour and in grey for depths deeper than the safety contour. The deep contour was set to highlight to the user where they might encounter shallow water effects such as squat.

1.12.5.3 Vessel limitations

Chapter 6 was specific to pilotage and made reference to earlier chapters on bridge organisation and passage planning. This chapter reiterated the message that *safe navigation in pilotage waters is a shared task of the bridge team and the pilot*. Section 6.2.4 stated that the pilot card should be updated to include full details of the ship's current condition and all relevant information, including defects that might affect the ship's manoeuvrability. Section 6.4 detailed the MPX and covered, among other elements, the passage plan and *circumstances when it may be necessary to deviate from the plan*. All changes to the plan or to individual bridge team responsibilities were to be agreed *before pilotage begins*. Contingency plans, with abort points, were to be identified and the working language confirmed. The MPX was also to cover any unusual ship handling characteristics and machinery limitations that could affect the safe conduct of the pilotage.

1.12.5.4 Allocation of Roles and Responsibilities

Section 6.5 of chapter 6 detailed pilotage duties and responsibilities and depicted a cooperative approach that involved the pilot taking a supporting role to the master, who was ultimately responsible for the safety of the ship. Section 6.5.1 covered the responsibilities of the bridge team and section 6.5.2 detailed the responsibilities of the pilot. The role of the bridge team was to operate the ship; monitor the pilot, progress of the plan, and UKCs; advise the master on ship's safety; and assist the pilot in the execution of their duties. Any misunderstandings were to be identified and clarified immediately if in any doubt. The pilot was to keep the bridge team informed of pilotage progress; any failures or deficiencies (such as with the tugs); any need to deviate from the agreed plan and, to respond to the bridge team's information, advice, and questions.

Section 6.6 expanded on the guidance in sections 6.5.1 and 6.5.2 and discussed manoeuvring, mooring and tug use. A system of coordinating action, checking and informing was described, though there was no specific mention of keeping the pilot informed of the ship's position compared to the safety contour, safety depth and shallow contour employed by the ship. Checklist C1.1 (MPX) and checklist C1.2 (the pilot card) were highlighted as general support to the MPX and pilotage. These checklists did not include a section to record the allocation of roles and responsibilities nor did they highlight the contour settings in ECDIS. The checklists did not have sections to record any agreed changes to the plan nor did they include a place to record the formal agreement of the plan at the end of the MPX.

The pilot was required to use the information given during the MPX and communicate clearly in the working language, using the IMO SMCP if necessary.

1.12.5.5 Use of English

Section 2.2.14 covered the use of English as the working language of international shipping and stated that:

> *When navigating under pilotage…the pilot should always be expected to explain instructions exchanged…to the master and bridge team in English or a defined working language common to all personnel involved.*

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers required every master or officer of the watch to have an adequate knowledge of written and spoken English. The use of IMO SMCP was encouraged to ensure a common baseline of understanding, and clear and effective communications in an emergency.

1.12.5.6 Tug Allocation

Section 6.6.2 covered tug use and mooring boats and highlighted the need to understand how tugs were to be used and their capabilities and limitations. The section did not provide guidance on how to deal with disagreements over the level of tug provision.

1.12.5.7 Agreeing the Plan

The challenge and response approach detailed in chapter 2 was applicable to pilotage and the expected result of the MPX process was the *effective and clear exchange of information*. Chapter 6 did state the need to agree any changes to the passage plan or to individual bridge team responsibilities, though did not state the need for agreement on the entire pilotage plan before it was enacted.

1.13 PREVIOUS/SIMILAR ACCIDENTS

1.13.1 *Zuga* – uncontrolled departure from berth

On 22 September 2022, the 4,602GRT, 100m oil and chemical tanker *Zuga* made an uncontrolled departure from Oikos 1, Canvey Island. *Zuga* had been berthed head-down at Oikos 1 and embarked a pilot for departure on the ebb tide. No tugs had been booked for the departure. A PLA near miss report was submitted for this accident, though no report was made to MAIB and the MAIB did not investigate this incident.

At 1600, lines were let go and *Zuga* was swept east-south-east along the jetty at 0.5 kts until the bows grounded in the mud of the bankside shoal at Oikos 2. The crew and the line handlers managed to secure *Zuga*'s stern to the eastern end of Oikos 1. A tug was called and *Zuga* made a safe departure at 1640 with no damage. The accident was subsequently investigated by PLA; however, the full details of the accident had not been disclosed by the pilot, Oikos staff or the line handlers. PLA investigators were unaware that *Zuga* had unmoored and grounded, but were led to believe instead that *Zuga*'s pilot had realised that a tug had not been ordered in accordance with PD op letter 30/2021, and had raised the near miss report to highlight that oversight alone. The incident was consequently closed on 16 October 2022, with no identified lessons promulgated until 1 November 2022.

1.13.2 *MSC Antigua* – grounding while berthing at London Gateway

On 29 March 2021, the 94,017GRT, 299m container ship *MSC Antigua* grounded on the southern side of the navigational channel while making a turn to starboard to berth head-down at London Gateway on the northern edge of the navigational channel. The wind was a light breeze from the south-west and the tidal stream was flooding at between 2kts and 4kts.

The PLA investigation found that the pilot passage plan did not include tug positions; checklists were not completed; notes were incorrect; no contingency plan was noted; and the master had not signed the MPX form. Tidal streams had been misjudged and the main engine had been used inadequately during manoeuvring. The MAIB did not investigate this accident.

PLA made recommendations to update its own passage planning guidance and for harbour masters to recommence periodic audit of pilot passage plans to determine if they were fit for purpose. The importance of the MPX was highlighted as a defined agreement of the pilot's passage plan. The allocation of roles and responsibilities for the bridge team to monitor manoeuvres was emphasised, as was the need to challenge *where necessary for safety of navigation*. The PLA recorded these recommendations as complete.

1.13.3 *Amber* – contact and grounding

At 0559 on 15 November 2012, 10,490GRT, 143m bulk carrier *Amber* made contact with moored craft and grounded on the south shore of the River Thames shortly after departing from Tilbury Power Station (MAIB report 22/2013[59]). The vessel's bridge team lost situational awareness in dense fog as the vessel manoeuvred from the berth on the north shore before grounding on the opposite side of the river. *Amber* was berthed head-down and the tidal stream was ebbing at 2kts to 3kts.

Amber was holed above the waterline and several barges were damaged by the contact. There was no environmental damage. The MAIB investigation found that the accident was caused by the bridge team's loss of situational awareness as the vessel left the berth in restricted visibility. The roles and responsibilities of the bridge team had not been confirmed before departure, no continuous radar watch was kept, and the vessel's position, course and speed were not effectively monitored during the manoeuvre.

Recommendations were made and accepted as implemented on the clarification of roles and responsibilities during pilotage; improvements to PLA's MPX form; VTS decision-making; and, for improvements to be made to the ICS Bridge Procedures Guide. The PLA included a checkbox on its MPX form to record that roles and responsibilities had been discussed and did change VTS procedures. The Bridge Procedures Guide was updated in 2016 to capture this recommendation.

1.13.4 *CMA CGM Platon* – contact with Bevans Wharf, River Thames

On 15 May 2011, the 17,594GRT, 170m container ship *CMA CGM Platon*, with pilot embarked, made heavy contact with a quay on the south bank of the River Thames shortly after leaving a berth on the north shore (MAIB report 26/2011[60]). While *CMA CGM Platon* was berthed head-downstream and the tidal stream was flooding, there was a local counter-current near the berth that gave the effect of a localised ebb stream. Once off the berth, the vessel's bows entered an area of flood stream, and the pilot did not manage to overcome its effects.

The investigation found that the master and pilot had not carried out a sufficiently detailed exchange of information before the manoeuvre. The investigation also found that the *PLA had no means for ensuring that the lessons identified in its accident investigations had been effectively promulgated to its pilots.*

PLA took several actions, including a review of effective tug use on the river; a risk assessment review leading to updates to the Towage Code (as appropriate); and the creation of a weekly email to pilots with a lessons learned link containing read receipts. Given the actions, only one recommendation (2011/127) was made, to update PLA procedures for tug use for Northfleet Hope Container Terminal departures. That recommendation was accepted and reported as fully implemented given an update to the Towage Code in December 2011.

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[59] https://www.gov.uk/maib-reports/contact-made-by-bulk-carrier-amber-with-moored-barges-and-its-subsequent-grounding-off-denton-wharf-gravesend-reach-on-the-river-thames-london

[60] https://www.gov.uk/maib-reports/contact-by-container-vessel-cma-cgm-platon-with-bevans-wharf-on-the-river-thames-england

1.13.5 *Vallermosa* – contact with the tankers *Navion Fennia* and *BW Orinoco*

On 25 February 2009, the 43,797GRT, 176m product tanker *Vallermosa*, with pilot embarked, made contact with two oil tankers during a manoeuvre to abort the approach to a terminal on Southampton Water (MAIB report 23/2009[61]). The investigation found that the pilot's effectiveness was reduced due to increasing stress, and that the master and bridge team did not provide adequate support to the pilot during the manoeuvre.

The report concluded that the principles of Bridge Resource Management could not be applied during the pilotage due to the lack of information exchanged between the pilot and master.

A recommendation (2009/172) was made to the UK Major Ports Group, British Ports Association and UK Marine Pilots Association to jointly define their expectations of bridge team and pilot performance. A recommendation (2009/174) was also made to the MCA to disseminate information on the expected levels of support to be provided by bridge teams when a pilot was embarked. The recommendations were accepted as implemented. Recommendations 2009/172 and 2009/174 resulted in changes to the Guide to Good Practice on Port Marine Operations in 2016.

1.13.6 *Sichem Melbourne* – contact with mooring structures

On 25 February 2008, the 8,455GRT, 127m product tanker *Sichem Melbourne* made contact with a mooring dolphin on departure from Coryton Refinery's No 3 berth on the River Thames, head-down on an ebb tide and with a pilot embarked (MAIB report 18/2008[62]). The investigation found that there was an inadequate exchange of information between the master and pilot before starting unmooring operations. It also concluded that there was poor communication between members of the bridge team and that the terminal's marine risk had not required the used of tugs for head-down, ebb tide departures.

An action taken by the terminal owners and PLA was to require tug assistance at all Coryton terminal jetties for head-down, ebb tide departures. PLA also mandated the use of its house-style passage planning and MPX document, implemented a system of random auditing of pilot passage plans and expedited its Bridge Team Management training for pilots.

A recommendation (M2008/166) was made to all UK Competent Harbour Authorities to ensure that sufficient time was allowed for a full exchange of information between the pilot and the ship's bridge team. A recommendation (2008/169) was also issued to the terminal operator to review and revise its risk assessment of marine operations. The recommendations were subsequently accepted as implemented.

1.13.7 *Pembroke Fisher* – contact with buoy while under pilotage

On 11 January 2008, the 9,356 GRT, 135m oil product tanker *Pembroke Fisher* suffered damage to its propulsion and steering systems after making contact with Black Shelf buoy off the Essex shore at Grays, England while under pilotage. Wind conditions were south-westerly, gusting force 8. The PLA report found that

[61] https://www.gov.uk/maib-reports/contact-made-by-product-tanker-vallermosa-with-oil-tankers-navion-fennia-and-bw-orinoco-at-fawley-marine-terminal-southampton-england

[62] https://www.gov.uk/maib-reports/contact-by-chemical-product-carrier-sichem-melbourne-with-mooring-structures-at-coryton-oil-refinery-terminal-river-thames-england

no tug was required by the Towage Code, though one had been ordered and was employed to assist in the ship's unberthing. *Pembroke Fisher* was berthed head-down at GATX No1, Grays, Essex and departed during an ebb tide and under compulsory pilotage. Insufficient distance was made astern into the channel before the tanker came ahead to make the passage downstream.

The PLA report concluded that the master and pilot attempted contradictory evasive actions to prevent the ship setting towards leeward obstructions. *Pembroke Fisher* was set onto Black Shelf buoy, damaging the propeller and rudder, which required the ship to be dry docked for repairs. The root cause of the accident was identified as failure of the master and pilot to agree the procedures for clearing the berth in sufficient detail, with poor bridge teamwork and communications found to be contributory factors. The MAIB did not investigate this accident.

The PLA investigated the accident and circulated 'lessons learned' to its pilots via the company's intranet system and by hard copy. The PLA also recommended that pilots should be given Bridge Team Management training and that work be undertaken to develop tug allocations based on wind speed.

1.14 SIMILAR ACCIDENT FROM THE WIDER TRANSPORT INDUSTRY

1.14.1 Freight train *4E11* – collision with freight train *4E82*

On 5 July 2022, freight train *4E11* was travelling from Felixstowe to Masborough, England when it passed a signal set to danger at Loversall Carr Junction. This signal had been set to protect *4E82*, a second freight train that was standing in the section ahead. Train *4E11* struck *4E82* at approximately 28 miles per hour. The collision caused significant damage to rail infrastructure, the lead locomotive and wagons of *4E11*, and the rear wagons of *4E82*. The route remained closed for 26 days for recovery and track repair work.

The Rail Accident Investigation Branch (RAIB) report[63] into the collision concluded that the driver did not control the speed of the train *4E11* to enable it to stop at the signal. This was because the driver had experienced a loss of awareness of the driving task, probably due to the effects of fatigue. The RAIB found that the driver's working pattern was likely to cause fatigue, and that they had experienced a low quality of rest, primarily caused by an undiagnosed sleep condition. The management systems of the employer, the freight operating company GB Railfreight Limited (GBRf), had not detected that the driver was at risk of fatigue. An underlying factor to the accident was the management of fatigue by GBRf, which did not follow current industry good practice. The risk assessment processes of GBRf also did not identify the hazards created by a driver driving while being fatigued.

RAIB made a recommendation to GBRf to reduce the risk of train driver fatigue, including improving risk assessments, processes and following industry good practice. A recommendation was also made to the Rail Safety and Standards Board to work in conjunction with freight and other train operators to include the identification of sleep disorder indicators in current standards for safety-critical medical assessments.

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[63] https://www.gov.uk/raib-reports/report-08-slash-2023-collision-between-two-freight-trains-at-loversall-carr-junction

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 OVERVIEW

During the early hours of 25 October 2022, *Ali Ka* departed from Oikos 1 with a pilot on board but without assistance from tugs. Control of the manoeuvre was lost and the vessel made contact with the western arm of Oikos 2 resulting in major damage to both the ship and the jetty.

This section of the report will analyse the factors that affected the planning and conduct of the manoeuvre, safety management and the appreciation of risk. While a serious marine casualty in its own right, this accident was also a near miss to something far more serious.

2.3 THE ACCIDENT

Ali Ka contacted the western arm of Oikos 2 because the pilot's departure plan missed a requirement for mandatory tug use, did not account for the full effects of the tidal stream and it was not amended to include information from the MPX, though that exchange was ineffective and unstructured. Critical information was difficult to access from PLA's marine SMS and this further hindered the timely production of a safe departure plan. It was highly likely that the pilot was fatigued and was not well supported by *Ali Ka*'s bridge team. Challenges went unheeded and *Ali Ka*'s proximity to shallow water, and Oikos 2, was not effectively monitored as the vessel left the berth. PLA managers were unaware of the fatigue risk and neither Oikos management nor PLA had mutually considered and accounted for their interdependencies regarding the control of major accident hazards.

2.3.1 The plan

As described in the ICS Bridge Procedures Guide, a safe plan is the result of appraisal, planning, execution, and monitoring. Pilot A had just over 6 hours and 15 minutes **(**see **Table 1)** between being allocated to the *Ali Ka* move and arriving at Gravesend to catch the harbour services launch at 0300. This presented the pilot with a trade-off between gaining some quality rest ahead of the pilotage act and producing a rigorous plan that incorporated appraised information.

Pilot A, who was likely to have been moderately fatigued at this point, chose to plan first and sleep later and the appraisal and planning processes were conducted away from the office as a result. Working from home and using Polaris Lite meant that pilot A was unable to access some of the required safety critical information through hyperlinks. This, and the fact that safety critical information was dispersed throughout PLA systems, meant that the pilot was hindered in their efforts to collect and assess all the relevant information.

Pilot A did not access the Polaris note about *Ali Ka*'s weak astern power and consequently this was not factored into their plan. This, combined with missing detail on the strength of the tidal stream, pilot A's lack of familiarity with the berth's environment and the relatively new Oikos 2 jetty, meant that the plan was missing important information. Having not visited Oikos 1 for almost 5 years, pilot A had not encountered the extension to Oikos 2 and was unfamiliar with the significant impact of this development in constraining the available navigable water for a head-down departure with a strong ebb tide. It was possible that pilot A would have been better prepared for the challenges faced with *Ali Ka*'s departure from Oikos 1, and more willing to take a tug, had the table-top training on the berth requested in April 2018 taken place.

The contingency plan marked on the pilot passage plan form by pilot A was to *anchor anywhere if possible outside the fairway.* This might have been a reasonable, if vague, plan in the event of an emergency once clear of the Oikos jetties. However, it proved insufficient to assist pilot A when the plan's flaws were realised at an early stage.

Pilot A used the Towage Code to inform them of tug requirements. As the Towage Code had not been updated to incorporate PD op letter 30/2021, pilot A was not apprised of the mandatory tug requirement for all head-down, ebb tide departures from Oikos 1. Pilot A was not alone in this as the DPC and the VTSO on duty at the time of the accident were also unaware of that requirement. The pilot of the *Zuga* near miss incident was also initially unaware of the mandatory tug requirement during their head-down, ebb tide departure on 22 September 2022. Fortunately, on that occasion, the grounding likely prevented any contact with Oikos 2 and the pilot managed to recover the situation and call for tug assistance. With 240 extant PD op letters ranging back 23 years, and no clear method to incorporate these into the formal marine SMS, it was unsurprising that several pilots were unaware of PD op letter 30/2021. Given that VTSOs were not included on the distribution list for PD op letters there was no way for them to know about this information. The result was that no tug was sought for the 0400 sailing of *Ali Ka*.

Lessons, actions taken and recommendations from the *MSC Antigua*, *Sichem Melbourne* and *Pembroke Fisher* investigations all highlighted problematic planning, particularly on tug use, accounting for tidal stream, and the development of contingency plans. In all of these previous cases it was recommended that pilot passage plans be audited to proactively improve standards through checking for common shortcomings and the adoption of positive feedback. The Guide to Good Practice on Port Marine Operations included such audits as an option to assist in the monitoring of pilot effectiveness. The content of pilot passage plans was not audited and the opportunity to learn from feedback to pilots was missed. The plan was impacted by incoherencies in the PLA's safety management system, which is analysed at section 2.4.

It is apparent that pilot A's passage plan missed key information and that this directly contributed to the subsequent loss of control for the manoeuvre. The MPX became the final barrier to the flaws in the plan becoming realised during the manoeuvre.

2.3.2 The master/pilot exchange

Pilot A discussed various matters relevant to *Ali Ka*'s master for 35 minutes before departure and it is likely that this allowed sufficient time to conduct a thorough MPX. However, fixated by the height of tide and the time of departure, the lack of tug support absorbed much of the conversation and, while several challenges were made to the decision to sail without an attendant tug, none were effective. Pilot A did cover how the departure manoeuvre was to be conducted but the MPX form did not reflect the lack of tug support. The strength of the tidal stream was a significant factor during the move but neither this, the impact of the wind on the move, nor the contingency plan should something go wrong were discussed. Information about the -12 setting being the effective neutral setting on the propulsion control was absent from the pilot card prepared by *Ali Ka* and only briefed by the master 18 minutes into the MPX. Following this there was no agreement on how pilot A would amend or adjust any requests for astern power and it was unclear how the master interpreted pilot A's engine orders. Pilot A did not discuss the passage plan out of the River Thames, nor were *Ali Ka*'s ECDIS safety contour settings queried. Despite the relevant checkbox on the MPX form being ticked, specific bridge team roles and responsibilities were not assigned. Consequently, the manoeuvre away from the berth was not monitored by the bridge team, and the proximity of *Ali Ka* to the shoal to the south-west of Oikos 1 was probably not noticed.

The investigation did not find any record of a clear decision to sail, nor any clear statement of the master's agreement with the pilot's passage plan. That the master instructed the ship's mooring teams not to untie their lines at 0400, but that 12 minutes later was ordering them to single up, indicated that the master had probably acquiesced to sail without tugs despite earlier protestations. This lack of positive agreement at the end of MPX discussions did not alert pilot A to the master's disquiet. It was possible that language difficulties, and the negative impact of fatigue on the pilot, might have contributed to poor communication during the MPX.

Issues with MPX had previously been considered by PLA as a result of the *MSC Antigua*, *Amber*, *CMA CGM Platon*, *Sichem Melbourne* and *Pembroke Fisher* accidents. The time and content required for a full exchange of information was raised in recommendations to all UK competent harbour authorities in the MAIB report on *Sichem Melbourne*. In response to MAIB recommendation 2013/229 from the *Amber* report, PLA included a checkbox to its pilot passage plan form for the requirement to clarify the roles and responsibilities of the bridge team. Pilot A had checked this box as a record of the *Ali Ka* MPX to confirm that this discussion had taken place, but no evidence of that discussion was found. It is apparent that PLA's change to the form was ineffective in delivering lasting improvements to the procedure.

The Guide to Good Practice on Port Marine Operations described the expectations for how the bridge team and pilot were to work together. Chapter 6 of the ICS Bridge Procedures Guide (Sixth Edition) provided best practice guidance to ship's teams and pilots on the coordination required between them all to achieve safe navigation during pilotage. PLA pilots' lack of awareness of the Sixth Edition meant that this guidance had limited reach. Chapter 6 did cover the roles and responsibilities of bridge teams and pilots, but this was excluded from the list in section 6.4 and checklist C1.1. Without strong links in the Bridge Procedures Guide's checklists these roles and responsibilities risk being overlooked by both bridge teams and pilots, as they were in this case. Further, while safe navigation was mentioned, the checklists did not suggest recording the ECDIS safety settings in use. Consequently, there was no link from the checklists to explicit monitoring of the ship's horizontal proximity to ECDIS contours in the list of roles and responsibilities. Without this link, in this case where 1m contours were available through the high-density ENCs of the area, and where *Ali Ka* had marked the area off Oikos 1 as unsafe **(Figure 15)**, there was limited drive towards effective monitoring of safe navigation while under pilotage. This was not recognised by pilot A or the master and so the bridge team did not subsequently provide effective support during the manoeuvre.

That the MPX undertaken on the bridge of *Ali Ka* was protracted, unstructured, assigned no specific roles and responsibilities, and did not deliver clear statements of approval with subsequent briefing of the bridge team meant that it was ineffective in achieving its objectives as described in the Guide to Good Practice on Port Marine Operations. As a result, the plan missed key information and was neither appropriately modified nor agreed. The conduct of the MPX probably left the master feeling harried into compliance with pilot A's plan. Consequently, the bridge team of *Ali Ka* did not fully participate in the manoeuvre and did not support pilot A in the delivery of a safe departure from port.

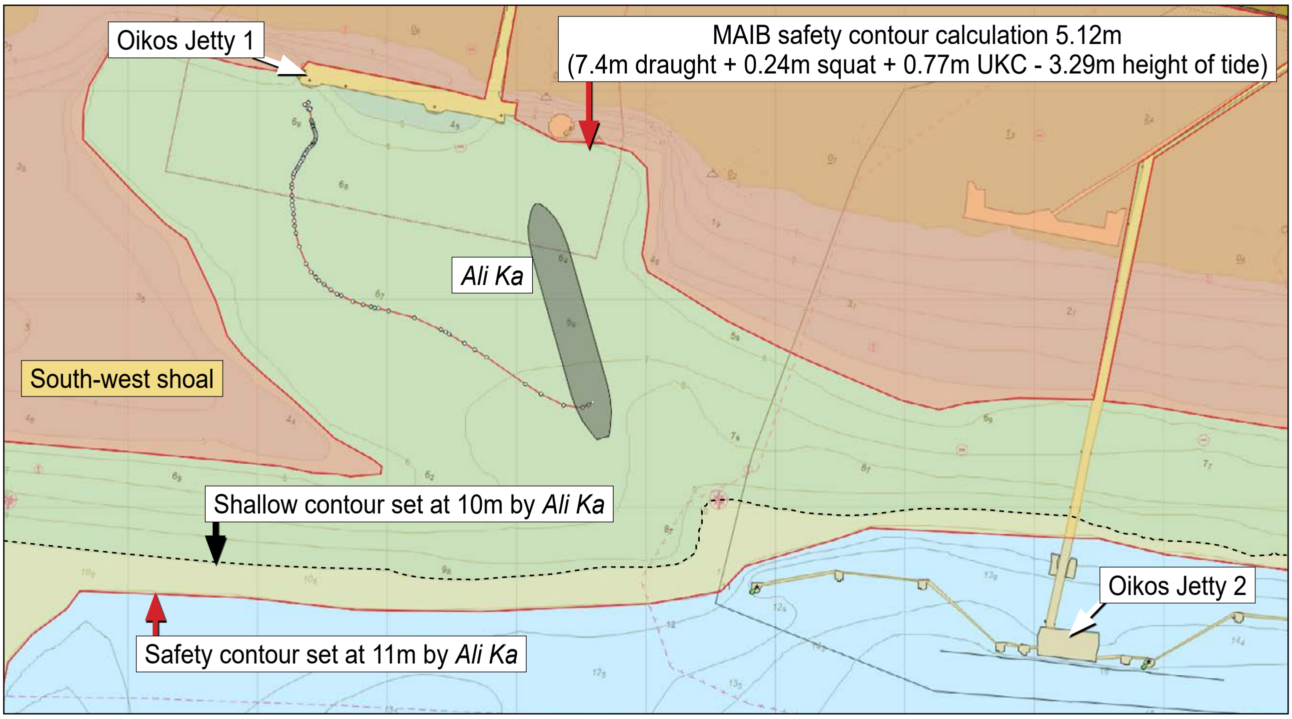

Figure 15: Depth contours relevant to *Ali Ka*'s departure from Oikos 1

2.3.3 The manoeuvre

In the 17 minutes between slipping the final line ashore at Oikos 1 and hitting Oikos 2 the weaknesses in the departure plan were realised. Pilot A did manage to manoeuvre *Ali Ka* to 90° off the line of Oikos 1 as intended. This manoeuvre presented the maximum aspect of *Ali Ka* to the ebbing tidal stream. While the bows were experiencing 0.5kts of tidal stream setting to the east south-east, the stern was placed in an area where the tidal streams were at least three times as strong, being greater than 1.5kts **(Figure 16)**. The further south *Ali Ka* moved the stronger the effect of the tidal stream became, setting *Ali Ka* into Oikos 2. Impacted by fatigue and bereft of effective support from the bridge team, pilot A did not detect the effect of the tidal stream until it was too late.

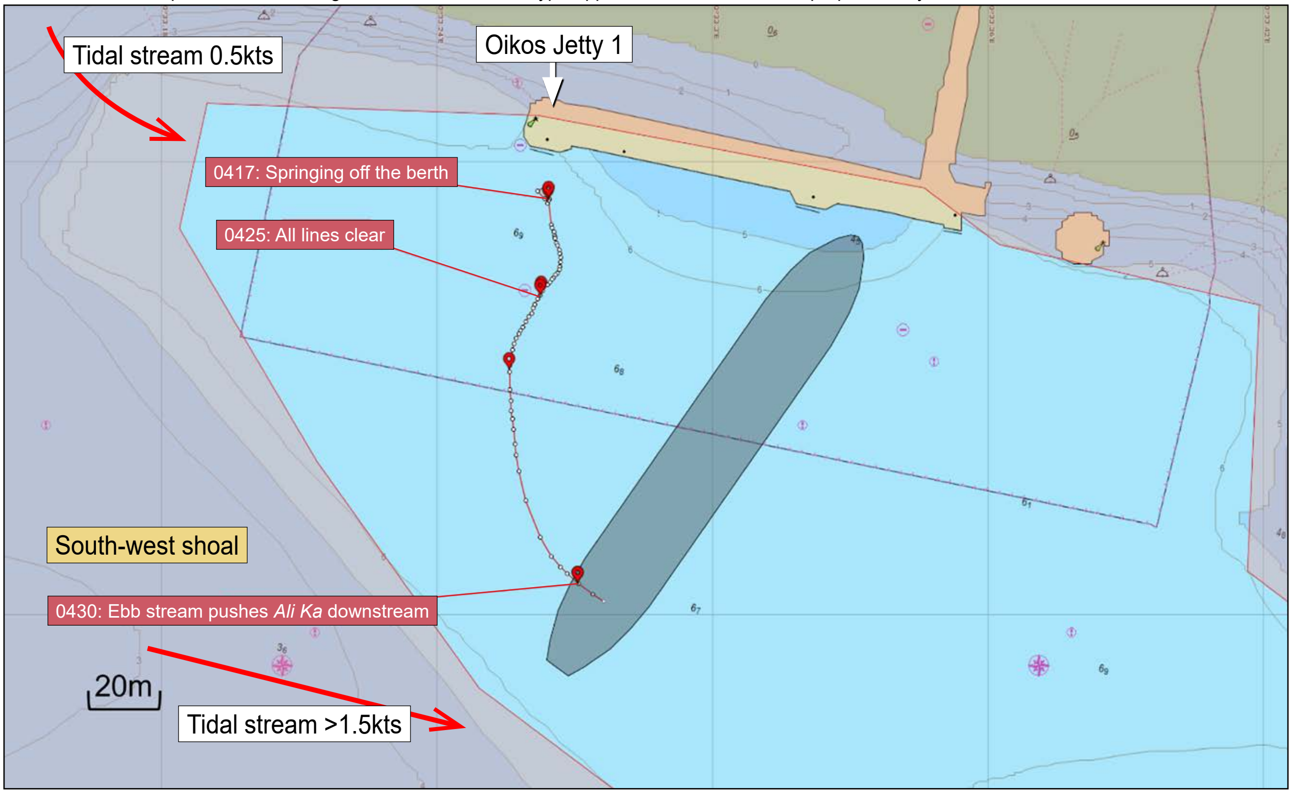

Figure 16: Increasing tidal stream strength during the manoeuvre away from Oikos 1

When pilot A ordered slow astern it was unclear what the master was expected to set on the lever, given that a -12 setting delivered a neutral effect. Staying at slow astern for almost 2 minutes, and primarily monitoring the manoeuvre using the ship's radar display, it slowly dawned on pilot A that this was insufficient to clear the western arm of Oikos 2. With a very brief window of time to exit safely between the shoal and Oikos 2, pilot A did not set sufficient astern power to make a safe exit. Aside from reporting the depth and the proximity to Oikos 1 during the initial departure from the berth, the bridge crew were broadly silent and did not challenge the pilot's decisions. The National Occupational Standards for Marine Pilotage performance criteria indicated an expectation that *the vessel's track and progress* were to be *effectively and frequently monitored* by the bridge team. The ICS Bridge Procedures Guide also included the need for crew to monitor the track and UKC and advise the master of any doubt about the ship's safety. No such monitoring or advice was evident by, and from, the crew of *Ali Ka*. Pilot A decided that the stern needed to move to port and consequently applied maximum starboard rudder and ahead power, with which the master and bridge team complied. The Guide to Good Practice on Port Marine Operations described the expectation for the bridge team to query the pilot's actions or omissions; however, no such queries were evident. This manoeuvre was successful in temporarily adjusting *Ali Ka*'s orientation but had placed the ship further north. Without tugs, or letting go the anchors and accepting a grounding, it was now almost impossible to avoid a contact with Oikos 2.

With the bows grazing the bankside shoal to the north of Oikos 2, and the tidal stream pushing *Ali Ka* bodily sideways at 0.9 kts, pilot A's use of full power astern was insufficient to extricate the ship into the main channel. It was only in these final moments that the master and bridge team spoke up, though this was too late to effect any real change. The final kick ahead in power probably minimised the damage from the inevitable contact with the western dolphin of Oikos 2. By ordering the anchors to be let go, the ship's swing to starboard was arrested and the bows came to rest 48m away from the pier at Oikos 2.

Similar to *Zuga*, the plan not to use tugs on departing Oikos 1, head-down in an ebb stream, did not work. Similar to *MSC Antigua*, *Amber*, *Vallermosa* and *Sichem Melbourne* the bridge team broadly left the manoeuvre up to the pilot and gave limited assistance or advice based on their monitoring of how the manoeuvre was developing. While the bridge team of *Ali Ka* were trained in BRM and the Trans Ka SMS referred to efficient use of bridge resources, BRM procedures were not employed to support pilot A in the conduct of the manoeuvre. The bridge team did not tell pilot A when *Ali Ka* started to clear the shoal, that the ship was making very little ground to the south, nor that the vessel was closing rapidly on Oikos 2. Consequently, this lack of bridge team support directly contributed to the failure of this manoeuvre and the contact with Oikos 2.

Pilot A had not received any BRM training in recent years and, when combined with a general lack of appreciation of the guidance in the ICS Bridge Procedures Guide (Sixth Edition) was at a disadvantage compared to those who had benefited from recent training.

By adopting comprehensive risk assessment processes that consider the hazards for berthing and unberthing a pilot can be well-placed to deliver a fully informed pilotage passage plan, particularly when all available controls and mitigations are included. Risk assessments had been conducted by PLA in 2014 for Oikos and for Coryton following the *Sichem Melbourne* accident. During the simulations to support that 2014 risk assessment, all manoeuvres from Oikos 1 were conducted using two tugs. Specific comment had been added to the risk assessment highlighting *additional tug requirements for all vessels* conducting *port side alongside ebb tide departures*. This baseline condition was not translated into the Towage Code and therefore did not best support vessels manoeuvring under pilotage in the vicinity of Oikos 1.

Given the gaps in the pilot's departure plan, the lack of a tug and the poor MPX, it was left to the vigilance and actions of the entire bridge team to rescue the unfolding situation. This collective effort was missing and the result was that control of *Ali Ka* was lost and the contact with Oikos 2 became inevitable.

2.3.4 Fatigue

Analysis of *Ali Ka*'s VDR, operations and hours of work and rest highlighted no concerns over crew fatigue, and it was considered that fatigue was not a significant factor for the master or crew during the accident. However, the BSSS fatigue study **(Annex A)** concluded that it was highly likely pilot A was experiencing moderate fatigue when producing the passage plan and that they had an elevated level of fatigue at the time of the accident, specifically that pilot A's behaviours and performance were demonstrative of a fatigued individual and that this directly contributed to the accident. Delayed reaction times, tunnel vision focused on the height of tide, reduced appreciation of risk, reduced clarity of communication, short and abrupt interactions with the master and potential forgetfulness were all exhibited by pilot A during the manoeuvre.

The study also highlighted that PLA's approach to fatigue was not fully effective at identifying and controlling fatigue risk. The result was that a highly likely fatigued pilot was unsuccessful in manoeuvring *Ali Ka* away from Oikos 1 and instead hit Oikos 2, causing significant damage.

While pilot rules and roster patterns formed the basis of PLA's fatigue risk management it was noted that the interpretation and implementation of the anticipated controls varied significantly. The PLA's pilot rosters were founded around the duration of pilotage acts and the assumption that 100% rest would be achieved between the return time and the base time for the next act. This included the hour between the allocation time and base time, when pilots were unlikely to be resting.

Pilot rosters did not account for the nominal allocation time, the impact that early notification of an act of pilotage could have, or a pilot's domestic life and circadian rhythm[64] on those dedicated rest periods. The parallels to the *4E11* rail accident are stark and demonstrate the high fatigue risk of shift workers, particularly following low quality rest periods, and the need to effectively mitigate fatigue risk.

It was likely that many pilots were keen to receive early notification of a night pilotage act so that they could carry out planning and manage their rest. In this case, following allocation at 2042, pilot A was engaged in producing the pilot passage plan for at least 1 hour and 40 minutes, and was likely to have been moderately fatigued during this planning. It was evident that pilot A was not resting at 2221, when the DPC made the last call. At best, pilot A then achieved just over 3.5 hours of rest before waking at 0200. The BSSS study established that, given their medical issues, pilot A would still have been predicted to experience 'high levels' of fatigue had they managed to nap during the afternoon before the accident and achieved low quality sleep between 2221 and 0200. With less sleep, as reported by pilot A, the predicted level of fatigue increased to 'severe'.

It was apparent the actual conduct of pilot rest periods in between pilotage acts often differed from that expected by PLA management. Specifically, it was unrealistic to attribute 100% of the time between return from one act of pilotage and base time for the next as rest, and this data inevitably presented a flawed baseline for fatigue management. Although PLA cannot ensure that a pilot's rest is of good quality, it is possible to make sure that their roster is accurately recorded, assessed, and altered to minimise the risk of fatigue. In this case fatigue risk had not been identified by PLA and, aside from the general roster construct, the two nights out rule, and a requirement to report fatigue were ineffective in identifying or controlling this risk. Some pilots had reported themselves as fatigued, but these reports were neither treated as near misses nor investigated and no management action was taken to learn lessons from these reports. Some PLA managers and pilots viewed people who reported as fatigued as either failing to manage their own rest effectively or attempting to avoid less favourable pilotage acts. The text of PD op letter 04/2006 suggested that tiredness claims would be assessed to check they were genuine, though PLA personnel were not trained to assess fatigue and it is unclear how claims were deemed to be genuine or otherwise.

Some of the PLA management team recognised that planned rest differed from actual rest, but this was neither accounted for nor used to assess the real fatigue risk. Consequently, PLA's pilot rosters did not fully manage the fatigue risk experienced.

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[64] *Circadian rhythms are physical, mental and behavioural changes that last about a day; they follow a 24 hour cycle. Circadian rhythms correspond to the light-dark cycle of an individual's environment and are influenced by natural factors within the body, but also within the environment; the most obvious being the sleep/wake cycle. The most important signal providing time of day information to set the internal clock and sleep-wake cycle is the light-dark cycle.*

From *Circadian Rhythms and Personality Disorders*, NHS Health Research Authority, 25 March 2014.

The lack of training in fatigue awareness at PLA, coupled with the lack of near miss reporting on the subject, resulted in limited opportunities for organisational learning and systematic improvements to the management of fatigue. All pilots were subject to extended periods of non-regular shift patterns and found it difficult to rest effectively between long acts of pilotage. Those non-regular shift patterns and associated challenges did not support the achievement of adequate rest and put pilots at risk of fatigue on a routine basis.

HSE publication HSG256 provided good guidance on how to manage fatigue, as a hazard of shift work, through the risk assessment process and could be used to identify the hazards created by a pilot operating while being fatigued. By being alert to the sources, symptoms and impacts of fatigue as part of a comprehensive fatigue risk management system, a port authority could adopt practices that best protect its people, ships and critical infrastructure, and enhance port safety. PLA fatigue management arrangements did not follow HSG256 guidance. The resulting lack of control over the fatigue risk left the PLA, and those reliant on safe pilotage, exposed to fatigue hazard.

Fatigue was highly likely to have affected pilot A's planning, capacity to absorb information, decision-making and reaction times, and this directly contributed to the accident occurring. These risks could have been better controlled had PLA followed HSG256 guidance.

2.3.5 Bridge Resource Management and challenge

2.3.5.1 *Ali Ka*

The pilot's passage plan was not agreed and specific roles and responsibilities to monitor the proximity to hazard were neither allocated nor agreed during the MPX. This led to members of the bridge team, all of whom were appropriately qualified and trained in BRM, not recognising their role in the plan and how to best assist the pilot in their execution of *Ali Ka*'s departure from port. Consequently, only the master voiced some challenge to the pilot before sailing. The master, probably for reasons of language, did not pick up on the request from the pilot of the *Delaware Express* to speak to pilot A and this opportunity to receive an external challenge was missed.

Support was sought from London VTS and the ship's agent during the master's challenge to pilot A over the lack of tug provision. Neither London VTS nor the ship's agent recognised the challenge or acted to stop the sailing. This was probably because both already understood the plan to sail without a tug and neither took the opportunity to question this plan or to seek the master's opinion on it. Evidently disquieted the master eventually acquiesced to the plan to sail and neither queried pilot A's decision-making nor raised any further challenge.

The rest of *Ali Ka*'s bridge team did not query or challenge pilot A's decisions and actions during the MPX or the manoeuvre. It was unclear how familiar the bridge team were with the guidance on pilotage or challenge and response in the ICS Bridge Procedures Guide (Sixth Edition) that was available on the bridge. Comments from the bridge team were unforthcoming on *Ali Ka*'s proximity to the shoal to the south-west of Oikos 1; that the ship was making insufficient ground to the south; or that the ship was drifting inexorably, and rapidly, towards Oikos 2. The pulse of ahead power applied by pilot A was not queried, nor did it stimulate the bridge team to action any potential contingency plan. The lowering of the anchors came too late to stop the impact with Oikos 2 and this contingency plan was only exercised in response to a request from pilot A.

This lack of challenge gave the pilot no pause for thought nor assistance to recognise early that the plan was not working and so directly contributed to the accident. Despite their training neither the master nor the bridge team of *Ali Ka* issued effective challenges to pilot A's plan during the manoeuvre.

2.3.5.2 Port of London Authority's Bridge Resource Management policy

Many PLA pilots believed that initial and 5-yearly refresher training in BRM was a requirement; however, the Marine Pilot Training Manual did not include a requirement for refresher training. Some pilots, including pilot A, had not received BRM training since becoming a pilot and their awareness of the guidance in the ICS Bridge Procedures Guide was also mixed. The benefits of regular BRM refresher training have been acknowledged for some years, as have the benefits of pilot-focused BRM training, drawing on the advice in chapter 6 of the ICS Bridge Procedures Guide (Sixth Edition). Clearer articulation of PLA's policy on BRM backed up with robust training records would help ensure awareness of and adherence to current good practice.

2.3.5.3 Port of London Authority's stop procedure

The PLA was directly aware of four distinct challenges made by various personnel as this accident unfolded. The first challenge was to the written procedure when the ship's agent asked if a tug was advised for the departure of *Ali Ka* from Oikos 1 even though none were required by the Towage Code. The DPC, aware of previous difficulties sailing from Oikos 1, agreed with the agent and suggested that a tug be booked. The second challenge was made by pilot A on realising that sailing with a tug would mean a later departure time and a lower height of tide. The DPC then changed their original decision and agreed to *Ali Ka* sailing without a tug. Despite both of these challenges no one either actively sought an alternative tug for 0400 or tried to achieve a compromise. Consequently, pilot A's plan was tacitly allowed to progress despite earlier reservations expressed by both the ship's agent and the DPC.

The third challenge over the lack of tug provision occurred when pilot A called London VTS after boarding *Ali Ka*. This was dismissed once pilot A was reminded of the sailing of *Delaware Express*; no one used this call to reflect on tug provision for the move or to check in with the DPC once more. Coincidentally, *Delaware Express* sailed as planned and released tug *VB Panther* in sufficient time for the tug to assist *Ali Ka* at 0400. As *VB Panther* was no longer booked for the *Ali Ka* departure, and the tug skipper was unaware of the move, the tug moored up and shut down. No one recognised this opportunity and consequently no tug was made available to *Ali Ka* for the ship's 0400 departure.

The fourth, and clearest, challenge to the emerging situation was made directly by the pilot of the *Delaware Express* to London VTS. As this conversation was only partially overheard on board *Ali Ka*, the master, pilot and bridge team were aware only that their move and tug provision was being discussed. However, this did not appear to raise doubts or questions with either the pilot or the master about the plan. The pilot of *Delaware Express* was explicit to London VTS about the mandatory tug requirement, where this was noted, how that applied to *Ali Ka*, and the consequences of proceeding ahead without a tug. The DPC, who was on a break, did not directly hear this challenge. Unfortunately, the VTSO did not relay exactly what the pilot of the *Delaware Express* had said and the DPC did not act to stop the departure. On asking whether it was okay to *let him* [*Ali Ka*] *go…if* [pilot A was] *happy to do it*, the VTSO did not explicitly check that pilot A was still happy to conduct the act of pilotage nor relayed the nature of the challenge. The lack of clear communication following this challenge did not support accurate decision-making and did not result in a final pause for thought nor a reappraisal of the situation. The flawed plan was still on track to deliver its unfortunate outcome.

The VTSO issued two more, unheard, challenges over VHF, noting that *Ali Ka* was coming close to Oikos 2, but by then the accident was inevitable. The DPC was not called as the situation unfolded and was only recalled to the VTS PCC once the accident had happened and two tugs were on their way.

During the investigation many PLA employees referred to a *stop procedure* but no specific record of that could be found in PLA procedures. While both the VTSO and the DPC were very experienced and had dealt with many difficult situations during their careers neither were well-versed in dealing with challenges to decision-making. Without clear training or procedures on how to deal with a challenge of this nature there was no effective final barrier in place to help prevent the accident. Pilot A also did not recognise these challenges but, as it is highly likely the pilot was in a fatigued state with compromised decision-making and reduced appreciation of risk, this was unsurprising.

Stop procedures, and the use of standard message markers, are important as final barriers when challenge can be stated clearly, recognised and accepted. However, stop procedures are poor barriers in themselves and need the right environment to work effectively. Ultimately, PLA's stop procedure was ineffective at dealing with clear challenges to the plan and did not help to prevent this accident.

2.4 SAFETY MANAGEMENT

2.4.1 Port of London Authority's marine safety management system

It was unsurprising, given the vast scope of PLA's responsibilities, that its Marine SMS was complicated and constituted many documents covering a wide range of topics. Individually, these documents were mostly clear, readable, and informative. The Towage Code had been highlighted as an example of best practice at one of the PMSC audits and was widely available on PLA's website and used by ship's agents, masters, pilots, DPCs, VTSOs and others as the premier source of guidance on tug use on the River Thames.

However easy to use and apparently thorough the Towage Code was, it did not contain information that had been gained through experience over the years. The investigation found that not only had PD op letter 30/2021 not been absorbed in the April 2022 update but actions taken regarding additional mandatory tug requirements following the *CMA CGM Platon* and *Sichem Melbourne* accident (included in PD op letter 16/2008) were also missing. Further, PD op letters 07/2017 (Esso Jetty, two tug requirement) and 12/2019 (Grays berthing and unberthing limits requiring additional tug provision) were not absorbed into the Towage Code as of the April 2022 update. PD op letter 19/2019 (Vopak 1 updated berthing parameters requiring additional tug provision) was still extant, though was broadly included in the Towage Code. There might have been good reason not to change the Towage Code if the additional tug requirements were not agreed. However, leaving the PD op letters open and unresolved meant pilots were unsure which requirement was to be followed. It was unclear what position PD op letters held in any hierarchy of documentation and whether, for example, an extant PD op letter from 2017 superseded a more recently updated document such as the April 2022 updates to the Towage Code. Further, that harbour masters, VTSOs, ship's agents and masters were not included in the distribution of PD op letters meant many were working to different guidelines to those the pilots were instructed to follow.

Pilots were also unaware whether PD op letters formed a formal part of the marine SMS and, with 240 extant letters dating back 23 years, this confusion was unhelpful. PD op letters were emailed to pilots when issued and then saved to a folder on the PLA's intranet. It was easy for pilots not to notice that a PD op letter had been issued as, for example, when returning from a leave break they were just one of several emails to read (recalling that there were often around three Resolver reports a day) and were not always immediately relevant to an individual pilot. Further, depending on when a pilot had joined PLA, it was possible that older PD op letters would only have been noted if the individual had carried out a thorough review of the intranet site.

The intranet site was searchable but did rely on a pilot knowing that there was something to search for that might be relevant to their upcoming act of pilotage. That both pilot A and the DPC on watch were unaware of the contents of PD op letter 30/2021 was unsurprising. It was unfortunate that the pilot who brought *Ali Ka* in, and the pilot of the *Delaware Express*, both of whom had attended the MMM where this requirement had been discussed, were effectively ignored as this accident unfolded.

The apparent presumption of part two of the Towage Code was that PLA would be in a position to encourage masters to use tugs and, if required, *impose the required number of tugs*. However, in this case the master of *Ali Ka* tried to obtain support to use a tug and was seemingly unable to impose this desire for tug provision on PLA, though this was not explicit and not pursued as a condition of sailing.

The Berth Guide served as a useful repository of information relevant to berths on the river and its contents for Oikos were thorough and served to highlight PD op letter 30/2021 on the mandatory tug requirement for all head-down, ebb tide departures. However, the Berth Guide was not a formal part of the marine SMS, the hyperlinks it contained did not work when accessing the document from home, and the chartlets it contained were indicative and did not reflect the most recent hydrographic surveys (though there were links to these).

This confusion of documentation, with unclear hierarchies and incomplete updates that were difficult to access, did not best support pilots in gathering all the requisite safety critical information to appraise and then plan their acts of pilotage. The contradictory guidance between documents demonstrated a lack of currency for PLA's marine SMS and this did not support the generation of a safe pilot passage plan.

2.4.2 Risk management

The scope of PLA's responsibilities meant that its risk picture was complicated. The MMMs did discuss navigational safety and did examine risk. The use of Resolver reports to generate risk heat maps and thematic risk analysis was a sound approach to identify emerging issues or where risk controls could be strengthened. Regular audits also added an important layer of external scrutiny of risk and safety across PLA's marine operations. However, this system was highly reliant on accurate Resolver reports, inquisitive investigation, and collaborative liaison meetings with river users and berth operators, all set within a just culture that was actively learning.

The *Zuga* case was instructive as a precursor to *Ali Ka*'s accident. Following the 2014 Oikos navigational risk assessment, the MMMs of September and November 2021, PD op letter 30/2021 and the April 2022 update to the Towage Code, *Zuga*'s pilot still attempted a head-down, ebb tide departure from Oikos 1 without tugs. That *Zuga* grounded during this uncontrolled departure was not reported to PLA harbour masters on the Resolver system. This underreporting, combined with the fact that no one at Oikos had reported the grounding independently, meant that PLA harbour masters did not detect the significance of the accident. Even as a 'near miss', this case was indicative that the system of controls that were supposed to be in place to stop this from happening had failed. Considering the large number of Resolver reports received it is possible that the SHM's team had insufficient time to analyse and process them all alongside their other daily tasks. Consequently, this accident went unrecognised as a warning and the risk controls were not reappraised.

Risk interdependencies between operators, such as Oikos and PLA, relied on active liaison. Oikos were focused on COMAH and had effectively outsourced appreciation of marine risk to PLA for the safeguarding of their two jetties (hazards 1 to 4 from the 2014 navigational risk assessment), with no checks in place to assure themselves that PLA was delivering appropriate mitigations such as the minimum tug requirements. Following the navigational risk assessment of Oikos in 2014, which was baselined on two tugs being used for every move, it was notable that the Towage Code did not reflect this underlying assumption and that no one at Oikos or PLA had queried this. The pilot representative had raised tug provision at Oikos to the MMM following study of *Sichem Melbourne*. That it took over 3 months to issue some guidance following the September 2021 MMM discussion of the 2009 *Sichem Melbourne* case was further evidence that the PLA did not always learn quickly.

The PMSC audits had highlighted that there was no formal risk assessment in place for the provision of a pilotage service and that risk assessment was not in place by the time of the accident. There were opportunities for the scope of that risk assessment work to have defined the links to be made with training, documentation, and fatigue. Human reliability assessments, as used in COMAH assessments, help to capture where gaps could exist between how management think rules were applied and how work was really completed. No human reliability assessment was completed for the navigational risk owned by PLA for the safeguarding of the two Oikos jetties from vessel contacts.

One example of where a risk gap had opened was fatigue. As demonstrated at section 2.3.4, the fatigue risk in pilots was not being fully managed. Further, the risk management processes of PLA and Oikos Storage Limited did not combine to mitigate the total risk of contact with shore infrastructure at this COMAH site.

2.4.3 Port of London Authority's learning culture

The management at PLA had identified safety lessons from the *Pembroke Fisher*, *Sichem Melbourne*, *CMA CGM Platon*, *Amber*, *MSC Antigua* and *Zuga* accidents, the 2014 navigational risk assessment work in support of the extension to Oikos 2 and during the MMMs in September and November of 2021. However, these lessons had not wholly persisted and had not led to lasting improvements to PLA's marine SMS. The *Ali Ka* accident was rightly categorised as a serious marine casualty; however, the investigation considered that this accident was additionally a near miss to a very serious marine casualty, or even a major accident (as defined by COMAH regulations). It was fortunate that there were no injuries, there was no associated pollution event, and that damage was repairable.

2.4.4 Trans Ka safety management system

While the Trans Ka passage plan format did calculate suggested values for the safety depth, deep, shallow and safety contours for deep sea, coastal waters, shallow waters and from the berth, it provided limited detail on how these should be put to best use. The safety depth, deep, shallow and safety contours used were arguably safe but only in that they indicated that it was unsafe for *Ali Ka* to conduct the departure from Oikos 1.

The contours used for *Ali Ka*'s departure were not adjusted for the height of tide and did not exploit the benefits of the available high-density ENCs for the area. It was possible to construct a safety contour that did account for the height of tide, the observed draught, likely squat and the company's requirement for a 10% safety margin on the dynamic draught. The investigation reappraised the safety contour calculations, which indicated that a value of 5.12m **(**see **Figure 15)** was compliant with company policy. Combined with the high-density ENC, a safety contour setting of 6m provided a more exact indication of the dangerous waters and the safe area for the manoeuvre than the 11m safety contour used by *Ali Ka*.

Any reporting of the ship's proximity to shallows would have been suboptimal at best using the contour values calculated by the bridge team on board *Ali Ka*, and the ECDIS was not set up to provide early warning of a potential grounding hazard. This left *Ali Ka* exposed to the unappreciated risk of grounding. This lack of risk appreciation by the bridge team meant that pilot A was not well supported during the departure manoeuvres.

SECTION 3 – CONCLUSIONS

3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. Control of *Ali Ka* was lost resulting in the ship making contact with Oikos 2 because the plan for the departure manoeuvre missed key information and was compromised by incoherencies in PLA documentation [2.3.1, 2.3.2, 2.3.3 and 2.4.1]

2. The MPX was ineffective and did not result in *Ali Ka*'s bridge team fully participating in an appropriately modified and agreed plan where the pilot was supported to deliver a safe departure from Oikos 1. [2.3.2]

3. *Ali Ka*'s BRM and training did not result in the master or bridge team issuing effective challenges to the pilot's plan. [2.3.5]

4. Fatigue was highly likely to have affected the pilot's decision-making and reaction times and this directly contributed to the accident. [2.3.4]

5. PLA's stop procedure was ineffective at dealing with clear challenges to the plan and did not help to prevent this accident. [2.3.5.3]

6. Previous accidents were not recognised as warnings and risk controls were not reappraised in time to inform the approaches employed for *Ali Ka*, for example in tug provision. [2.4.2]

7. PLA's management of the allocation and monitoring of pilots did not sufficiently control the fatigue risk. [2.3.4]

8. The risk management processes of PLA and Oikos Storage Limited did not combine to mitigate the risk of contact with shore infrastructure at Oikos 2, which was a COMAH site. [2.4.2]

9. The suboptimal calculation, and depiction in the ECDIS, of safety contour values left all exposed to unappreciated risk. This lack of risk appreciation by the ship's bridge team meant that pilot A was not well supported during the departure manoeuvres. [2.4.4]

3.2 OTHER SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT

1. The pilot passage plan did not deliver a safe departure from harbour for *Ali Ka*. [2.3.1 and 2.3.3]

2. Components of PLA's marine SMS were not current, hard to access and in some cases contradictory and this did not support the generation of a safe pilot passage plan. [2.3.1 and 2.4.1]

3. PLA's management had identified safety lessons from previous accidents and also from navigational risk assessments, but these lessons had not wholly persisted and has not led to lasting improvements to PLA's marine SMS. [2.4.3]

3.3 SAFETY ISSUES NOT DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. Roles and responsibilities of bridge teams are not included in the ICS Bridge Procedures Guide's MPX checklists. [2.3.2]

SECTION 4 – ACTION TAKEN

4.1 MAIB ACTIONS

The **MAIB** has written to the chief executive officer at PLA about learning from previous accidents.

4.2 ACTIONS TAKEN BY OTHER ORGANISATIONS

The **Port of London Authority** has:

- Updated the Code of Practice for Ship Towage Operations on the Thames to include a mandatory minimum tug requirement at Oikos jetties.
- Reviewed extant pilotage department operational letters and, where possible, incorporated them into either the safety management system or standing rules and guidance, and cancelled those that were no longer applicable.
- Included the Berth Guide in its formal SMS.
- Reviewed and clarified the guidance to vessel traffic services staff on fatigue management during a shift, to include reviewed guidance on breaks and minimum staffing numbers.
- Started a qualitative audit of pilot passage plans, including the provision of feedback to the pilot body and, as necessary, updating supporting documentation.
- Introduced checks to make sure that the audits of pilot passage plans are delivering continuous improvement in the execution of pilotage acts.
- Adapted the process for amending the safety management system to make sure that new and updated safety critical information is embodied in an accessible, timely and coherent manner.
- Employed an additional documentary control officer to facilitate continuous improvement to the safety management system.

SECTION 5 – RECOMMENDATIONS

The **Port of London Authority** is recommended to:

2024/115 Conduct a thorough review of the risk assessments for all COMAH and high-risk berths in collaboration with their operators for the conduct of all berthing and unberthing manoeuvres in the Statutory Harbour Area, and implement any resulting mitigations. Specific consideration should be given to tug use in a range of environmental conditions.

2024/116 Highlight to all PLA marine pilots the best practice contained in the ICS Bridge Procedures Guide, particularly Chapter 6 – Pilotage; reference this guide in the SMS; and, provide guidance to pilots on recognising and responding to challenges from the bridge teams being assisted.

2024/117 Develop and implement a stop procedure to include detailed guidance on the roles and responsibilities associated with the recognition, escalation and safe resolution of challenges.

2024/118 Review the risks to safe pilotage from pilot fatigue, informed by an independent, specialist review of current working practices and, as necessary, implement a comprehensive fatigue risk management system that encapsulates the requirements and responsibilities outlined in regulatory and maritime industry guidance.

Trans Ka Tankers is recommended to:

2024/119 Review and revise its Bridge Resource Management training to include agreeing and assigning roles and responsibilities in support of embarked pilots, diligent exercise of the MPX, and challenge and response procedures specific to working with an embarked pilot.

2024/120 Review and revise the policy for the accurate setting of safety contours in ECDIS to best support pilotage and the appreciation of risk during manoeuvring to and from the berth.

Oikos Storage Limited is recommended to:

2024/121 Conduct risk assessments of its berths in collaboration with the Port of London Authority for the conduct of all berthing and unberthing manoeuvres, and implement any resulting mitigations. Specific consideration should be given to assurance mechanisms where Oikos is dependent on mitigations delivered by external organisations, and particularly pilotage and tug use in a range of environmental conditions.

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

2024/122 Include specific roles and responsibilities to be agreed during the master/pilot exchange in checklists C1.1 and C1.2 in the next iteration of the Bridge Procedures Guide.

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

Annex A

Baines Simmons fatigue study

BAINES SIMMONS
SAFETY SERVICES

Fatigue Risk Management Assessment Undertaken for the MAIB

June 2023

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Project Management

Project Client	Marine Accident Investigation Branch
Project Title	Fatigue Risk Management Assessment for the MAIB
Baines Simmons Programme Manager	[redacted]
Baines Simmons Governance	[redacted] and [redacted]
Version	2.0
Issue Date	01/06/2023

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Contents

1 Objective and Scope

1.1 Background

The MAIB invited Baines Simmons to support in a live investigation, where an independent sleep research expert was required to determine the likelihood of fatigue being a contributory factor in a specific accident from the available sleep, shift pattern worked, task factors and fatigue management system.

1.2 Scope

The MAIB specified that this report should:

- Provide an assessment of the sleep/work pattern, task factors and fatigue management system
- Assess whether those involved were likely fatigued, whether they were suffering performance decrements and what the decrements were
- Determine what the estimate fatigue or performance level would be for an 'average' individual working the schedule of the pilot involved in the accident, assuming a sleep need of 8 hours and an 'average' build up for fatigue based on the hours awake and circadian effects
- Assess whether the fatigue management system, based on current documentation (e.g., company working hours policy), is compliant with regulations (i.e., the specific legislative framework concerned) and would be effective in managing fatigue hazards from the work pattern defined in the documentation
- Assess whether the fatigue management system, based on current local adaptations to the fatigue management system, was compliant with regulations and would have been effective in managing fatigue hazards from the work pattern defined in the documentation
- Determine the compliance of the fatigue management system with a well-regarded benchmark of a fatigue risk management system (FRMS) relevant to the maritime industry

In order to answer this specification, this report will be split into two key parts:

1. Is there evidence that fatigue may have played a role in this specific case?
2. Was the fatigue management system in place compliant with regulation, best practice and effective to control fatigue across the workforce?

2 Is there evidence that fatigue may have played a role in this specific case?

2.1 Methodology

The methodology followed for this assessment is that outlined in the Clockwork Research white paper 'A Framework for Investigating Fatigue'[1], which uses an evidence-based approach to determine whether fatigue is likely to have played a role in an incident or accident. This framework follows three steps:

1. Determine whether an individual may have been suffering from fatigue
2. Determine whether fatigue had an impact on performance
3. Determine whether fatigue may have been a contributory/causal factor

This framework ensures that the following two essential conditions for determining whether fatigue played a role in an incident or accident are met, that is:

- At the time of the incident the individual concerned was fatigued, and
- A change in performance consistent with fatigue contributed to the incident

For this assessment, the following evidence, provided by MAIB, was considered:

- A sleep/wake/work diary collected for the 5 days prior to the accident
- The POLARIS pilotage history for the Pilot, between 01/09/2022 to 31/10/2022
- The taxi and Gravesend Launch history for the Pilot, between 20/10/2022 to 26/10/2022
- A complete transcript taken from the Bridge recording from the Ali Ka, including times and Turkish translation
- A narrative of events collated by MAIB, including further transcripts from VTS and radio transmissions
- Critical Decision Making (CDM) interview transcripts
- MAIB Human Factors investigation observations

To determine whether the individual may have been suffering from fatigue at the time of the accident, the data on sleep, wake and work history was assessed by qualified experts in sleep and fatigue risk management, and analysed using a bio-mathematical fatigue model. The same experts also assessed the transcripts and CDM findings to identify behaviours or actions that are consistent with the effects of fatigue. This assessment was undertaken collaboratively by two qualified members of the Baines Simmons Fatigue Risk Management team (bios provided in Appendix 1).

[1] Accessible at: https://www.bainessimmons.com/knowledge/papers-and-presentations/?sort=Fatigue%20Risk%20Management

SAFTE-FAST fatigue model

The bio-mathematical model utilised for this assessment was the SAFTE-FAST model. More details about the SAFTE-FAST model are provided in Appendix 2. This fatigue model was selected for the analysis because:

- The model provides the ability to generate a predicted fatigue level for every minute of a 24h period, rather than one estimated fatigue level across a working period. This allows greater granularity of analysis. This means that the changing level of fatigue across 24h can be seen, alongside predicted circadian and sleep parameters (Appendix 2) at the time of the accident
- The model provides both a mean predicted fatigue level and upper and lower estimates for this level, based on a statistical measure of variability in data (one standard deviation above and below the mean, which covers 68% of a normally distributed population)
- The real sleep of the individual involved can be entered into the fatigue model, rather than relying on predicted sleep
- This model is used by the US Navy in assessment and development of working patterns

2.2 Results

Determine whether an individual may have been suffering from fatigue

Sleep, wake and work history

The marine pilot worked the Port of London Authority Sea Pilot roster consisting of nine 24 hour periods on watch, followed by 6 days off. During the period of work assessed (01/09/2022-31/10/2022), the pilot only undertook one overtime act, all others occurred during his normal watch activities.

In the immediate block of watches prior to the accident (which occurred in the early hours of the 25th of October 2022), the pilot undertook the following acts:

Table 1: Work pattern for the pilot in the days immediately prior to the accident

Allocated	Base	Pilot onboard	Pilot disembark	Return
20/10/2022 17:53	21/10/2022 00:30	21/10/2022 03:45	21/10/2022 08:30	21/10/2022 09:30
21/10/2022 19:03	22/10/2022 01:30	22/10/2022 07:15	22/10/2022 12:00	22/10/2022 12:45
23/10/2022 06:00	23/10/2022 07:00	23/10/2022 10:20	23/10/2022 15:20	23/10/2022 16:00
24/10/2022 05:10	24/10/2022 05:15	24/10/2022 06:10	24/10/2022 07:45	24/10/2022 08:30
24/10/2022 20:56 (call from Pilot to DPC to discuss departure plan) 24/10/2022 22:16 (call from Pilot to DPC to bring forward sailing time) 24/10/2022 22:21 (call from DPC to Pilot regarding tug and sailing time)	25/10/2022 02:53 (Pilot arrives Gravesend car park barrier)	25/10/2022 03:42 (Pilot on bridge of *Ali Ka*)		

According to PLA documentation, the allocation time is when the pilot was confirmed as taking the vessel in question (usually 1 hour prior to base time, although longer for Havens acts), the base time is when they are required to arrive on base, onboard and disembark are the times that the pilot boards and disembarks the vessel, and return time is the time that the pilot either returns to base, or to another agreed upon point (which may be home). As can be observed in table 1, the allocation time can be the night prior to a late departure (as with the acts carried out on the 21st, 22nd, and 25th of October), or with less than 1h (for example the act on the 24th of October). A similar pattern can be seen with the base time. This indicates that practice differs from documented procedure.

The pilot's sleep and wake history around these acts of pilotage was collected by the MAIB.

In the days preceding the accident, the pilot had undertaken acts of pilotage with significant potential to cause sleep disruption, given that the work occurred either during or across the night (as on the 20th and 21st of October), or began in the early morning (as on the 23rd and 24th of October).

Due to the circadian rhythm in alertness, sleeping outside the night-time hours is of lower quality, and less likely to occur at all.

Based on the work and sleep history provided by MAIB, a fatigue model assessment was undertaken.

The fatigue model predicts the fatigue level of an *average individual*, based on a sleep need of 8h, and an average accumulation of fatigue during time awake. The model also assumes an intermediate chronotype. This means that, for individuals with a different sleep need, or a strong chronotype preference (morning or evening type), actual fatigue may be more or less than the results shown.

Different people are also more or less impacted by different degrees of sleep loss. This is reflected by the grey shading on the SAFTE-FAST outputs below, which cover a range in which 68% of the population with the same sleep/work history would be predicted to sit (34% above the mean value, 34% below the mean value). The more sleep loss occurs, the greater the variability, so the wider the grey shaded area becomes.

When providing his sleep history to the MAIB, the pilot stated that he had spent 4h in bed the night prior to the accident but had been unable to sleep due to stress.

SAFTE-FAST analysis and results

In order to provide for a complete assessment, two different scenarios have been modelled, shown in Figures 1 and 2 below.

Scenario 1 (no sleep prior to the accident as reported by the pilot, i.e. worst case scenario)

In Figure 1, the analysis assumes that no sleep occurred during the 4 hour period in bed, as reported by the pilot. In this case, at 04:30 local time (during the chain of events in which the accident occurred) the model predicts an average fatigue score of 65.1%, based on 2h 30 min sleep being obtained in the prior 24h (during an afternoon nap), and a sleep debt accumulated over the previous week in excess of 9h.

A SAFTE-FAST average fatigue score of 65% is equivalent to a score of 8 on the Karolinska Sleepiness Scale (KSS) ('sleepy, some effort to keep alert'), representing a severe level of fatigue (table 2). With this level of fatigue, microsleeps (unintentional, brief periods of sleep) would be expected to occur, and the average individual would be expected to have a reaction time 50% longer than when well rested (reaction time), with a 6.5 times increased likelihood of a lapse in attention compared to when well-rested (lapse index).

The shaded area shows that the fatigue of most people (i.e. the 68% who fall one standard deviation either above or below the average fatigue score) is also predicted to be high or severe at this time.

Table 2: Predicted fatigue level associated with SAFTE-FAST predicted KSS scores

Predicted KSS	1-4.5	4.6-6.9	7-8	>8
Predicted Fatigue	Low	Moderate	High	Severe

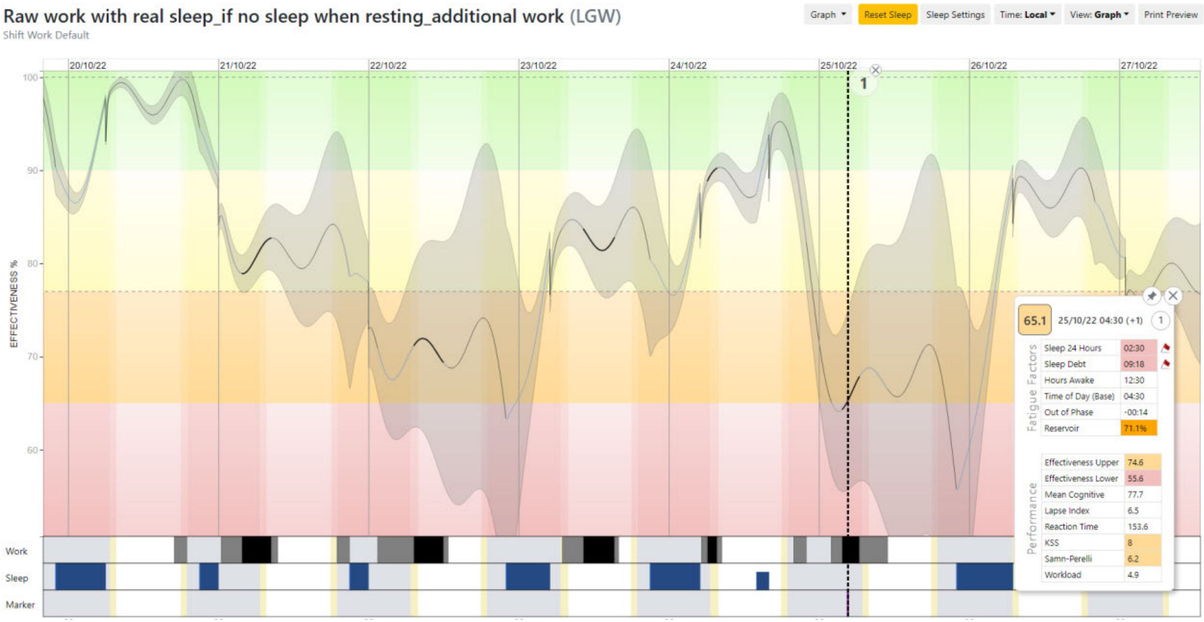


Figure 1: SAFTE-FAST output for the watches immediately preceding the accident, assuming no sleep was obtained the night immediately before the pilotage act of interest. The vertical dashed line is positioned at 04:30 (UTC+1), during the course of the events leading to the collision.

Scenario 2 (if the pilot obtained some sleep prior to the accident)

An alternative modelling scenario has also been produced. In this case, during the 4 hours that the pilot spent in bed, a period of poor quality sleep has been modelled. This sleep is of very low quality, providing only 25% of the recuperative value of a normal night of sleep. Whilst the pilot reported obtaining no sleep, it may be possible that the pilot fell asleep briefly during the time spent in bed, which may not have been remembered. To account for this possibility, the low quality sleep has been added in Figure 2.

If sleep was obtained during the 4 hours spent in bed, even of low quality, the average predicted fatigue score is 76.4%, equivalent to a KSS of 7 ('sleepy, no effort to keep alert). This average predicted fatigue level is high (compared to severe when no sleep is obtained), whilst the spread of the data means that the predicted level of fatigue for the population ranges between moderate/high (predicted fatigue score of 79.7%) to high (predicted fatigue score of 73.2%).

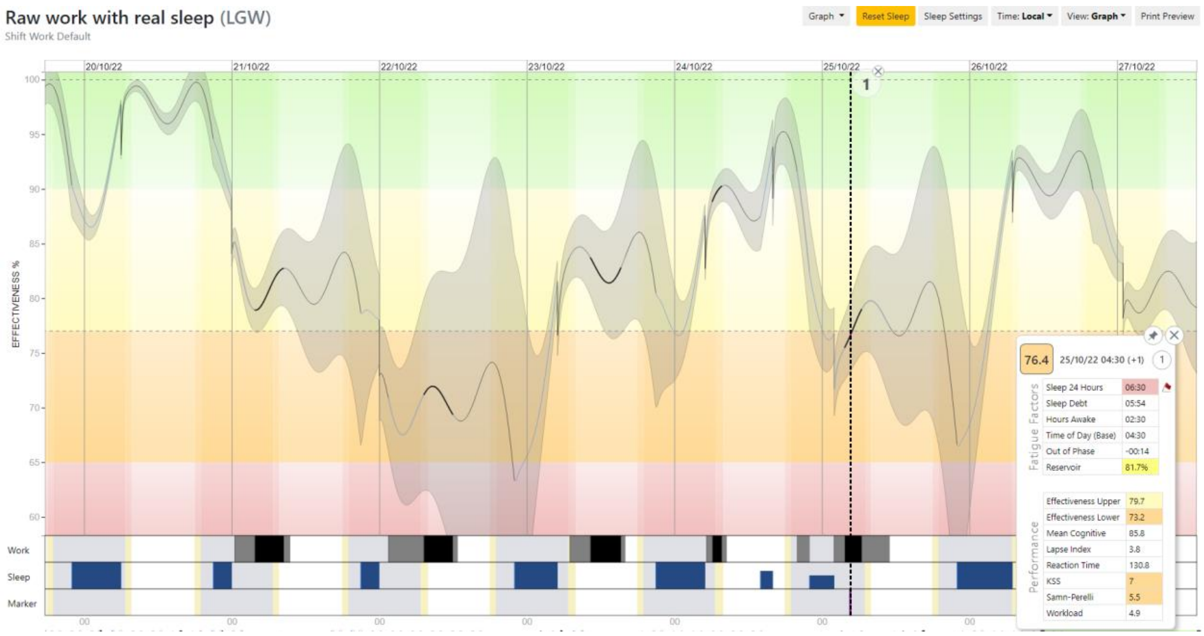


Figure 2: SAFTE-FAST output for the watches immediately preceding the accident, assuming a small amount of low quality sleep was obtained during the night immediately prior to the pilotage act of interest.

Table 3 shows a comparison of the two modelled scenarios, considering the average and upper and lower estimates of the fatigue scores produced by the SAFTE-FAST model.

Table 3: Summary of SAFTE-FAST output scores for the two modelled scenarios

SAFTE-FAST result	**Scenario 1 (no sleep the night prior to the accident)**	**Scenario 2 (4h low quality sleep obtained the night prior to the accident)**
Average predicted fatigue score and level	65%. Severe	76.4%. High
One standard deviation above the mean score and fatigue level	74.6%. High	79.7%. Moderate/high
One standard deviation below the mean score and fatigue level	55.6%. Severe	73.2%. High

If the pilot did fall asleep during the time spent in bed between 22:00-02:00, we would expect a slight reduction in the predicted fatigue level – because this reduces the sleep debt and total time spent awake since the last sleep at the time of the accident.

We do not know if the pilot did fall asleep briefly during the time spent in bed or spent the entire time awake. Some people may not remember brief periods of sleep. It is therefore highly likely that the pilot falls within the spectrum represented by Figure 1 and Figure 2.

In addition to the sleep data collected, the Pilot was reported as having high blood pressure. Links have been established in the scientific literature between sleep duration and quality and hypertension (for example Knutson et al, 2009[2], Guo et al, 2013[3] and Pepin et al, 2014[4]), the directionality of this relationship appears to be that poor sleep contributes to hypertension. The Pilot's sleep may therefore also have been impacted by this.

Summary

Both of these analyses indicate that, based on the sleep, wake and work history of the pilot, it is highly likely that the pilot was experiencing an elevated level of fatigue, with the average SAFTE-FAST predicted scores falling in ranges classified as high or severe fatigue, at the time of the accident.

Behaviours and performance changes consistent with fatigue

In order to further explore whether the pilot may have been suffering from fatigue, the on-board transcripts and data collected through the CDM interviews were examined to identify behaviours or changes in performance consistent with a fatigued individual.

When people experience sleep loss and elevated fatigue, common behavioural and performance changes occur due to the impacts of sleep loss.

When reviewing the on-board transcript, the following behaviours and performance changes were identified which are consistent with fatigue:

- Tunnel vision focus on water depth and distance from the Oikos 1 jetty, whilst missing the closeness of the Oikos 2 dolphin
- Uni-dimensional conversations which focus on the plan, what time it is, and the tide level at that time
- Potentially reduced appreciation of risk, relating to the assistance that a tug may provide, and how this balances with the risk from the falling water levels
- Reduced clarity of communication
- Interactions with others, primarily the Master, were short and abrupt
- Potential forgetfulness in not changing the radio channel back, resulting in later missed radio calls from VTS

Whilst these behaviours are consistent with fatigue, they may be explained by other factors, for example the personality of the Pilot, stress, or due to lack of recency on this particular berth. Irrespective of potential other explanations, fatigue exacerbates any predispositions for, for example, poor communication, and impairs the ability to regulate behaviour.

From the Critical Decision Making (CDM) interview, along with the MAIB's summary of the VDR review, further behaviours consistent with fatigue were identified, including:

- Pilot's responses on the bridge were slow
- Potential loss of situational awareness relating to the position of the Oikos 2 dolphin, combined with incomplete sharing of the mental model with the Master
- Tunnel vision on the tide level and time of day

[2] Knutson, KL et al (2009) *Arch Intern Med.* 2009;169(11):1055-1061. doi:10.1001/archinternmed.2009.119
[3] Guo, X et al (2013) *Sleep Medicine*. 2013; 14(4): 324-332. doi.10.1016/j.sleep.2012.12.001
[4] Pepin, J-L (2014) *Sleep Medicine Reviews*. 2014; 18(6): 509-519. doi.10.1016/j.smrv.2014.03.003

- Potential overload of mental capacity

Determine whether an individual may have been suffering from fatigue: summary

Based on the sleep and wake history, work history, as assessed in the SAFTE-FAST results, and the identified behaviours, the evidence demonstrates a high likelihood that the Pilot was experiencing elevated fatigue levels at the time of the accident.

Determine whether fatigue had an impact on performance

As described above, behaviours consistent with a fatigued individual have been identified. Based on the MAIB's data collection, the pilot did not normally display slow reaction times, abrupt communication styles and reduced clarity of communication.

Determine whether fatigue had an impact on performance: summary

The data collected by the MAIB, demonstrating behaviours consistent with fatigue, also supports that these behaviours reflect a lower than normal performance by the pilot. This is consistent with a high likelihood that fatigue had an impact on the Pilot's performance.

Determine whether fatigue may have been a significant performance shaping factor

In order to determine whether fatigue may have been a significant performance shaping factor in an accident, fatigue must not only be identified as likely or highly likely present in the individual, but the decrements in performance or fatigue-related errors made must play a role in the direct sequence of events that led to the accident.

In this accident, the following can be stated:

- In the 24 hours prior to the accident, the Pilot struggled to sleep. Reporting no sleep the night prior to the accident due to stress, but an afternoon nap was taken. In all, we estimate that prior to the accident the Pilot had obtained approximately 2h 30min of sleep in the 24 hours prior to the accident
- The Pilot's work history in the 5 days preceding the accident also resulted in sleep disruption, due to the night work and early mornings. This resulted in the fatigue model predicting a sleep debt of over 9 hours prior to the accident. In other words, a shortfall of 9 hours between the sleep the Pilot needs and the sleep he obtained. Partial sleep deprivation influences attention, especially vigilance (Alhola et al, 2007)[5]
- The Pilot had taken an afternoon nap on the day prior to the accident, so is predicted to have been awake for 12h 30min at the time of the accident
- The SAFTE-FAST analysis considering this data predicts that the Pilot was experiencing a severe or high level of fatigue during the course of events leading to the accident
- The Pilot appears to have demonstrated 'tunnel-visioned' focussing on the depth of the tide and the distance from the Oikos 1 jetty, and did not appear to consider the risk of going without a tug or the risk associated with the position of the Oikos 2 dolphin
- The Pilot's communication was abrupt and at times unclear
- Communication was uni-dimensional, not considering other areas
- The Pilot's reaction times were slow

[5] Alhola et al (2007). Neuropsychiatr Dis Treat. 2007 Oct; 3(5): 553–567)

2.3 Determine whether fatigue may have been a performance shaping factor: summary

From the evidence, the following conclusions can be drawn:

- The Pilot's sleep/wake history makes it highly likely that he was experiencing an elevated level of fatigue at the time of the accident
- The Pilot demonstrated behaviours and performance consistent with a fatigued individual
- It is highly probable that these behaviours and the performance played a direct role in the course of events leading to the accident

As such, it can be concluded that fatigue was a significant performance shaping factor in this accident.

3 Assessment of the fatigue risk management system in place at the organisation

The MAIB also requested that we assess the employer's fatigue management system, based on current documentation, for:

- Compliance with current regulations
- Effectiveness in managing fatigue hazards
- Compliance with a well-regarded benchmark of a fatigue risk management system relevant to the maritime industry

Specifically relevant to this investigation, the key documents examined were:

- Port of London Authority Marine Pilot Training Manual version 3.1 issued 02/08/2022
- Port of London Authority Sea Pilots Working Rules and operational guidelines version 8 issued 03/06/2021
- Port of London Authority Marine Safety Management Systems Manual version 27.3 issued 05/01/2023
- Port of London Authority Pilotage Department Operational Letter OPL/2014/09
- Port of London Authority Pilotage Department Operational Letter OP/25/2011

Additionally, the Port of London Authority Manual of River Pilots Working Rules and operational guidelines version 4.1 issued 02/06/2021 was also examined. However, as the Pilot involved was a Sea Pilot, the review of the River Pilot documentation was to provide additional context, rather than being a core part of this assessment.

3.1 Methodology

Two members of the Baines Simmons fatigue risk management department, each with extensive experience of the implementation and assessment of fatigue risk management in multiple safety critical industries undertook an assessment of the documentation provided by the MAIB. This assessment compared the documentation against both the legislative environment and best practice, and also considered the effectiveness of the procedures in place to control fatigue based on the experience of the assessors.

Current regulations

The legal position of Marine Pilots when it comes to the regulation of working time differs from that of other mariners. Whilst the Marine Pilots must hold and maintain a Master Mariners qualification, for the purposes of working time regulation their employer manages their working time alongside other shift-working shore-based personnel. This means that the relevant regulations are the European Working Time Directive, (EUWTD) 2003/88/EC and the requirements from the UK Health and Safety Executive (HSE) relating to managing hazards associated with shift work.

Relating to training, the Port Skills and Safety Marine Pilotage National Occupational Standards (NOS) (2011) was used as a reference.

Benchmark relevant to the maritime industry

The benchmark guidelines used for this part of the assessment were:

- International Maritime Organisation (IMO) Guidelines on Fatigue (MSC.1/Circ. 1598 January 2019)
- Maritime and Coastguard Agency (MCA) Marine Guidance Notice (MGN) 505 (M) Amendment 1. Human Element Guidance – Part 1. Fatigue and Fitness for Duty: Statutory Duties, Causes of Fatigue and Guidance on Good Practice

These materials apply to other mariners and are relevant to the industry in which the marine pilot works. They are also detailed, going beyond simple hours of work regulation (which alone are insufficient to manage fatigue risk) into the key principles of fatigue risk management, allowing a breadth of assessment.

3.2 Results

Compliance with current regulations

The Sea Pilots Working Rules and operational guidelines focussed on the design and operation of the Pilot roster and paid little attention to the control of fatigue save the use of the "Two Nights Out Rule" to control fatigue and the reporting of fatigue. It did however focus on ensuring fairness within the roster, the roster order, and how pilots reported sickness within their working pattern.

Within this section, the compliance with the EUWTD will first be assessed, in terms of working time limitations, then compliance with the HSE requirements. Both sets of requirements must be considered, because working time regulations are not sufficient to control the risk of fatigue in a shift working environment.

European Working Time Directive (EUWTD), 2003/88/EC

Rest Periods

The EUWTD states that a worker is provided with a daily uninterrupted rest period of 11 hours. In the Sea Pilot Working Rules, the minimum rest period provided after an act of pilotage was 8 hours, or the length of the previous act of pilotage (base time to base time), whichever was the longer. The Sea Pilot Working Rules outlined that, if 11 hours of rest could not be provided, then 3 hours of compensatory rest was provided following the next act of pilotage.

The working rules state that the shortening of rest below 11 hours is in exceptional circumstances, but such circumstances are not outlined. The example provided was not very clear to the outside reader, although probably easier to understand for those who work with the rules on a daily basis.

Additional rest is provided for Havens Acts, although it was not clear whether this was due to their additional complexity, potential for longer duration, or another reason.

Actual planning time may not be fully included in the act of pilotage and allocation of rest

Because the length of the previous act of pilotage was taken from base time to base time (i.e., the time that the pilot is required to be on base, including the time on board the vessel), the allocation time, from which planning may have commenced, was not included in the calculation of a rest period. Whilst it appears from the PLA documentation that the intent was that planning occurs from base time, in this current case, the Pilot was making calls to DPC in the hours prior to base time (table 1), indicating planning commenced earlier. It was also not entirely clear if the rest time ended at the beginning of the following base time, or at allocation time.

No provision for ensuring adequate sleep during rest periods

Similar to the EUWTD, the provided rest periods in the Sea Pilot Working Rules did not include a consideration of whether sufficient sleep was likely to be obtained during the rest period, whether due to the length of the rest period, or due to the time of day at which the rest occurred.

There were no recorded limits on overtime to ensure that weekly and fortnightly rest was provided

The EUWTD also requires that the employer provides either 24 hours uninterrupted rest per week, or 48 hours per fortnight. The standard roster for the Sea Pilots consisted of 9 consecutive 24 hour periods on watch, followed by 6 consecutive 24 hour periods off watch. This allowed for over 48 hours off every two weeks. However, Pilots were able to work overtime watches on a voluntary basis during their off-work period. The control of overtime did not highlight the need to ensure that Pilots retained sufficient rest during their time off when working overtime, to ensure that they retained the 48 hours free of all work per 14 days. Rather the controls related to ensuring that overtime during days off (called stand down period) did not impact upon the ability of the pilot to return to their correct order in the roster position.

Limits on daily and cumulative working time and their tracking were not documented

Under the EUWTD, weekly working time is limited to an average 48 hours working week. The intent of daily and cumulative working time limitations is the management of fatigue risk. Whilst employers can opt out of the 48h average working week, they should still ensure that workers do not work excessively long hours. For those involved in nightwork (defined as working at least 3 hours during the night as part of their regular working pattern), daily work should not exceed an average of 8 hours per day, over a rolling 17-week reference period.

Beyond the allocation of rest periods, there was no method described in the Sea Pilot Working Rules to track, monitor, or limit the number of working hours on a daily or cumulative basis.

UK Health and Safety Executive Regulations

The specific regulations relevant here are:

- The Health and Safety at Work etc. Act 1974 (the HSW Act)
- The Management of Health and Safety at Work Regulations 1999 (MHSWR)

The HSW Act requires organisations to identify risks associated with their work activities and protect employees and the public from these risks. Shift work and fatigue is one such risk which must be managed, and documented through the organisation's risk management approaches.

In the document 'Managing Shift Work' published by the Health and Safety Executive[6], there is a recommended approach which includes considering the risks of shift work, establishing systems to manage the risks of shift work, assessing the risks associated with shiftwork, taking actions to reduce the risks, and checking and reviewing the shiftwork arrangements regularly. This is applicable to all shift-working organisations in the UK.

The PLA Sea Pilots Working Rules contained one main area that is stated as a fatigue reduction strategy – the 'Two Nights Out Rule'. The two nights out rule was designed to protect against excessive night time working. Following two nights of consecutive working, the pilot had to inform the pilotage co-ordinator that they wish to take advantage of the two nights out rule, at which point it would be enacted. Enacting the rule did not protect the pilot from any additional work following the completion of their rest period after the second night of work, but the pilot would not be allocated to any act of pilotage if it was anticipated to run after 22:00 on the third night.

Whilst reducing the operation of consecutive nights, particularly if work was also possible during the day due to position on the roster and completing rest periods, is an essential component of fatigue risk management, the controls must be effective. In the Sea Pilot Working Rules, a 'night out' was not defined in terms of the time between which the work took place – the definition was based on the allocation time, but there was no statement of between which times this allocation time should occur for the act to be counted as a 'night out'. MAIB report that PLA staff use 22:00-06:00 as the definition of a night, but this is not documented. Further, as table 1 shows, the allocation time was not necessarily at the beginning of an act of pilotage, but could be many hours earlier.

The requirement for the pilot to enact the 'two nights out' policy, rather than it being an automatic application within the working pattern, was also not complete protection against fatigue risk. It is clear from research that people are poor judges of their own fatigue levels, particularly when they have not received fatigue awareness training. This may mean that pilots did not activate the 'two nights out' procedure because they did not recognise that they were at an elevated risk of fatigue.

Within the Sea Pilot Working Rules, there was no further indication of changes or mitigations that have been made as a result of a risk assessment that identified fatigue, as outlined in the HSE Managing Shift Work materials.

The Marine Safety Management Systems Manual was also reviewed as part of this assessment. The Marine SMS does not discuss specific hazards, such as fatigue, so it is not possible to know whether fatigue is considered by this process.

Fatigue training and awareness

In the PLA Marine Pilot Training Manual, training provision for all pilots was outlined. The standards against which this training was assessed included the National Occupational Standards for Marine Pilotage, which were referenced in the PLA Marine Pilot Training Manual. Whilst these standards are

[6] Managing shift work: Health and safety guidance (2006). ISBN 9780717661978. Accessible from https://www.hse.gov.uk/pubns/books/hsg256.htm

largely technical, other areas of required knowledge are included. This includes knowledge of fatigue and stress, and how it can impact upon performance. The specific details are outlined in table 4.

Table 4: Sections of the National Occupational Standards for Marine Pilotage which require knowledge of stress and fatigue

Section	Requirement relevant to fatigue
PSS MP101 Plan an act of pilotage	K9 how to assess levels of personal stress and fatigue and the potential impact of stress and fatigue on individual capability
PSS MP102 Embarking and disembarking	None
PSS MP103 Assess standards on the piloted vessel	K5 the effects of stress and fatigue on capability
PSS MP104 Work effectively with the bridge team	K7 the effects of stress and fatigue on capability
PSS MP105 Liaise and communicate with the port	None
PSS MP106 Transit the pilotage district	K5 the effects of stress and fatigue on capability
PSS MP107 Manoeuvre vessels in harbours and their approaches	K5 the effects of stress and fatigue on capability
PSS MP108 Respond to problems and emergency situations	K9 the effects of stress and fatigue on capability
PSS MP109 Manage personal and professional conduct and development	None

Within the PLA Marine Pilot Training Manual, fatigue was not mentioned as an area in which training was provided. The only discussion of fatigue within this manual was under professional conduct and development: *'A pilot must be in a fit state to carry out his duties effectively at all times, paying particular regard to the effects of fatigue and the effects of prescribed medication'*. However, it was not clear whether Pilots were provided with the knowledge required to assist them in identifying whether they were fatigued and what the effects of fatigue are.

It may be that fatigue was covered during Bridge Resource Management – Pilots (BRMP) training, but the syllabus for this was not provided in the training manual. It was also not clear whether BRMP was a recurrent training course, or if it was only provided to trainees.

Conclusion

Compliance with the regulations is not fully demonstrated, and the EUWTD is of limited effectiveness

The current regulations in relation to fatigue management for Marine Pilots was limited to that in the EUWTD and their responsibilities under the Health and Safety at Work Act. The EUWTD is limited in its scope, predominantly focussing on total hours of work and rest periods provided, but does not consider when those rest periods should be provided in order to ensure sufficient sleep can be obtained.

The Sea Pilot Working Rules specified a minimum of 8 hours continuous rest period per 24 hours for the sea pilots, and any time short of 11 hours should be given in additional compensatory rest following the next act of pilotage. This provided for the 11 hours required in the EUWTD, although it is not necessarily continuous, as stated in the EUWTD. Additionally, the Sea Pilot Working Rules did not necessarily include planning time within the act of pilotage from which rest is calculated (if planning began at allocation time), thus potentially eroding rest time. There was no information in the Sea Pilot Working Rules relating to the control of daily and cumulative working hours, beyond the use of rest periods, nor ensuring that Overtime cannot impinge on the requirement to provide 48 hours free from all work per fortnight.

Further fatigue management arrangements, in line with the requirements of the Health and Safety at Work Act, was provided through the 'two nights out rule'. This rule provided a guaranteed rest period during the night if pilots completed night acts on two consecutive nights, but a night was not defined, and the policy needed to be enacted by the pilot themselves, rather than being automatically enacted following two acts during night-time hours. There was no evidence that other potential fatigue hazards, for example relating to multiple consecutive very early starts, had been identified and mitigated.

It was not clear that pilots are provided with any training or awareness relating to fatigue and its effects, making it difficult for them to identify fatigue in themselves and others and manage it appropriately.

Effectiveness in managing fatigue hazards

The section above describes some areas where the current Sea Pilot Working Rules had limited effectiveness at managing fatigue hazards. This section will explore this in further detail.

The principle of fatigue risk management is that prescriptive hours of work regulation alone (for example the EUWTD) are ineffective in fully controlling fatigue risks, due to the complexity of fatigue as a hazard. Instead, fatigue hazards should be identified, and protections or mitigations put in place alongside the prescriptive regulations which act as an 'outer envelope'.

An example of this is the 11 hour continuous rest period required in the EUWTD per 24 hours. Whilst 11 hours is long enough to provide for a sleep that meets most people's sleep need (for most between 7 and 9 hours), this is not necessarily the case in reality. Members of the workforce may commute, or may sleep onsite whilst they are working 24 hour shifts. The 11 hour rest period may be at night – when sleep is biologically more likely to occur – or during the day, when sleep is less likely to occur at all. Fatigue risk management acknowledges these differences and mitigates accordingly. For example, where the workforce travel from longer distances, more time off may be allocated, or rooms closer to work may be obtained. If rest occurs during the day, more time may be given, or the subsequent work period may be shorter.

There were several areas which limited the effectiveness of the PLA Sea Pilot Working Rules and Marine Pilot Training Manual to control the fatigue risk. These included:

- No documented requirement for fatigue awareness training for Pilots, Pilot Coordinators, or Vessel Traffic Services personnel to aid them to recognise fatigue, understand the consequences of fatigue, or to support them in making good decisions to ensure fatigue risk was managed
- The 'two nights out' policy to reduce the likelihood of excessive night work has several limitations:
    - A 'night' was not defined (MAIB discussions with PLA staff indicate that a 'night' was considered to be 2200-0600, but this was not documented)

  - There was no documented requirement to ensure that the rest period was not shortened below 11 hours following night work
  - The two nights out policy could not be used by pilots if one of the two nights was as a result of overtime working, only for acts within a rostered watch
  - The policy was not automatically initiated following a Pilot being tasked to two consecutive night acts and had to be requested by the Pilot, who must do so immediately following completion of the second night act
- Whilst working time was tracked to ensure fairness, the PLA did not place limits on cumulative weekly, monthly or yearly hours spent on task
- It was not clear whether planning time was included within the hours used to calculate subsequent rest periods, as this was calculated from base-to-base time, not from allocated time, when planning may occur
- Passage planning time was not mentioned in the Working Rules document aside for Inner List and Havens Vessels. Guidance was not provided on the impact that fatigue may have if planning is carried out at a time of day when fatigue may be elevated
- Pilots were able to report fatigue and were encouraged to do so if they were not fit for duty. However, given the lack of documented training, it was not clear how Pilots were to identify if they were no longer fit for duty due to fatigue, or to recognise that they may have become unfit during the course of an act of pilotage, allowing proactive risk management
  - A pilot reporting fatigue was recorded in the daily log, but there was no requirement for a fatigued pilot to submit a safety report or fatigue report that explained how they recognised that they were unfit due to fatigue, or the causes of that fatigue. This limited organisational learning and the ability to improve mitigation measures
- Beyond fair sharing of overtime, and the ability for pilots to add or remove themselves from the voluntary overtime list, there was no clear means of controlling potential fatigue occurring as a result of overtime work.

Conclusion

Based on our experience, such limitations mean that whilst there were some systems and processes in place to control fatigue risk, such as the two nights out policy, without adequately trained personnel, and when the policy was not automatically implemented, it would be of limited benefit in controlling fatigue. In addition, fatigue can also arise as a result of cumulative early starts or late finishes that were not accounted for in this policy. The lack of a requirement to submit a fatigue or safety report following a Pilot reporting fatigue also limited organisational learning and a systematic improvement in the management of fatigue.

Compliance with well-regarded best practice of fatigue risk management from a relevant industry

The materials used for this comparison were:

- International Maritime Organisation (IMO) Guidelines on Fatigue (MSC.1/Circ. 1598 January 2019)

- Maritime and Coastguard Agency (MCA) Marine Guidance Notice (MGN) 505 (M) Amendment 1. Human Element Guidance – Part 1. Fatigue and Fitness for Duty: Statutory Duties, Causes of Fatigue and Guidance on Good Practice

To provide an assessment at a greater level of detail, Annex C of MGN 505 (M) Amendment 1 – Fatigue Management Plan General Principles has been utilised to demonstrate how the PLA's documents compared with an approach that could be used, that of a fatigue management plan. The results of this assessment are provided in table 5.

Table 5: Assessment against Annex C of MGN 505 (M) Amendment 1 – Fatigue Management Plan General Principles

Fatigue Management Plan Section	Objective	Principles	Principle sub-element	Observations from the PLA materials
1. Understand fatigue	All personnel, on board and ashore, involved in operation and management of ships have appropriate knowledge and understanding of fatigue and fatigue management	1. The company has procedures in place to ensure that all personnel, on board and ashore, involved in operation and management of ships;	i) understand the causes of fatigue and fitness impairing factors, including a) normal human biological factors b) the effect of wakeful activity, work, working patterns, workload, environmental conditions, social and cultural conditions etc.	From the materials provided, we do not have any evidence that the PLA was providing Pilots or other personnel with fatigue awareness training
			ii) understand the company's fatigue management policy and practices	From the materials provided, we do not have any evidence that the PLA was providing Pilots or other personnel with fatigue awareness training. There was no specific company fatigue management policy. Practices include the 2 nights out policy, which was included in the Sea Pilots Working Rules, and the ability to report fatigue. However, it was not clear whether these were discussed in training to ensure that Pilots understand them.
2. Fatigue preventative practices	All personnel, on-board and ashore, involved in operation and management of ships have appropriate knowledge and understanding of the various management	1. The company has procedures in place to ensure that all personnel, on board and ashore, involved in operation and management of ships understand policies	i) How to recognise fatigue, stress and impaired fitness in themselves and in colleagues	From the materials provided, we do not have any evidence that the PLA was providing Pilots or other personnel with fatigue awareness training
			ii) Effective roster management that; a) Complies with hours of work and rest regulations	The working pattern broadly complied with the EUWTD.

	and operational practices that can contribute to preventing fatigue	and practices to mitigate the effects of fatigue and factors leading to impaired performance;	b) Enables adequate rest and sleep c) Minimises disruptions to periods of rest and sleep d) Maintains a reasonable balance between working hours and circadian rhythms e) Limits tours to a manageable length f) Provides adequate flexibility in roster arrangements to enable effective management of unavoidable disruptions	Rest periods should be at least 11 consecutive hours during a 24 hour on watch period, but can be reduced to 8 hours due to operational necessity (although the specific requirements for this were not outlined in the Sea Pilot Working Rules). The rest period did not need to be provided at a time of day where sleep is more likely in order to increase the likelihood of obtaining sufficient sleep Rest periods during the 9 x 24 hours on duty were provided following acts of pilotage. There was no guidance relating to how this may impact an established sleep/wake pattern Rest periods during the 9 x 24 hours on duty were provided following acts of pilotage. There was no guidance relating to how this may disrupt the circadian rhythm Watches were limited to 9 consecutive 24 hour watches, followed by 6 days off. Pilots were able to work overtime voluntarily during their stand-down periods. It was not clear whether PLA had assessed this working pattern to determine whether this is of manageable length particularly given the unpredictability of the timing of acts of pilotage during the 9 consecutive watches. The 24 hour watch period, with pilots working in a strict order of allocation provided multiple options for pilots to be available to cover unavoidable disruptions (e.g., delays to ships departing or arriving)

				prior to the allocation of a pilot to the act of pilotage. Pilots were also able to use the 'two nights out' policy to avoid the potential of being allocated to a third consecutive act of pilotage at night.
			iii) Seafarers maintain a healthy personal lifestyle, including: A) Adequate sleep, rest and recreation B) Healthy, well balanced diet C) Exercise	No evidence for this was found in the assessment. However, MAIB are aware of wellbeing information was made available to all PLA staff, although it is not clear whether the Pilots had access to this.
			iv) Foster an effective onboard culture; A) Listening, reporting, learning "just culture B) Workforce involvement in safety improvement C) Full consideration for personal requirements	The Sea Pilot Working Rules, Marine Piot Training Manual, and Marine Safety Management System Manual did not discuss a Just Culture, or an effective onboard culture. The Sea Pilot Working Rules were in part a collective agreement, but it was not clear whether the workforce was involved in other areas of safety improvement beyond reporting (for example reporting of near miss events and pilot ladder deficiencies). The working rules and fatigue arrangements did not consider personal requirements.
			v) Habitability, on board environmental conditions a) Quality of crew accommodation b) Noise, vibration, heat, cold	N/A for this assessment

			c) Pitching, rolling, and other ship movement d) Recreational facilities e) Access to internet, sat-phone etc	
3. Duties and responsibilities	All personnel, on board and ashore, involved in operation and management of ships have appropriate knowledge and understanding of their duties in respect of fatigue and their responsibilities under current merchant shipping regulations	1. The company has procedures in place to ensure that all personnel, on board and ashore, involved in operation and management of ships;	i) Have appropriate knowledge and understanding of their duties and responsibilities undercurrent merchant shipping regulations, including; A) Hours of work and rest B) Health and safety of workers and other persons C) ISM and DSM Codes D) Risks to health and safety E) International guidance on ship safety	The PLA Training Manual outlined how knowledge of Regulations was provided to new Pilots as they join PLA.
4. Management policies and practices	Fatigue is prevented, monitored and controlled through effective management policies and practices	1. The company has established appropriate policies and practices that are designed to ensure that all personnel, on board and ashore, involved in operation and management of ships;	i) Have received appropriate training and are sufficiently aware of a) Fatigue, performance and fitness impairing factors b) The various management and operational practices that can contribute to preventing fatigue c) The company's fatigue management policy and practices d) Appropriate knowledge and understanding of their duties in respect of fatigue and their	Fatigue management appeared to be based on the Sea Pilots Working Rules. These working rules, or the Marine Pilot training manual did not outline any training which related to increasing awareness of fatigue and, with the exception of the two nights out rule, did not contain management or operational practices that could contribute to preventing fatigue. The company did not appear to have a fatigue management policy or practice and there was no statement of their duties in respect of fatigue and their responsibilities under current merchant shipping regulations.

			responsibilities under current merchant shipping regulations	
			ii) Accurate records of work and rest are reported to the company	As described in the Sea Pilot Working Rules Section 2.1, the Pilotage Coordinator was responsible for maintaining records, including the allocated acts of pilotage, which would include work and rest.
			iii) Procedures are in place to: a) Verify hours of work and fitness for duty records b) Monitor and assess the levels of fatigue experienced by sea-going personnel and evaluate the causes for that fatigue and any mitigating actions that could be taken c) Review the fatigue management plan for effectiveness, non-conformities, breaches of legislation etc. d) Ensuring that all changes to legislation, guidance, safety management system (SMS), fatigue management plan (FMP) etc. are notified to all appropriate personnel in a timely way so as to enable continual compliance with appropriate requirements	The Pilotage Coordinator was responsible for maintaining records. There was no information in the Sea Pilot Working rules as to how this was verified. Pilots were able to report fatigue, but beyond being noted in the log, there was no detail on whether further information is collected to enable monitoring and assessing levels of fatigue or any mitigating actions that can be taken. There were no fatigue management plans, so they were not reviewed for effectiveness, non-conformities, breaches of legislation etc., and changes are not notified to others. There was no evidence that fitness for duty information was communicated to Pilots, nor was fitness for duty monitored, beyond logging if a pilot reports fatigue.

			e) New or amended information regarding fitness for duty is notified to all appropriate staff in a timely manner f) Monitoring the fitness for duty of sea-going personnel	
5. Development of a Fatigue Management Plan	The effective fatigue management plan is developed and implemented that is appropriate to the company's operations	1. Everyone in the company, at sea and ashore, recognises the benefits of an effective fatigue management plan		The PLA did not use fatigue management plans
		2. All risks of fatigue are taken into account	a) Human biological factors	The Sea Pilot Working Rules provided for a rest period of 11 hours consecutively (which may be shortened to 8 hours) every 24 hours. Most people have a sleep need between 7 and 9 hours in 24 hours. Where 11 hours as a minimum is provided, this should be of sufficient duration to enable sleep need to be met. However, this depends on time of day, taking into account the individual's circadian rhythm
			b) Hours of work and rest, sleep debt and sleep hygiene	Following an act of pilotage, the rest period must have been at least as long as the act of pilotage, or 11 hours, whichever was the longest. The two night out policy should act to reduce on-going accumulation of sleep debt following night work, where it is enacted by the pilot.
			c) Shift patterns and nature of work	Beyond longer rest and planning durations being provided for Inner List and Havens acts, the nature of the work was not

				explicitly considered within the Sea Pilot Working rules. Current mitigations for fatigue risks associated with the Shift Pattern were the two nights out rule, and the ability for Pilots to report being fatigued. Beyond the two nights out rule, there were no other specific mitigations associated with risks that may have arisen from other elements of the shift pattern or nature of work
			d) Disruptions to sleep and rest	The two nights out rule, if enacted by pilots, would reduce sleep disruption from continuing across two nights – although the pilot may still have been tasked to an act of pilotage so long as it was predicted to be complete before 2200 on the third night. This may still have significantly impacted on their sleep opportunity depending on the length of their commute. There were no other controls for disruptions to sleep and rest.
			e) Effect of crossing timezones and travel to and from place of duty	Within their normal course of work, PLA Pilots rarely crossed time zones (it may potentially have occurred in the event of overcarriage should the next port be in mainland Europe). However, the effect of crossing time zones during time off (e.g., going on holiday) should be considered in fatigue awareness training.
			f) Length of tours of duty (in combination with Watchkeeping patterns)	The roster watch pattern consisted of 9 consecutive 24 hour watches followed by 6 days off. It was not clear whether the risk of this number of consecutive watches had been assessed, nor whether the duration of time off had been assessed as being sufficient

			g) Leadership and management capabilities	Pilots received Bridge Resource Management Training, but there was no documented requirement in the PLA documents for this to include the risk of fatigue impacting leadership and management capabilities
			h) Stress	We found no evidence that the combined risk of fatigue and stress were considered within the documents, for example where stress may result in sleep loss.
			i) General health of seafarers	We found no evidence that the impact of general health of seafarers on fatigue was considered
			j) Personal and social conditions on board	PLA Pilots received Bridge Resource Management training, which has not been reviewed.
			k) Environmental issues, e.g., geographical location of vessels	Pilots received specific and extensive training relating to the geography of the PLA Pilotage area. However, it was not clear how much recency training was provided, as in the accident being investigated here, and how fatigue may impact risk to pilotage
			l) Trading patterns, including port calls and cargo working	N/A
			m) Company policies, practices, administrative procedures, ship-shore communication	No evidence has been found as to whether the fatigue risk of company policies, practices, administrative procedures etc., had been assessed to consider if they may inadvertently increase fatigue risk
			n) Ship-specific factors – technical including familiarisation with a new ship	Pilots must regularly familiarise themselves with new ships. No evidence has been found as to whether the impact of fatigue may increase the risk associated with pilots working in an unfamiliar ship environment

			o) Ship-specific factors – social	Pilots receive Bridge Resource Management Training to assist in their working with an unfamiliar ships' crew. There is no evidence that fatigue awareness training was provided that highlights how fatigue may impact the effectiveness of working with others.
			p) Effective monitoring of fatigue, health, fitness for duty etc.	If Pilots reported fatigue, this was recorded in the duty log. However, there was no other evidence that fatigue and fitness for duty was monitored
		3. Involve a full range of affected personnel	a) masters	N/A
			b) crew at all levels	The Sea Pilot Rules were in part a Collective Agreement, indicating Pilots had been involved in their writing
			c) shore side staff	It is not clear if shore-side staff (e.g., VTS) had their own fatigue risk management, as this is outside the scope of this assessment
		4. Work for an effective safety culture, which embodies	a) The principles of a 'Just Culture'	The Sea Pilot Working Rules, the Marine Pilot Training Manual, and the Marine Safety Management Systems Manual did not mention a Just Culture.
			b) All personnel taking ownership of safety	Beyond the main principles of the roster, most of the responsibility and ownership of fatigue risk management appeared to be delegated to the Pilot. The Pilot was responsible for reporting fatigue when they were not fit to work, and had to enact the 2 night out policy. There was no guidance related to maximum amount of overtime that Pilots could volunteer for, the pilot must only be available for their next planned watch to begin.
			c) Recognition that fatigue, and the 'can-do' attitude culture that enables it, is dangerous to seafarers,	We found no evidence that this had been recognised.

			ships, cargoes and company viability, and that it should not be tolerated at any level in the industry	

In addition to the comparison with the MCA example Fatigue Management Plan elements, the assessment has been augmented with an example list of important aspects of company responsibility related to fatigue risk management from the IMO MSC.1 Circ. 1598 module 2 (summarised in module 3). The comparison is provided in table 6.

Table 6: Assessment against the company responsibilities outlined in the IMO MSC.1 Circ.1598 module 2

Aspect	Observation from the PLA materials
1. Developing policies and practices within the ship's safety management system to manage fatigue-related risks	Within the Sea Pilot Working Rules, 2 methods were identified that specifically mentioned being in place to control fatigue: • The 'two nights out' policy • Reporting fatigue Rest periods were provided every 24 hours on watch that must have been a minimum 8 hours in length continuously (although it was not clear whether this time includes planning time), although a rest period could only be shortened from 11 hours continuously to 8 hours in 'exceptional circumstances'. What counts as exceptional circumstances was not outlined. There was no specific fatigue policy
2. Developing work schedules that prevent high levels of fatigue during duty periods	Pilots were on watch for 9 consecutive 24 hour periods, followed by 6 days off. Rest periods were provided following acts of pilotage to ensure that a minimum of 8 consecutive hours of rest were provided per 24 hour period, and pilots were able to enact the '2 nights out' policy if they had been tasked to night acts on two consecutive nights. However, there was no evidence that the scheduling practices were checked for their efficacy, and the two nights out policy relied on the pilot enacting it. It was not automatically applied following two night acts. Two operational letters[7] have also been reviewed, which highlighted that the two nights out rule could not be used if one of the two nights arose from overtime working during days off (stand-down) periods, or if the two nights out rule was not immediately enacted following the return from the pilotage act conducted on the second night. Without the PLA utilising its assurance processes outlined in the Safety Management System to check the effectiveness of the fatigue controls, it could not be assured that the work schedules were able to prevent high levels of fatigue during duty periods.
3. Developing work schedules that allow for adequate rest and recovery periods between duty schedules (if possible allow for an anchor sleep period of seven to eight hours)	During the period of time on watch, the marine pilots were provided with a minimum of 8 hours (ideally 11 hours) following acts of pilotage each 24 hours. There was no requirement in the Sea Pilots

[7] OPL/2014/09 and OP/25/2011, both still extant

	rules for this rest to be allocated at specific times of day – including to ensure 'anchor sleep'[8]. Responsibility for the pilots being fit for duty was assigned to the pilots through their requirements for professional conduct and development.
4. Implementing appropriate and safe duty/watch periods taking into account circadian rhythms	The watch period did not take into account circadian rhythms. No information appeared to be provided relating to the circadian impact of planning or carrying out acts of pilotage. The only consideration of the circadian rhythm was the two nights out rule, which must have been activated by the pilot immediately following the second night out.
5. Providing adequate sleep environment on the ship	N/A on board a ship. On base, facilities were provided for rest and making food, but we were not aware that bedrooms that meet the standards of an adequate sleep environment (dark, quiet, cool and comfortable) were provided for Pilots who wish to rest on base before or after an act of pilotage. This may be because all pilots were required to live close to base although we have not seen any documents referring to this.
6. Ensuring all seafarers are trained and aware of the causes and consequences of fatigue	There is no evidence in the documentation that we have reviewed that any training was provided on the causes and consequences of fatigue
7. Promoting a safety reporting culture with open communication and no fear of reprisal	Pilots had the ability to report fatigue if they determined that they were no longer fit for duty. However, there did not appear to be any training to enable Pilots to identify fatigue. The fatigue reporting seemed to be limited to recording the action in the daily log, rather than collecting further data from the pilot in order to understand the causes of fatigue to improve fatigue management. The tone of the two operational letters relating to the use of the 'two nights out' policy may have impacted on the willingness of pilots to use the policy, and declare themselves unfit due to fatigue if they do not utilise the policy.
8. Continuously assessing, controlling, monitoring and evaluating fatigue-related hazards	We have not seen any evidence that the PLA was continuously assessing, controlling, monitoring and evaluating fatigue related hazards.

3.3 Conclusion

The fatigue risk management process for Sea Pilots at the Port of London Authority was primarily governed by the Sea Pilots Working Rules. These working rules were focussed on the operation of the roster, rather than specifically considering details of fatigue risk management.

There is a lack of regulation for specific fatigue risk management for Marine Pilots, in contrast to the guidelines and guidance published for other Mariners by the IMO and the MCA. Requirements are largely governed by the European Working Time Directive (EUWTD), 2003/88/EC and the Health

[8] Anchor sleep is ensuring that at least one sleep period during a 24h watch period is aligned with the individual's body clock night. This allows for better quality and increased likelihood of sleep occurring, and also reduces some of the circadian disruption caused by rotating or 24h shift patterns.

and Safety at Work Act. As fatigue is a hazard of shiftwork, it is appropriate and necessary for it to be managed through the risk assessment process.

This assessment has compared the PLA fatigue management arrangements with two best practice examples, the fatigue management plan published by the MCA, and the Company Responsibilities for managing fatigue risk that is included within the IMO's fatigue risk management materials. Aside from the 'two nights out' policy and the ability for pilots to report fatigue, there was no other evidence of additional controls to manage fatigue risk. Rest periods were provided, but there was no evidence that the time of day this rest occurs was considered, and the two nights out policy did not appear to be robust, given that it could not be applied following two consecutive nights if one was as a result of overtime, and it had to be requested by the pilot, rather than being automatically applied following two night acts. Pilots had the ability to report fatigue, but we have seen no evidence of fatigue awareness training being conducted, reducing the effectiveness of this control as pilots may not have been aware of the variety of signs and symptoms of fatigue, the effects that fatigue has on their performance, nor the collection of fatigue or safety reports following a Pilot identifying that they were not fit for duty due to fatigue. This limited organisational learning.

When compared to these industry relevant best practice examples, it was clear that both had significantly more elements than the PLA fatigue management arrangements. Additionally, because of the lack of training, and no apparent evidence of risk assessment, monitoring, or assurance, the fatigue risk management approach is not effective at identifying and controlling fatigue risk.

4 Overall conclusion

In this assessment, the following conclusions can be drawn:

- Fatigue is highly likely to have been a significant performance shaping factor in the accident
  - Evidence for elevated fatigue is based on the sleep history, predicted high or severe fatigue levels in the SAFTE-FAST fatigue modelling, and the Pilot's behaviours and performance, which were consistent with that of a fatigued individual, directly playing a role in the course of events
- The fatigue risk management arrangements of the operator were not robust
  - Due to the lack of specific regulation governing Marine Pilot's fatigue risk management in the UK, the EUWTD does not provide an effective regulatory framework for the control of fatigue hazards. This is provided by the Health and Safety at work act, but no evidence of this being used for fatigue management (for example following the 'Managing Shift Work' guidance) was not seen
  - Rest periods provided to the Pilots did not consider the time of day at which the rest occurred, and therefore the likely amount of sleep obtained, and may not have been long enough, due to being shortened to 8 hours, and potentially not including all planning time
  - Pilots and other staff were not provided with fatigue training to enable them to recognise fatigue in themselves and others and use the reporting system when necessary
  - The main fatigue control – the 'two nights out' policy had limited effectiveness as it needed to be enacted by the pilot, could not be used if one of the nights was due to overtime, and did not control against other fatigue hazards

In the accident investigated in the first part of this report, the pilot had operated at times of day that resulted in sleep loss, but would have been unlikely to have triggered the two night policy because the two acts of pilotage prior to the accident had on base times of 05:15 and 07:00. In the absence of a definition of 'night' it is unlikely that a 07:00 base time would have been considered a night act. Given this, the only protection from the pilot operating whilst fatigued was the pilot identifying this in themselves and reporting being fatigued, therefore not undertaking the act of pilotage. This did not occur, but we do not know why.

5 Appendix 1: Bios of team members working on this report

[redacted], Senior Manager of Fatigue Risk Management

[redacted] is the Senior Manager of Fatigue Risk Management at Baines Simmons. A specialist in human performance in the aviation and aerospace environments, [redacted] has 10 years of experience working with operators to develop and implement Fatigue Risk Management Systems (FRMS) across multiple regulatory environments, and provides scientific support to Regulators assessing FRM submissions and scientific safety cases. [redacted] worked for 9 years at Clockwork Research before it was integrated with its sister company, Baines Simmons.

[redacted] specialises in the integration of key data streams into the FRMS. A highly experienced user of bio-mathematical fatigue models, [redacted] develops key metrics for the analysis of roster-related-fatigue levels and roster-related fatigue contributors. [redacted] also works closely with operators to implement effective, data-rich fatigue reporting systems, and to identify barriers to reporting.

[redacted] has undertaken scientific safety cases, fatigue management diagnostics and implemented Fatigue Risk Management in some of the world's largest airlines including Southwest Airlines and Cathay Pacific, as well as in the rail and maritime industries, including prior work in Marine Pilotage operations.

[redacted] obtained an honours degree in Physiological Sciences from the University of Oxford, focusing on cardiovascular physiology and immunology, a Master's degree in Space Physiology and Health at King's College London, and a Master's Degree in Sleep Medicine at Oxford University.

[redacted], Senior Researcher

[redacted] is a Senior Researcher at Clockwork Research. She specialises in the psycho-behavioural predictors of jet lag and fatigue in the aviation sector. Her role involves a wide range of tasks, including the development of fatigue surveys and survey analysis, development of fatigue investigation process, review and recommendations of procedures, scientific study of roster patterns and the use of bio-mathematical models to conduct roster analysis.

[redacted] joined Clockwork Research in April 2018, having previously completed her PhD in Health Psychology exploring the psycho-behavioural predictors of jet lag amongst long-haul cabin crew at the University of Surrey, UK. Her research examined the relationship between subjective (symptom perception) and objective (shift in melatonin acrophase) jet lag in order to provide a comprehensive account of jet lag in long-haul cabin crew. The nature of subjective jet lag was further explored in terms of how long-haul crew make sense of jet lag and how this affects their adaptation to jet lag. Finally, based on recent evidence about the circadian resetting properties of food timing, [redacted] also evaluated the impact of mealtimes for reducing jet lag in long-haul crew.

[redacted]'s interest in the field of jet lag and fatigue in aviation is not only academic but also personal having worked as long-haul cabin crew for 24 years. [redacted] also works as a Visiting Researcher and Academic Tutor in Psychology for the University of Surrey. She is a Chartered member of the British Psychological Society and an Associate Fellow of the Higher Education Academy.

[redacted], Consultant

After graduating in Chemical Engineering, [redacted] studied medicine as a second degree. Following pre-registration jobs in London and General Practice training in Gloucestershire, he spent three years as a Principal in General Practice in Wantage, Oxfordshire before making a career decision to specialise in Occupational Medicine. He commenced as a Senior Registrar with the UK Atomic Energy Authority at Harwell and completed his higher professional training with British Airways whilst undertaking a Doctor of Medicine degree examining the effects of long-haul travel on performance.

Following specialist accreditation, he was promoted to Consultant and subsequently Senior Consultant with British Airways and assumed the role of Head of Occupational and Aviation Medicine to cover for extended sickness absence. On leaving British Airways he was appointed Group Head of Occupational Health at Centrica plc before moving to bp in 2006 where he held a number of senior leadership roles concluding his career as global Senior Health Director. Throughout his occupational medicine career, [redacted] worked in corporate roles in high hazard, safety critical industries.

Outside of his core activities, he has worked as a consultant providing acclimatisation advice following transmeridian travel to the British Olympic Association, British Paralympic Association, UK Sport, the Football Association, Rugby Football Union and individual national teams preparing for international competitions since the Sydney 2000 Olympic Games. [redacted] is an Adjunct Professor in the Appleton Institute, Central Queensland University, Adelaide, Australia and a Visiting Senior Research Fellow in the School of Sport, Health and Exercise Science in the University of Portsmouth, UK. In 2018 [redacted] took on the role of Registrar and Deputy President of the Faculty of Occupational Medicine of the Royal College of Physicians and remained in post until June 2021.

In addition, from 2012 to 2021, [redacted] was a Member of Her Majesty's Secretary of State's Honorary Medical Advisory Panel on Driving and Diabetes Mellitus and from 2018 to 2021 was Chair of the Health Technical Committee of the Energy Institute.

Since retiring from full-time employment in 2021, [redacted] has worked as an independent consultant in fatigue management and the governance of health services. He currently sits on the Medical Advisory Committee of the Royal National Lifeboat Institution and continues to lecture on medical leadership to postgraduates at University College London.

6 Appendix 2: The SAFTE-FAST fatigue model

6.1 SAFTE-FAST glossary

- **Fatigue threshold:** 77% performance effectiveness

SAFTE-FAST colour zones[9]

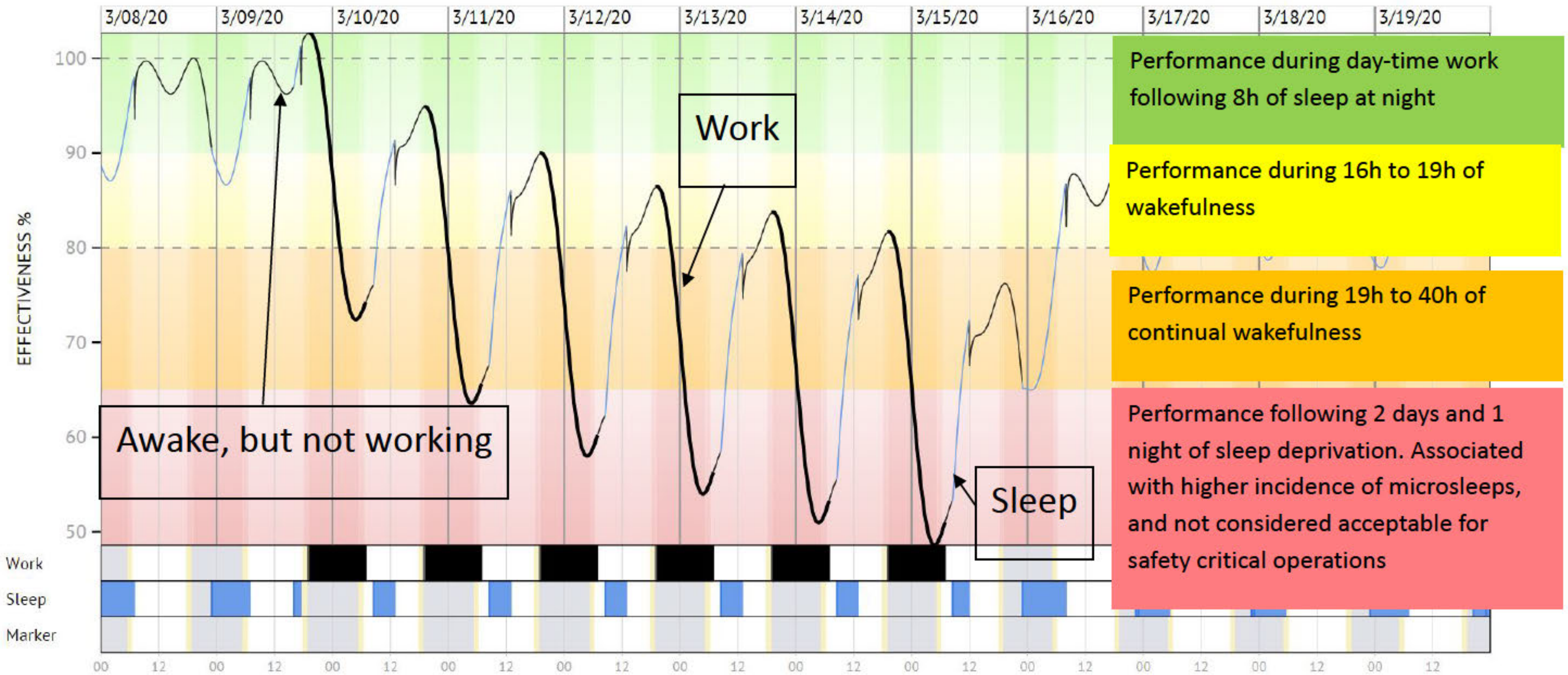
Zone	SAFTE-FAST score	Equivalent to:
Green	90-100%	Predicted performance during a 16-hour day following 8 hours of excellent sleep. A fully rested person working during the day would remain in this effectiveness zone. It is important to note that time in the 'green zone' is not necessarily fatigue free: the output is merely an estimate based on average data, albeit one that is well supported by research findings. SAFTE-FAST scores in the this range are equivalent to KSS scores of KSS1 to KSS 4.5
Yellow	80 - <90%	Predicted performance during a window following 16 to 19 hours of wakefulness. SAFTE-FAST scores in this range are equivalent to KSS scores of KSS 4.5-KSS 6.6
Orange	65 - < 80%	Predicted performance during a window of between 19 and 40 hours of continual wakefulness (for example, remaining awake for 24 hours following a 16h day). A score of 77% is associated with reaction times ~30% slower than well rested and a likely increase in lapses of 2.7 times, and has been shown (in the laboratory setting) to be equivalent to the reaction time performance of an individual with a blood alcohol concentration (BAC) of 0.05%. A score of 70% is associated with the reaction time of an individual with a BAC of 0.08%. SAFTE-FAST scores in this range are equivalent to KSS scores of KSS 6.6-KSS 8.0
Red	<65%	Predicted performance following 2 days and 1 night of sleep deprivation (40 hours of wakefulness). Scores in this level are associated with >50% slower reaction times and are normally considered unacceptable for safety-critical operations. SAFTE-FAST scores in this range are equivalent to KSS scores of KSS 8 to KSS 9

Contributory factor	Explanation	Threshold
Recent Sleep	The total number of hours of sleep in the previous 24 hours	This factor is flagged if recent sleep is <8 hours
Chronic Sleep Debt	The cumulative number of hours of sleep that have been missed (i.e. number of hours less than 8h) since the last recuperative sleep. This includes both the duration and quality of sleep, as lower quality sleep has less recuperative value	This factor is flagged if chronic sleep debt is >8 hours in total
Hours Awake	The number of continuous hours since the last period of sleep	This factor is flagged if hours awake is >17 hours
Time of Day	An evaluation of susceptibility to error based on the person's own adjusting circadian rhythm	This factor is flagged if the time of day is between 0000h-0600h based on the person's own adjusting circadian rhythm
Out of Phase	A measure of "jet lag" or "shift lag". More specifically, it is a measure of how out of phase (out of sync) the person is with the	This factor is flagged if the individual's personal circadian rhythm is >3 hours

[9] Adapted from material contained within the SAFTE-FAST Console User Manual, Institutes of Behaviour Resources Inc.

	local time zone, measured as the number of hours out of phase	out of phase with the current pattern of sleep and wakefulness

Understanding SAFTE-FAST outputs



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