ACCIDENT REPORT

Report on the investigation of the

grounding of the ultra-large container vessel

CMA CGM Vasco de Gama

Thorn Channel, Southampton, England

22 August 2016

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

SERIOUS MARINE CASUALTY REPORT NO 23/2017 OCTOBER 2017

Extract from

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.

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ABP	-	Associated British Ports
AIS	-	Automatic Identification System
BRM	-	Bridge Resource Management
CHA	-	Competent Harbour Authority
con	-	The conduct of navigation of the vessel
DfT	-	Department for Transport
dwt	-	deadweight tonnage
ECDIS	-	Electronic Chart Display and Information System
ECS	-	Electronic Chart System
ETA	-	estimated time of arrival
FAL1	-	French Asia Line 1
IALA	-	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICS	-	International Chamber of Shipping
ICS Guide	-	International Chamber of Shipping Bridge Procedures Guide
IMO	-	International Maritime Organization
IMS	-	Integrated Management System
ISM Code	-	International Safety Management Code
ISO	-	International Organization for Standardization
kt	-	knot
kW	-	kilowatt
LOA	-	length overall
m	-	metre
MCA	-	Maritime and Coastguard Agency
MPX	-	Master-Pilot Exchange
nm	-	nautical mile

OHSAS	-	Occupational Health and Safety Assessment Series
OOW	-	Officer of the Watch
OOWA	-	Officer of the Watch Assistant
PMSC	-	Port Marine Safety Code
PPU	-	Portable Pilot Unit
ROT	-	rate of turn
SMS	-	Safety Management System
STCW	-	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended
t	-	tonne
TEU	-	twenty foot equivalent unit
UKC	-	Under Keel Clearance
UTC	-	Universal Co-ordinated Time
VHF	-	Very High Frequency
VTS	-	Vessel Traffic Services

TIMES: all times given are in local time (UTC +1 hour)

COURSES: all courses given are in degrees gyro

SYNOPSIS

In the early hours of the morning on 22 August 2016, the 399.2m ultra-large container vessel *CMA CGM Vasco de Gama*, grounded on the western side of the Thorn Channel whilst approaching the Port of Southampton. *CMA CGM Vasco de Gama* was the largest ship on the UK ship registry and had two Southampton pilots embarked. One of the pilots had control of the vessel's navigation at the time of the grounding. Fortunately, *CMA CGM Vasco de Gama* was undamaged by the grounding and was able to be refloated, with tug assistance, on the rising tide.

The grounding occurred because the vessel was too far north of the intended track when the turn into the Thorn Channel was commenced. This reduced the sea room available for the manoeuvre and, given the environmental conditions, *CMA CGM Vasco de Gama* was unable to sustain the rate of turn required to remain in the dredged channel.

The execution of the vessel's turn around Bramble Bank and into the Thorn Channel by the lead pilot was not in accordance with the port's guidance for large inbound vessels. *CMA CGM Vasco de Gama*'s bridge team, assistant pilot and the Vessel Traffic Services, could not usefully monitor the lead pilot's actions, or the vessel's progress through the Precautionary Area. This was because a detailed pilotage plan had not been produced; the lead pilot's intended manoeuvre around Bramble Bank was not explained; the bridge team roles and responsibilities were unclear; and the electronic navigation aids on board were not fully utilised.

The investigation identified that the vessel's bridge team and the port pilots had the experience, knowledge and resources available to effectively plan and execute the pilotage. However, the standards of navigation displayed during the pilotage fell short of the standards expected by CMA Ships and Associated British Ports. It was apparent that complacency and a degree of over confidence on the part of the master and port pilots contributed to this accident. However, it was also apparent from recent similar incidents and the findings of previous MAIB reports that many of the practices evident in this case were not specific to this single pilotage act, or to *CMA CGM Vasco de Gama*.

Actions have been taken by CMA Ships and Associated British Ports to address some of the issues identified in this report and to improve navigational safety. The findings of this report will be used by the MAIB as part of a safety study that will investigate the use of modern electronic navigation aids on board merchant vessels, and the impact they have had on navigation practices.

Recommendations aimed at reducing the likelihood of future groundings and improving levels of navigation, bridge resource management, and use of electronic navigation aids have been made to CMA Ships and Associated British Ports.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *CMA CGM VASCO DE GAMA*

SHIP PARTICULARS	
Vessel's name	*CMA CGM Vasco de Gama*
Flag	UK
Classification society	Bureau Veritas
IMO numbers	9706889
Type	Ultra-large container vessel
Registered owner	CHC Second Shipping S.A.
Manager	CMA Ships
Construction	Steel
Year of build	2015
Length overall	399.2m
Gross tonnage	178228t
Draught	13.75m
Main engine power	63910kW
Authorised cargo	Containers
VOYAGE PARTICULARS	
Port of departure	Algeciras
Intended port of arrival	Southampton
Type of voyage	Long international
Manning	28
MARINE CASUALTY INFORMATION	
Date and time	22 August 2016 at 0032
Type of marine casualty or incident	Serious Marine Casualty
Location of incident	Thorn Channel precautionary area, Southampton
Place on board	n/a
Injuries/fatalities	None
Damage/environmental impact	None
Ship operation	Port pilotage
Voyage segment	Arrival
External environment	Night time, visibility good, west-south-westerly wind blowing at 20-22kts, sea state slight.
Persons on board	31 (28 crew, 2 pilots and 1 passenger)

Image courtesy of Hummelhummel

CMA CGM Vasco de Gama

1.2 NARRATIVE

At 0542 on 19 August 2016, *CMA CGM Vasco de Gama* departed Algeciras, Spain bound for Southampton, England. At 2045 on 21 August 2016, the vessel's officer of the watch (OOW) made radio contact with Southampton Vessel Traffic Services (VTS) when it was confirmed that two harbour pilots would board the vessel 4 miles south of the Nab Tower **(Figure 1)**. At 2215, as the vessel approached the pilot boarding station, *CMA CGM Vasco de Gama*'s master took over the conduct of the vessel's navigation (con) from the OOW.

At 2245, *CMA CGM Vasco de Gama* arrived at the designated pilot boarding point and embarked the two pilots. When the pilots arrived on the bridge a few minutes later, they were greeted by the master and the OOW. There was also a helmsman on the wheel, and a lookout stationed on the bridge.

The master handed over the con to the lead pilot. Once the lead pilot had attained his situational awareness, he ordered an increase in speed and a change of course to make the approach toward the Nab Channel. He then explained to the master that the ship would be heading into a spring flood tide and was unlikely to make a good speed. He also told the master that the passage would be delayed slightly, due to the late sailing of an outbound vessel, *Cap Hatteras*.

With the lead pilot positioned on the port side of the bridge navigation console and focusing on navigating the vessel, the master continued to exchange information with the assistant pilot. The assistant pilot used a partly completed port passage plan form **(Annex A)** and the port's generic passage plan guidance leaflets **(Annex B)** to help explain the pilotage and berthing plans. During the exchange, the master confirmed the vessel's draught as 13.75m and asked about the tug arrangements at

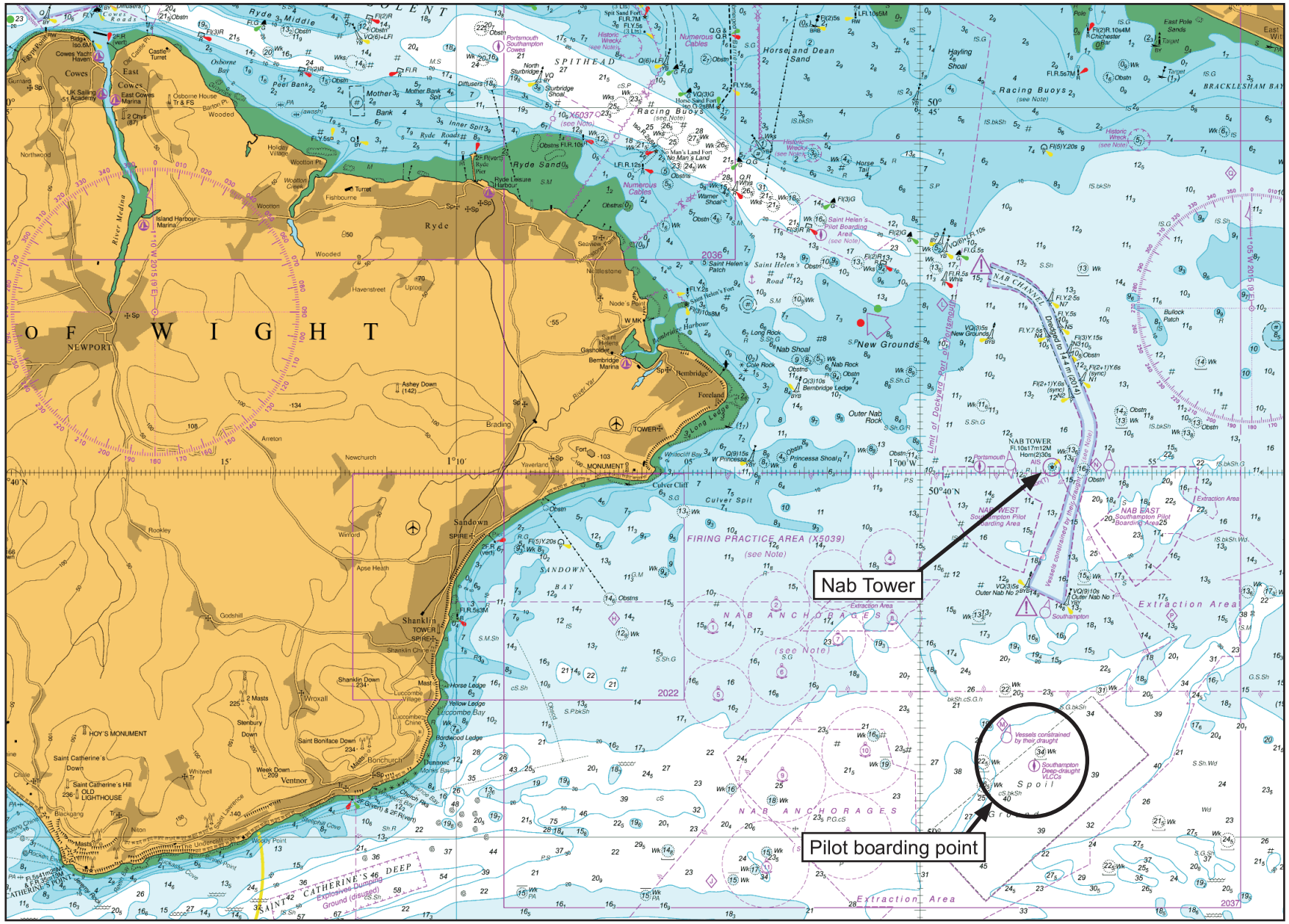

Figure 1: Extract of chart 2045 showing pilot boarding point

the berth. Following the discussion, the master positioned himself on the starboard side of the navigation console and the assistant pilot began setting up his Portable Pilot Unit (PPU)[1] **(Figure 2)**.

Figure 2: ADX Portable Pilot Unit

[1] The PPU provided an electronic chart system (ECS) for the pilots that was independent of the ship's equipment.

At 2300, a Southampton VTS officer called *CMA CGM Vasco de Gama* on VHF radio channel 12 and provided an update on vessel movements in the pilotage area **(Figure 3)**. In response to the call, the lead pilot reduced the vessel's speed to ensure that it passed the outbound *Cap Hatteras* before entering the Thorn Channel Precautionary Area **(Figure 4)**. A few minutes later, the assistant pilot informed the lead pilot that he had successfully set up the PPU. The PPU's display screen was positioned on the port side of the navigation console in front of the lead pilot **(Figure 5)**.

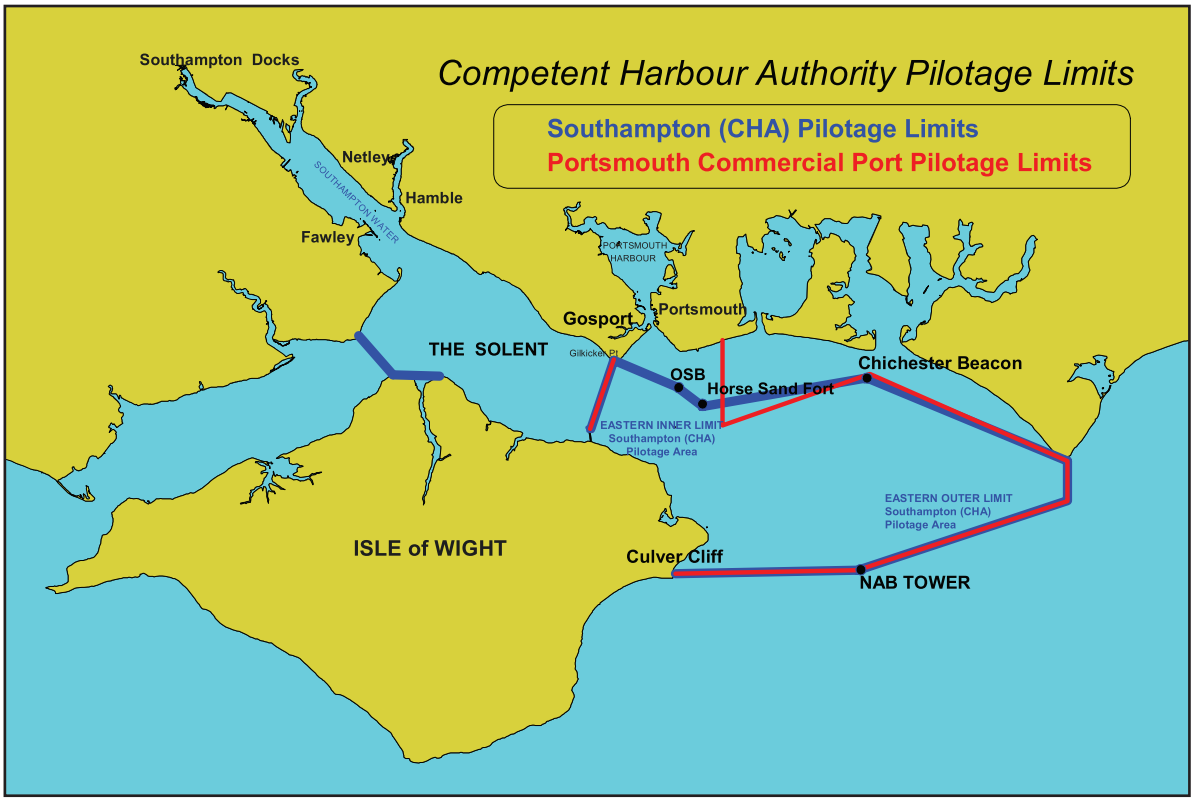

Figure 3: Competent Harbour Authority pilotage limits

At 2331, *CMA CGM Vasco de Gama* passed the outbound container vessel *NYK Oceanus*. As the vessels passed, the lead and assistant pilots discussed the leeway that *CMA CGM Vasco de Gama* was making, and the relative positioning of the other large container vessel within the channel.

When *CMA CGM Vasco de Gama* arrived at the 'Forts' reporting point the VTS officer re-affirmed that *Cap Hatteras* was giving an ETA of 0020 at the Prince Consort buoy to clear the Precautionary Area. The VTS officer then asked the lead pilot what assistance he required from the VTS to help with the vessel's turn into the Thorn Channel. The pilot asked for a 6 cable[2] distance countdown to the Gurnard buoy.

At 2343, the lead pilot received a call to his mobile telephone from the pilot on board *Cap Hatteras*, to discuss how and where they would execute the passing manoeuvre between the two vessels. Both pilots agreed to a conventional port to port pass, with the speed of *CMA CGM Vasco de Gama* being adjusted to ensure the pass took place to the east of the Prince Consort buoy.

[2] A cable is a measure of distance. 1 cable = 0.1 nautical mile = 185 metres

Reproduced from Admiralty Chart BA 2036 by permission of the Controller of HMSO and the UK Hydrographic Office

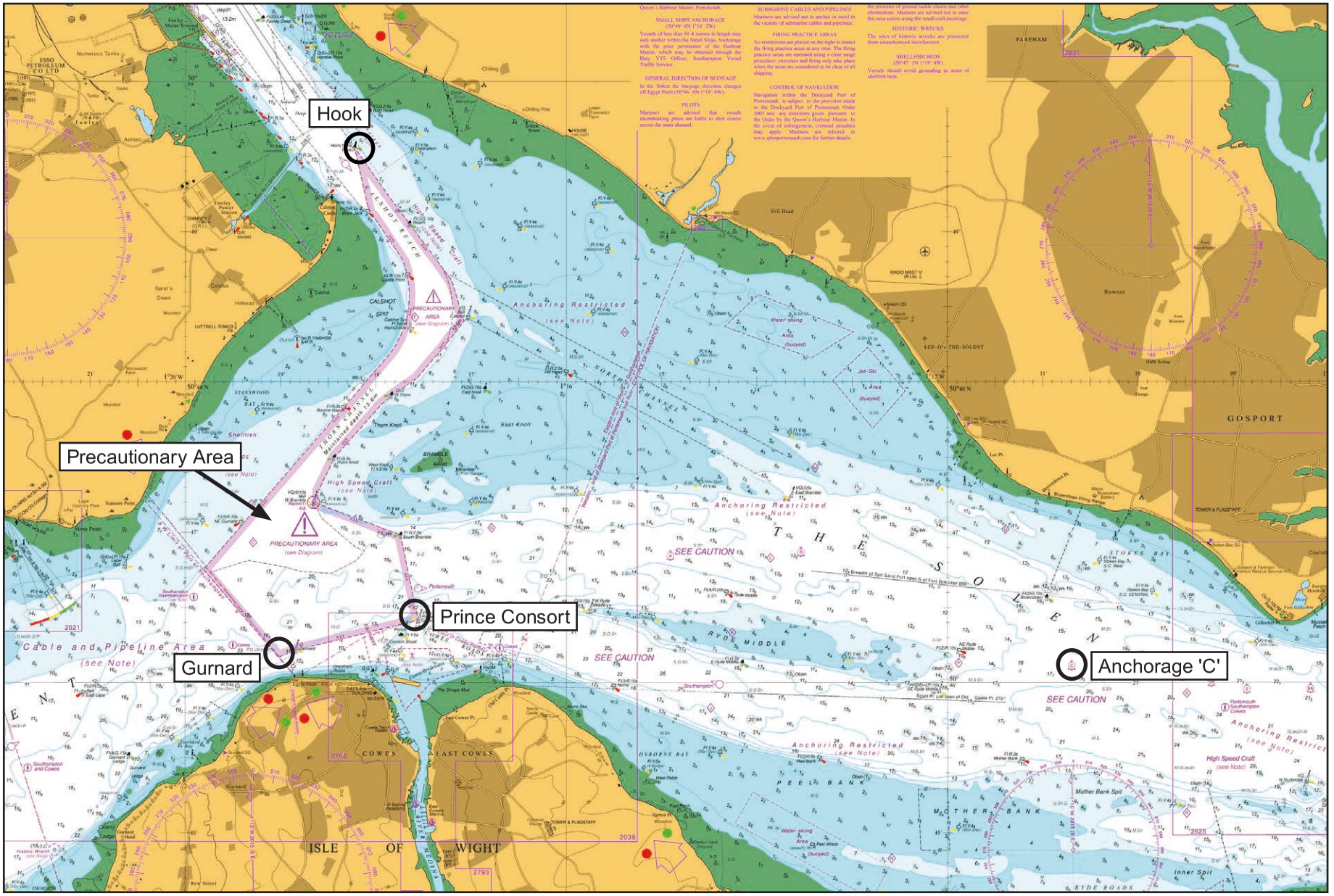

Figure 4: Extract of chart 2036 showing the Thorn Channel Precautionary Area

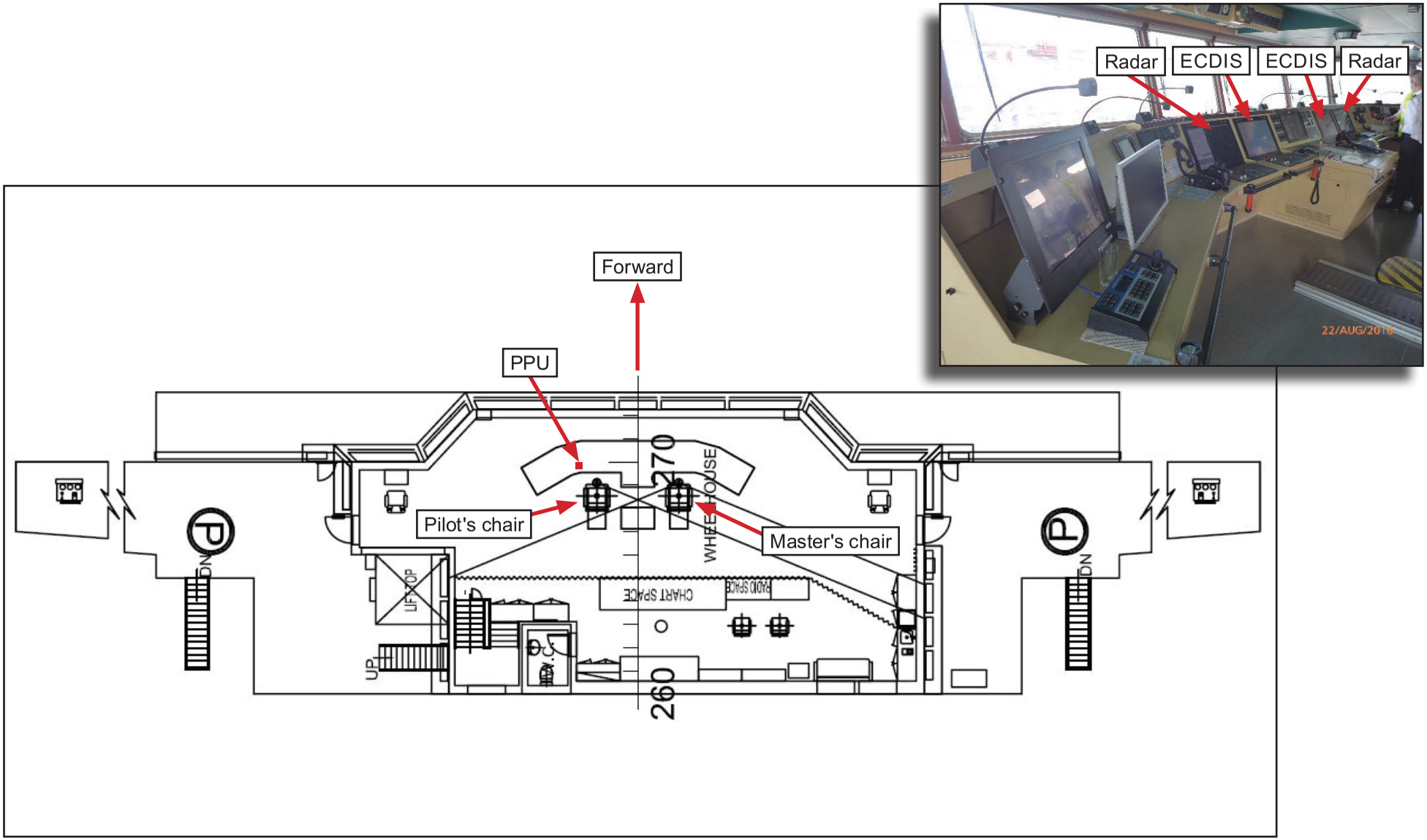

Figure 5: Bridge layout (**inset:** Bridge navigation console)

Shortly before midnight, *CMA CGM Vasco de Gama* passed the small outbound container vessel *X Press Shannon*. At 0009 (22 August), as *CMA CGM Vasco de Gama* approached the South Ryde Middle buoy, the lead pilot ordered an increase of speed to half ahead. Over the next 5 minutes, the ship gathered speed from 7.5kts to 12kts.

At 0019, the lead pilot informed the master of his planned manoeuvre into the Precautionary Area in order to round Bramble Bank. To combat the strong flood tide and prevailing headwind, the lead pilot stated that he intended to navigate the vessel "deep" into the Precautionary Area before commencing the starboard turn into the Thorn Channel.

At 0021, *CMA CGM Vasco de Gama* passed abeam of *Cap Hatteras* on a heading of 289° in a position 0.5nm to the east of the Prince Consort buoy. The lead pilot then gave the helmsman a series of courses to steer that, over the next 4 minutes, brought *CMA CGM Vasco de Gama* onto a heading of 260°. During the turn, the vessel passed 0.25nm north of the Prince Consort buoy **(Figure 6)** at a speed of 11.9kts. The VTS officer began his countdown on the VHF radio when the vessel was 6 cables away from the Gurnard buoy **(Figure 7)**.

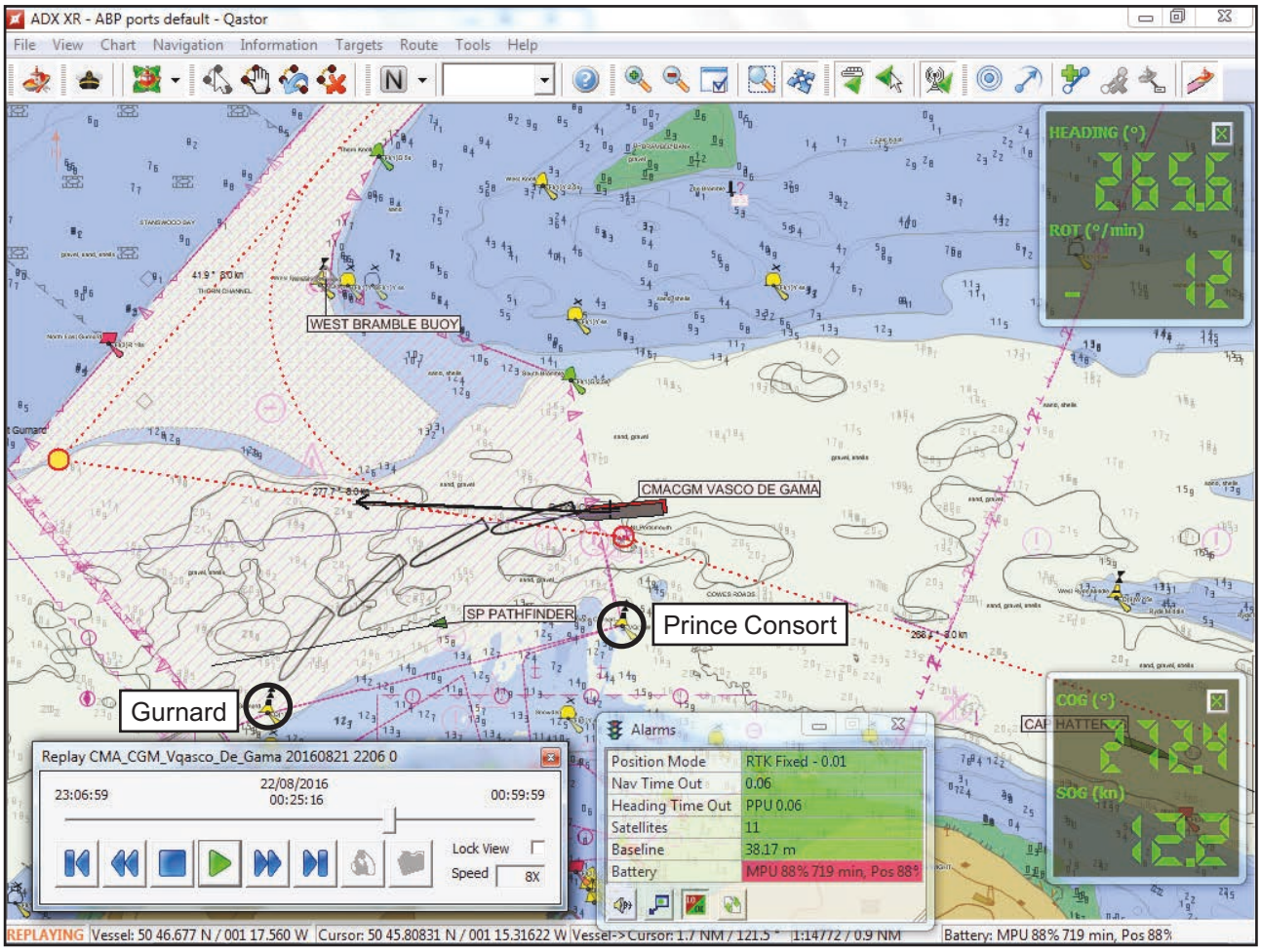

Figure 6: PPU screenshot showing *CMA CGM Vasco de Gama* passing Prince Consort buoy

Figure 7: VTS officer's radar screenshot showing the countdown to the Gurnard buoy

At 0026, on the VTS officer's count of 3 cables, the lead pilot gave a helm order of "starboard 10°". Twenty seconds later, as the VTS officer's countdown reached 2 cables, he ordered full helm to starboard (35°). Shortly afterwards, he increased the engine speed to full ahead.

Initially, the vessel's rate of turn (ROT)[3] climbed to 31° per minute **(Figure 8)**, but the pilots soon began to discuss their concerns about the effect of the vessel's stern coming into the wind. A few seconds later, as the ROT began to drop **(Figure 9)**, the lead pilot asked "where is all this tide when you want it"? The lead pilot explained to the assistant pilot that he began his turn to starboard early and that the engine was set to full ahead. At the same time, the master expressed similar concern to the OOW in his native language, Romanian.

As the vessel approached the westward edge of the dredged channel and entered shallower water, the lead pilot told *CMA CGM Vasco de Gama*'s master that they must keep going. At 0031, with the ROT continuing to drop, the VTS officer called the pilots on VHF channel 12 and advised them that the vessel appeared to be leaving the channel **(Figure 10)**. The lead pilot acknowledged the VTS intervention. The VTS officer then alerted the local tug skippers and placed them on standby to provide rapid assistance if needed.

At 0032, in position 50° 49.4'N 001° 19.02'W, about 0.4nm north-north-east of the north-east Gurnard buoy **(Figure 11)**, *CMA CGM Vasco de Gama* grounded on the gently shelving seabed with the engine at full ahead. As *CMA CGM Vasco de Gama* slowed, the lead pilot tried to use the bow thrusters to drive the vessel back into the

[3] Rate of turn is defined as the speed at which a vessel alters its heading.

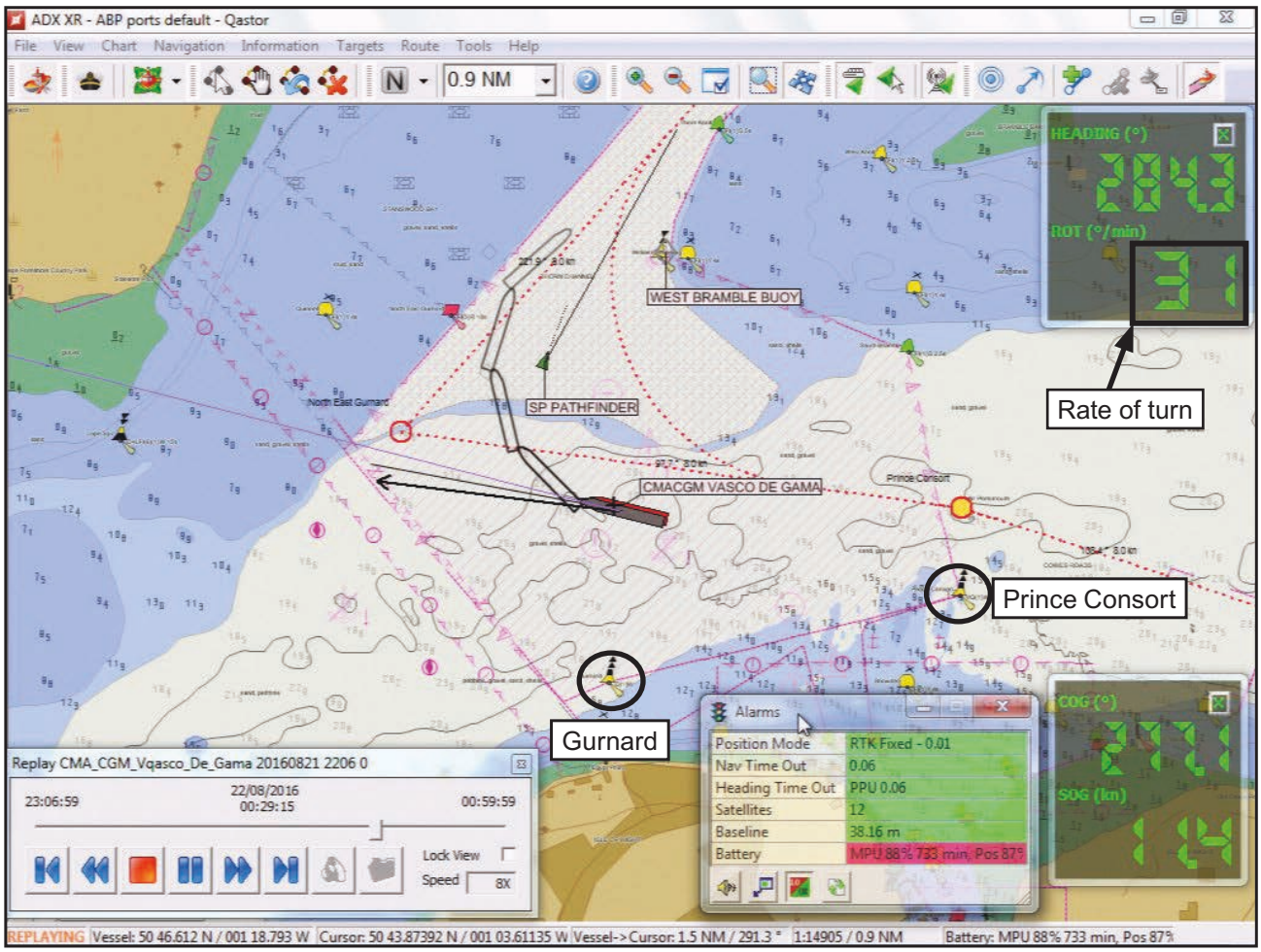

Figure 8: PPU screenshot showing the commencement of the turn

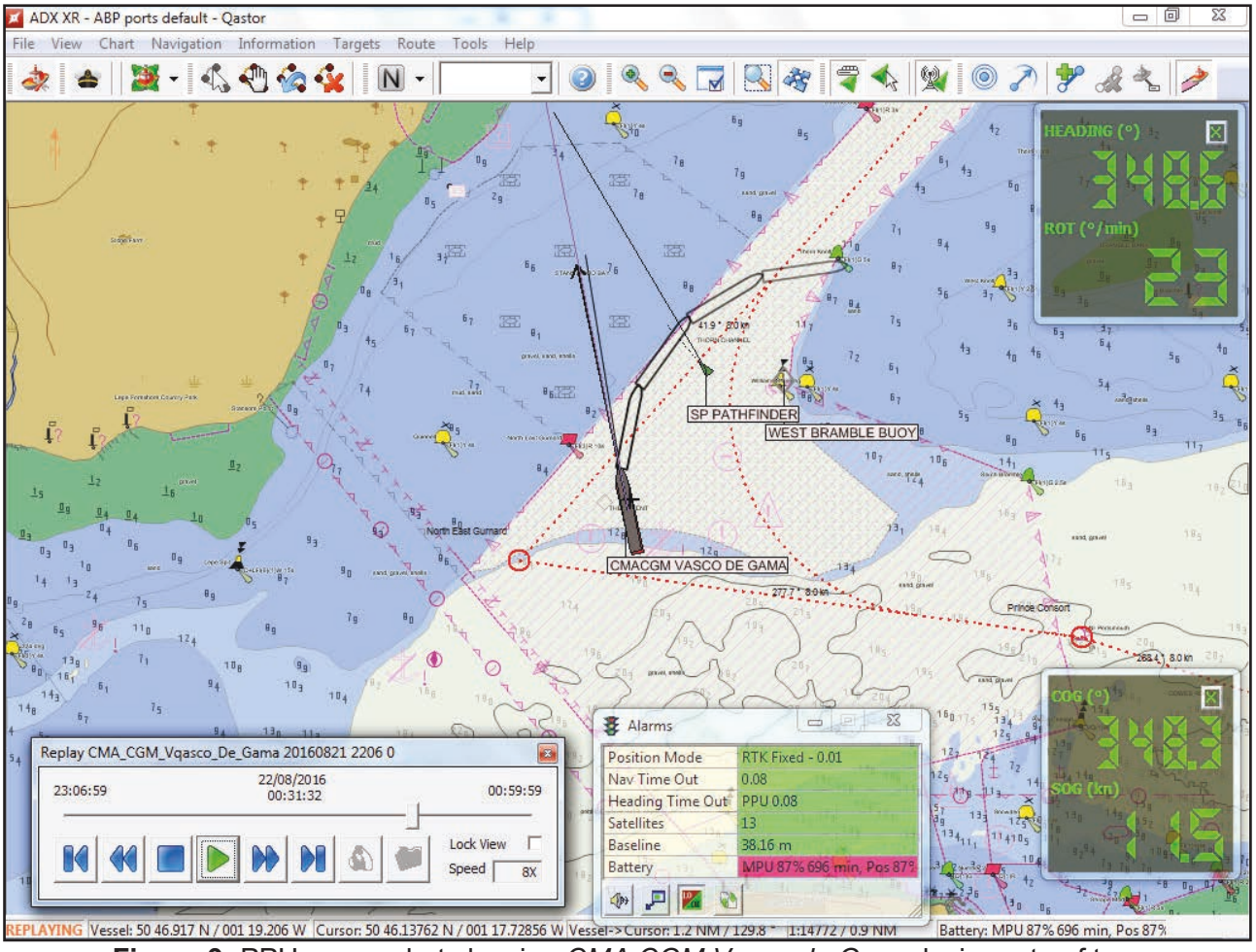

Figure 9: PPU screenshot showing *CMA CGM Vasco de Gama* losing rate of turn

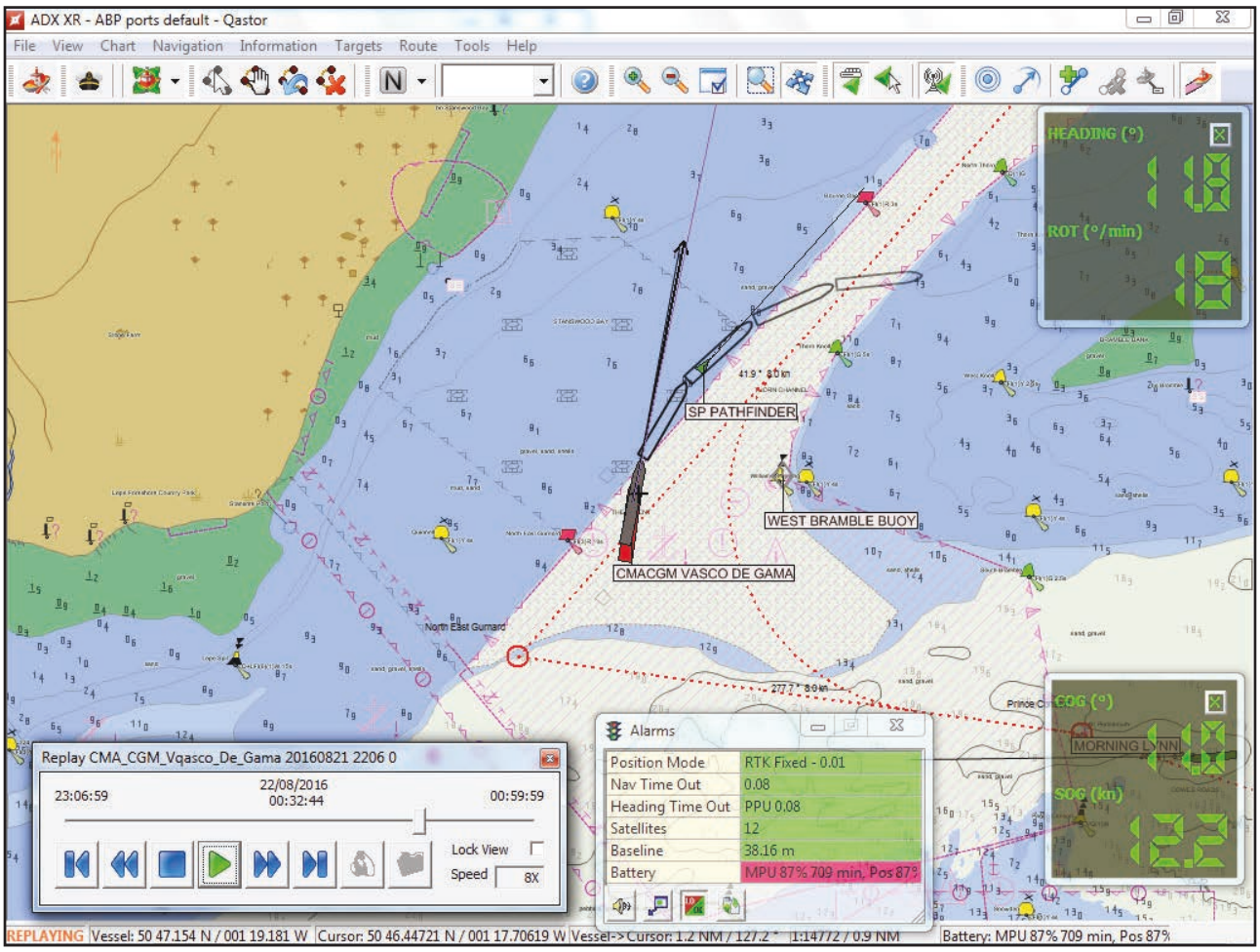

Figure 10: PPU screenshot showing *CMA CGM Vasco de Gama* departing the dredged channel

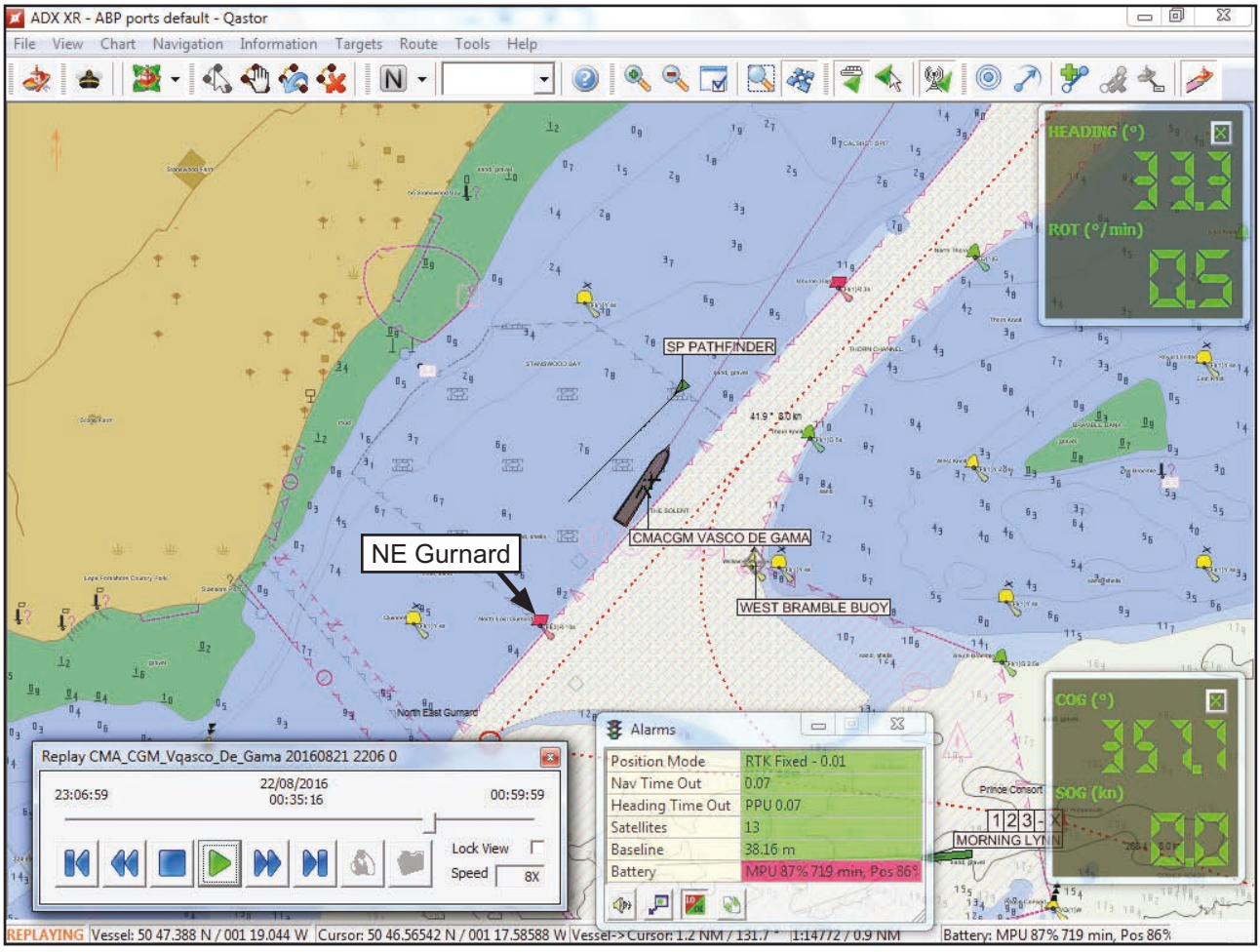

Figure 11: PPU screenshot showing the grounding position

Thorn Channel. This was unsuccessful and, once it was confirmed that the vessel had come to a full stop and was firmly aground, the ship's engine and bow thrusters were stopped. The VTS officer called the lead pilot on the VHF radio and agreed with him to dispatch tugs to assist the vessel.

The master alerted his crew and then called the company's emergency telephone number and reported the situation. With the crew mustered and using the vessel's checklist for grounding as a guide, the master implemented the vessel's emergency procedures. The crew's initial inspections and tank soundings indicated that the vessel's hull had not been breached.

At 0053, the first two harbour tugs arrived on scene and the ship's crew started de-ballasting the vessel. About 5 minutes later, a third tug arrived. At 0103, with one tug pulling aft, the vessel's engine driving astern and two tugs and the bow thrusters pushing to starboard, the vessel refloated on the rising tide. Once the vessel was afloat, the crew verified its watertight integrity and the assistant pilot took over the con for the passage to the container terminal.

An underwater hull inspection carried out alongside the berth later that day revealed that the vessel had sustained no damage. On the following day, after further inspections by UK Flag State surveyors, the ship's classification society and the ship's insurers, *CMA CGM Vasco de Gama* departed Southampton.

1.3 ENVIRONMENTAL CONDITIONS

The accident occurred during the hours of darkness on a rising spring tide with good visibility and a west-south-westerly wind blowing at 20-22kts. The sea state was slight and the tide height was 3.53m. The seabed where the ship grounded was composed of sand and gravel, with local charted shellfish beds.

In the Solent area, the tidal stream flows in an easterly direction until about 1.5hrs before high water at Portsmouth, when it quickly reverses direction. The tide will flow into Southampton water from the Solent until high water at Portsmouth. High water at Portsmouth on the day of the grounding was 0227 with a tide height of 4.77m.

For most of its passage through the Solent, *CMA CGM Vasco de Gama* was pushing into the tide until it commenced the turn within the Precautionary Area, about 2 hours before high water at Portsmouth **(Figure 12)**.

1.4 *CMA CGM VASCO DE GAMA*

1.4.1 General vessel information

CMA CGM Vasco de Gama was a UK registered ultra-large container vessel[4]. It was built in China in 2015 and was one of six CMA CGM *Explorer* class vessels. It had a cargo-carrying capacity of 17,859TEU[5] and its length overall, beam and fully loaded draught, was 399.2m, 54m and 16m respectively.

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[4] Ultra-large container vessel – means a container vessel with a carrying capacity, length, beam, or draught equal to or greater than 14,501TEU, 366m, 49m and 15.2m respectively.

[5] TEU – Twenty foot Equivalent Unit. This uses a 20-foot standard container as a measure of container ship carrying capacity.

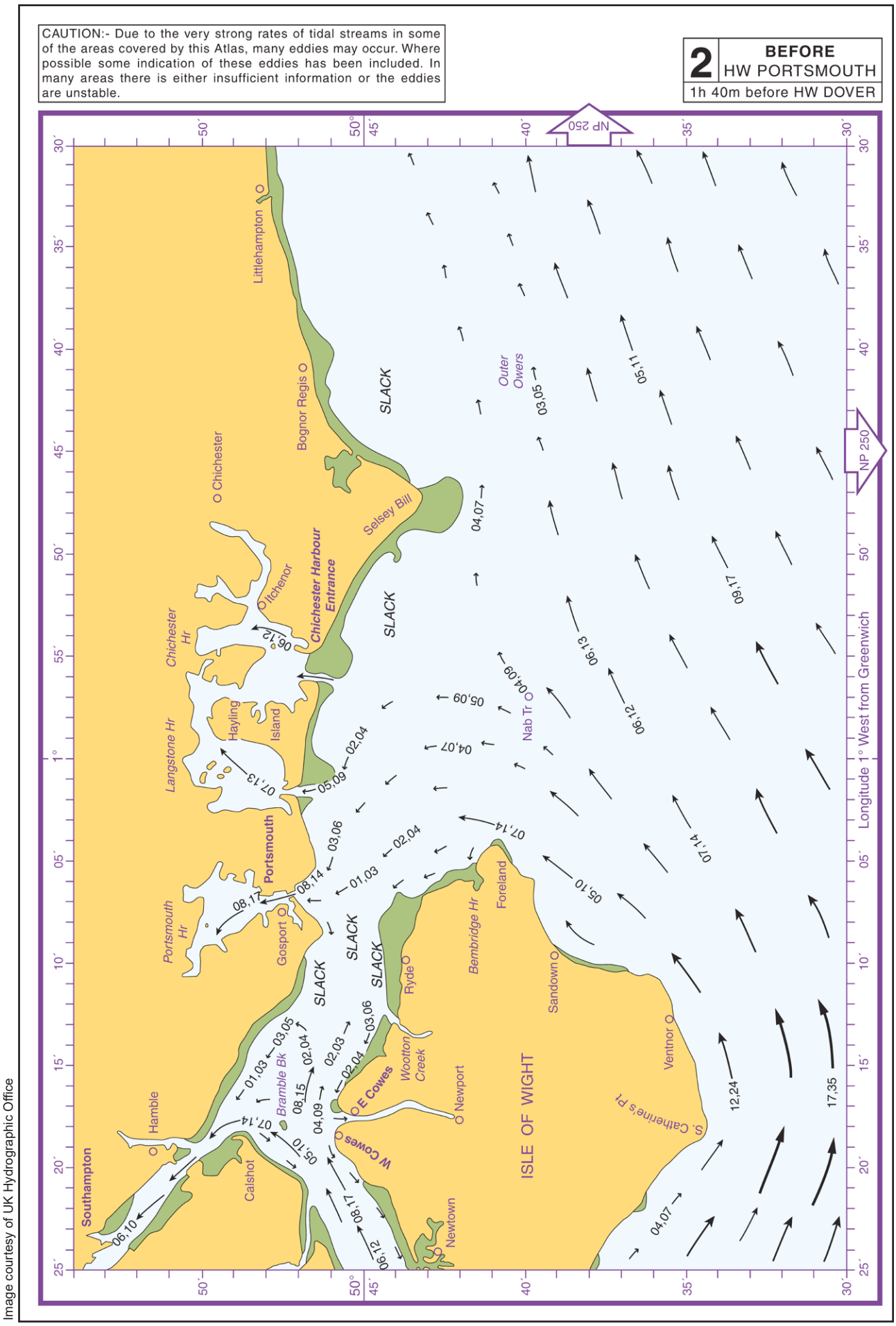

Image courtesy of UK Hydrographic Office

Figure 12: Tidal streams 2 hours before high water Portsmouth

The vessel was managed by CMA Ships and was one of 12 operating on the CMA CGM Group's *French Asia Line 1* (FAL1). The FAL1 trading route joined eastern Asia with northern Europe and included 19 ports of call. *CMA CGM Vasco de Gama* would normally call into the Port of Southampton eight times per year.

1.4.2 Propulsion machinery and steering gear

CMA CGM Vasco de Gama had a single main engine driving a right-handed six blade fixed pitched propeller and a twisted leading edge rudder. It also had two 2,000kW bow thrusters. The vessel's maximum speed was 23kts and its bow thrusters were ineffective at speeds above 5kts.

The main engine was controlled from the bridge via an electronic load management system. The load management system was programmed to protect the engine by governing the rate at which it responded to telegraph orders. Like the other *Explorer* class vessels, the electronic load management function could be overridden on the bridge. During the pilotage, there were no load restrictions on the main engine and its electronic power management system had been overridden.

1.4.3 Navigation equipment

CMA CGM Vasco de Gama was fitted with two Nacos Platinum Series independent Electronic Chart Display and Information System (ECDIS) units, manufactured by Wartsila SAM Electronics, which were fully compliant with International Maritime Organization (IMO) requirements. ECDIS was the vessel's primary means of navigation and the units were networked with the ship's radars and Automatic Identification System (AIS). The radar pictures were overlaid with the ECDIS routes and the information received from the AIS.

There was an ECDIS and radar display screen positioned on the navigation console in front of each bridge chair **(Figure 5)**. The ECDIS used its course, speed and ROT data to provide a look ahead function that displayed the vessel's predicted track over a pre-selected timescale on the screen.

The vessel's master and deck officers had received generic and equipment-specific ECDIS training.

1.4.4 Crew

CMA CGM Vasco de Gama had a crew of 28 and, in addition to the two pilots, was carrying one passenger. The vessel's officers were Romanian and its ratings were Filipino.

The master was 49 years old and held a Romanian STCW[6] II/2 Master's Certificate of Competency. He had been master for 10 years and had worked on container vessels operated by CMA Ships for all that period. His contracted work agreement was for 3 months on board and 3 months on leave. He had just completed his second contract on board *CMA CGM Vasco de Gama*. During his time with CMA Ships he had visited the Port of Southampton several times.

[6] STCW – International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended.

The OOW at the time of the grounding was a second officer. He was 33 years old and had recently obtained his Romanian STCW II/2 Chief Mate's Certificate of Competency. He had worked on container vessels operated by CMA Ships for several years and had been assigned to *CMA CGM Vasco de Gama* since it came into service. He was the vessel's navigating officer and had frequently visited Southampton. His work contract was for a period of 4 months on and 2 months off.

1.5 CMA CGM GROUP AND CMA SHIPS

1.5.1 General vessel management structure

The CMA CGM Group was an international logistics company and operated one of the world's biggest shipping fleets. In 2016, the CMA CGM Group transported over 18 million containers, employed over 29,000 people and operated about 536 vessels worldwide.

The CMA CGM managed vessels were divided into groups and managed from various offices around the world by CMA Ships. *CMA CGM Vasco de Gama* was part of a group of vessels managed from the CMA CGM Group headquarters in Marseille, France.

1.5.2 Safety management

CMA Ships operated an Integrated Management System (IMS). This encompassed the voluntary quality, environmental and safety management requirements set out in the ISO 9001, ISO 14001 and OHSAS 18001 standards[7], as well as the mandatory requirements of the International Safety Management Code (ISM Code). The IMS contained generic procedures that were created and approved by shore management and applicable to the whole company fleet, and vessel specific procedures for individual ships that were created on board and approved by shore management.

The company's bridge procedures, checklists and navigational safety guidelines were set out in a series of bridge cards that were compiled together in the IMS to form a bridge manual. The bridge manual contained bridge cards for watchkeeping, bridge management, passage planning, navigation with ECDIS, preparations for arrival and pilot management.

The vessels were regularly visited by CMA Ships' management staff and were subject to annual internal ISM Code audits. The auditors used electronic checklists for each area of the ship, including the bridge, to assist the audit process. The bridge checklist did not refer directly to pilotage management procedures.

CMA CGM Vasco de Gama's last internal IMS audit prior to the accident was undertaken between 17 and 22 September 2015 while the vessel was on passage between Le Havre and Malta. No navigation or bridge procedure non-conformities were identified during the audit.

[7] ISO 9001 – Quality; ISO 14001 – Environment; OHSAS 18001 – Occupational Health and Safety.

1.6 PORT OF SOUTHAMPTON

1.6.1 Background

Southampton is one of the UK's busiest deep-water ports, visited by a wide variety of vessel types including oil tankers, container vessels and cruise ships. At the time of the incident, the port included the second largest container terminal in the UK and could accept the world's largest container vessels.

The Port of Southampton was owned and managed by Associated British Ports (ABP). ABP Southampton was the statutory and competent harbour authority for the navigable areas of the River Test, River Itchen, Southampton Water and parts of the Solent. As such, it provided VTS and pilotage services throughout Southampton Water and much of the central and eastern Solent **(Figure 13)**.

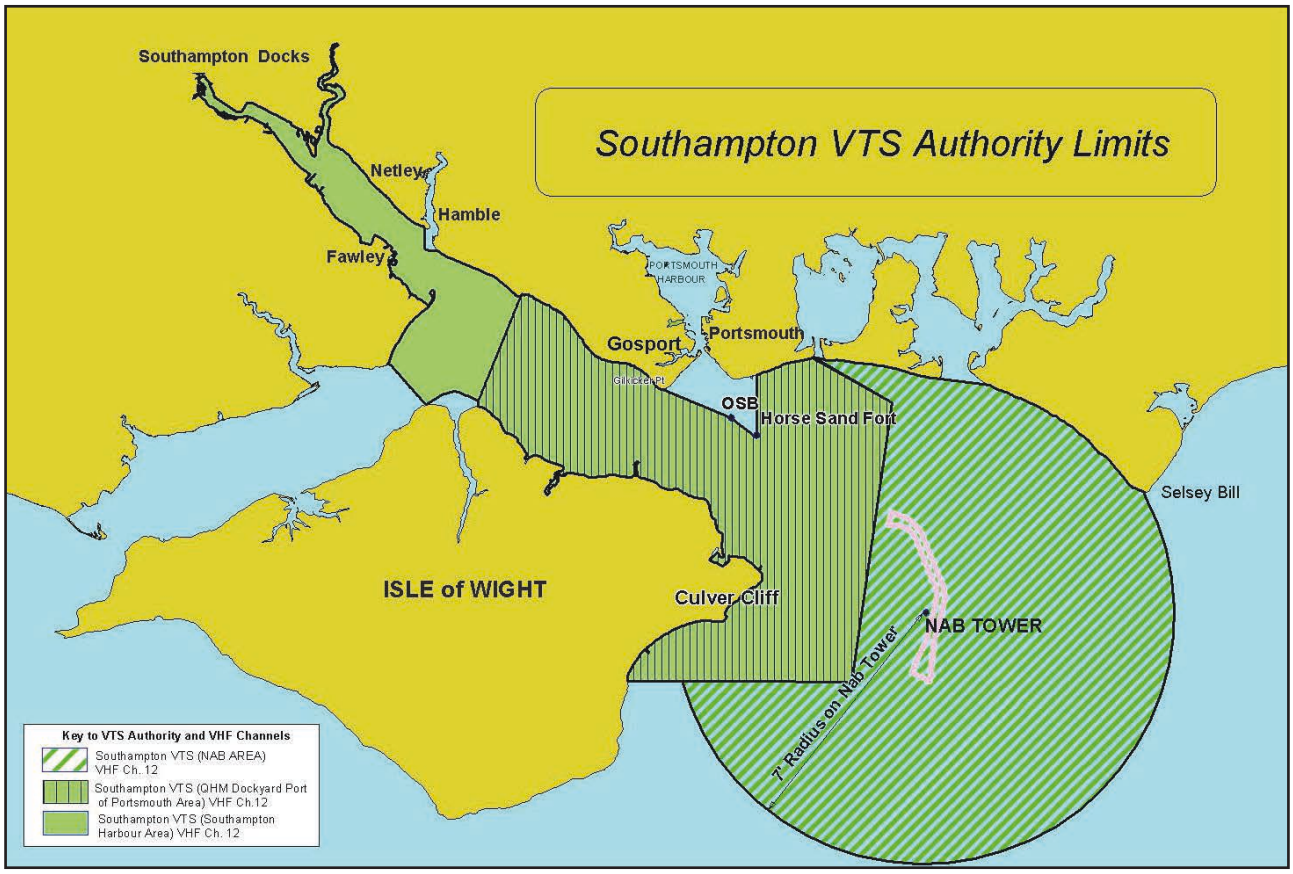

Figure 13: Southampton VTS area

1.6.2 Safety management

ABP Southampton operated a safety management system (SMS) based on the UK Government's Department for Transport (DfT) non-mandatory Port Marine Safety Code (PMSC). The PMSC was introduced by the DfT in 1996 with the aim of improving safety standards across all UK ports. It was administered on behalf of the DfT by the Maritime and Coastguard Agency (MCA).

To comply with the PMSC, port authorities had to:

- *Ensure all risks are formally assessed and as low as reasonably practicable in accordance with good practice.*
- *Operate an effective marine safety management system (SMS) which has been developed after consultation and uses formal risk assessment.*
- *Use competent people (i.e. trained, qualified and experienced) in positions of responsibility for safety of navigation.*

Once a port had implemented the requirements set out in the PMSC through its SMS, it could formally declare itself compliant with the Code by submitting a return to the MCA. In 2016, there were about 450 statutory ports in the UK, of which 152 had declared compliance with the PMSC.

ABP had declared the Port of Southampton compliant to the PMSC and its appointed Designated Person had carried out regular audits to verify continued compliance. The designated person's last audit before the accident had been conducted on 27 and 28 June 2016.

ABP Southampton's SMS contained a suite of risk assessments for its general port operations ashore and afloat. Its risk assessment titled *Grounding: Solent – Piloted - Non-Hazardous* **(Annex C)**, considered the most likely scenario to be:

> *Vessel grounds in fair weather, no significant damage and refloats on next tide. No injuries, no (or very minor) pollution, no impact on port operations.*

The risk assessment described the worst credible scenario as:

> *Large vessel grounds leading to multiple slight injuries. Major structural damage to vessel, major pollution, serious adverse publicity, and financial impact on the port.*

Likely causes included: adverse tide, current and weather, inadequate bridge resource management (BRM), human error ship's crew and/or pilot, unclear master/pilot information exchange, and failure to follow the passage plan, special directions and standing notices.

The list of controls to mitigate the risk included: BRM training, passage planning (pilot and VTS), pilotage directions and notices to mariners, pre-arrival information (port to ship).

The risk assessment was reviewed following the grounding of the container vessel *APL Vanda* in the Precautionary Area on 13 February 2016. Following the review, the port undertook to review the guidance and instructions for container ships in its Port Users Information and Navigation Guidelines **(Annex D)**.

1.6.3 Vessel Traffic Services

Southampton VTS provided an *Information* and *Traffic Organisation Service* for all vessels over 20m in length. The aim of the service was to prevent the development of dangerous maritime traffic situations and to provide for the safe and efficient movement of vessel traffic within the VTS area **(Figure 13)**.

Traffic Organisation Services are concerned with, for example:

- forward planning of vessel movements
- congestion and dangerous situations;
- the movement of special transports;
- traffic clearance systems;
- VTS sailing plans;
- routes to be followed; and
- adherence to governing rules and regulations.

All VTS officers in Southampton were qualified to the V-103 competency standards[8] set out by the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) in the IALA VTS manual.

1.6.4 Pilots and pilotage

ABP Southampton was the competent harbour authority for the Port of Southampton and pilotage was compulsory within its pilotage limits for all vessels of 61m or more in length. The pilot boarding point for inbound ultra-large container vessels such as *CMA CGM Vasco de Gama*, was 4nm south of the Nab Tower, and the passage to the berth typically took about 3.5 hours. In August 2016, ABP Southampton employed 47 pilots and provided a 24-hour service 7-days a week. Its pilots worked to set shift patterns and typically performed three acts of pilotage during each 24-hour duty period.

The two pilots who boarded *CMA CGM Vasco de Gama* were British nationals and each held a Class 1 Unrestricted pilot's licence. The lead pilot was 54 years old and had been employed by the ABP Southampton for 16 years. The assistant pilot was also 54 years old and had been employed by the ABP Southampton for 14 years.

The pilots started their 24-hour shift at 0800 on 21 August 2017; *CMA CGM Vasco de Gama* was the lead pilot's second pilotage act of the shift and the assistant pilot's first. The lead pilot's first act of the shift, on board an outbound passenger ship, started at 1630 and ended at 2000.

1.6.5 Pilot training, licensing and professional development

To become a licensed pilot for Southampton, candidates had to complete a structured training schedule and skills development programme **(Annex E)**. The skills development programme included the conduct of acts of pilotage on a variety of vessels under the close supervision of experienced licensed pilots. This practical pilotage training was supplemented by the use of simulation, both computer and manned model, and self-directed learning.

[8] IALA recommendation V-103 on Standards for Training and Certification of VTS Personnel – model courses: V-103/1 VTS Operator Training; V-103/2 VTS Supervisor Training; V-103/3 VTS On-the-Job Training; V 103/4 VTS On-the-Job Training Instructor; and V-103/5 The Revalidation Process for VTS Qualification and Certification.

Trainee pilots would expect to become a Lower 2nd Class pilot after 3 months following theoretical and practical assessments. Initially, pilots holding the Lower 2nd Class licence were authorised to work on vessels up to 110m in length; after 6 months, the vessel length restriction was increased to 140m. The port's pilot training schedule and internal examination process was designed to enable Lower 2nd Class pilots to progress on to larger vessels and gain Class 1 Unrestricted licences after 5 years. Once pilots had attained the Class 1 Unrestricted status, they were expected to complete simulator training at intervals of approximately 3 years, but were no longer subject to onboard practical assessment.

In 2012, *CMA CGM Vasco de Gama*'s lead pilot and three other ABP Southampton pilots attended a 4-day ship-handling seminar at the CMA CGM Group headquarters in Marseille. The objective of the seminar was to prepare the pilots and the vessel masters for the arrival of CMA CGM's newest 13,800TEU vessels to Southampton. During the seminar, the pilots conducted several inbound and outbound passages on the company's bridge simulator. The training exercises simulated varying conditions and included emergency situations and abort manoeuvres.

1.6.6 Specialist pilotage groups

ABP Southampton had specialist pilotage groups for tankers, container vessels and cruise ships that Class 1 Unrestricted pilots could apply to join. The two pilots on board *CMA CGM Vasco de Gama* when it grounded were both members of a container vessel specialist group. The lead pilot had been a member of this group for 10 years, and the assistant pilot for 4 years.

CMA CGM Vasco de Gama had visited Southampton several times and both pilots were familiar with it and the other Explorer class vessels.

1.6.7 Pilotage of ultra-large container vessels

In accordance with Southampton's Pilotage Directions, all container vessels with a length overall of 365m or greater, and/or a beam of 45m or greater were required to carry two pilots: a lead and an assistant. Both pilots were required to be part of the container specialist group.

The use of an assistant pilot was originally identified as a safety control measure by ABP Southampton in its risk assessment for navigating and berthing tankers. This was subsequently applied as a risk control measure for the pilotage of ultra-large container vessels.

For container vessels, the two assigned pilots decided their pilotage roles between themselves prior to boarding. Typically, one pilot would take the lead for the passage from the pilot boarding point to a position adjacent to the Fawley Oil Terminal; the other took the role of the assistant. They would then switch roles, with the assistant pilot taking the lead for the remainder of the passage and for the berthing manoeuvre.

This assignment and change of pilotage roles was not documented within the ABP Southampton SMS, nor were the duties, responsibilities and expectations of the assistant pilot role.

1.7 THE BRAMBLE BANK TURN

1.7.1 General

The turn around Bramble Bank into the Thorn Channel was known to be difficult for large vessels, particularly when inbound. It involves two substantial course alterations: one to port abeam of the Prince Consort buoy of up to 40° and one to starboard, close to the Gurnard buoy, of about 140° **(Figure 14)**. The prevailing winds in the Solent are typically south-westerly and there is a significant tidal stream direction and rate change at the southern end of the Thorn Channel Precautionary Area. For ultra-large container vessels, the turn was typically undertaken at a speed of between 10 and 12kts.

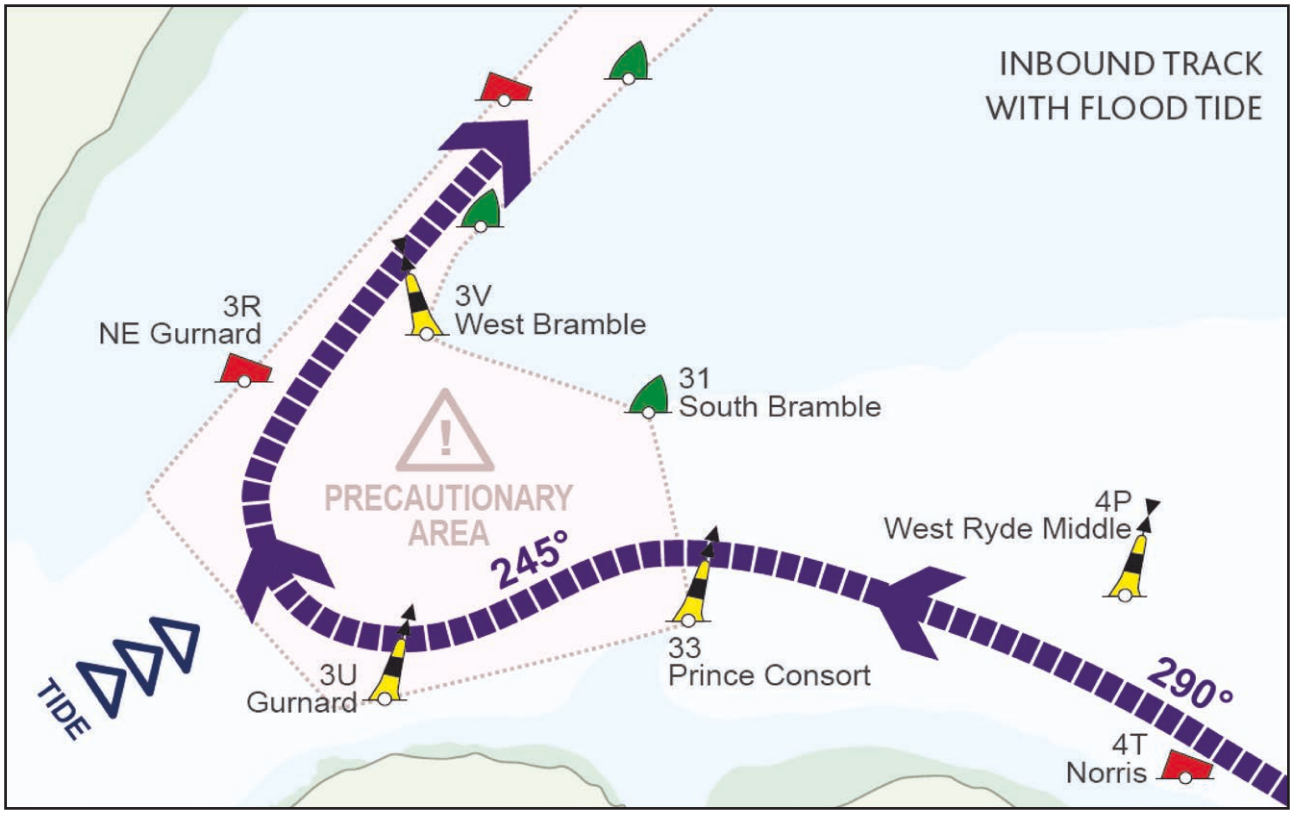

Figure 14: Execution of the Bramble Bank turn

Before the most recent generation of ultra-large container vessels was scheduled to arrive in Southampton, ABP undertook studies to assess the pilotage risks involved. Based on the outcomes of the studies, the port put specific controls in place to minimise the risk. The controls included:

- The carriage of two pilots
- Transit during daylight hours only and at slack water
- Use of escort tugs
- Use of PPUs
- Maximum wind speed of 15kts at the berth

- Use of additional tugs during berthing

- No passenger ships on the Mayflower Cruise Terminal in Southampton docks (limitation removed following dredging operations).

Many of these controls and limitations were relaxed over time as the port gained confidence based on experience and knowledge of the vessels' handling characteristics and manoeuvrability. Of note, the daylight hours and tidal restrictions were removed and escort tugs were no longer required.

1.7.2 Precautionary Area

The Thorn Channel Precautionary Area was defined as the area between the Hook buoy and the Prince Consort buoy **(Figure 4)**, and all vessels greater than 220m length overall were required to be given a clear and unimpeded passage ahead when transiting through it. In addition, the Southampton Port Users Information and Navigational Guidelines explained that:

> *c) Two vessels each having a length of 180m or greater shall not pass or overtake each other between Hook Buoy and a line drawn due south of West Bramble Buoy.*
>
> *g) The Pilot and Duty VTSWM[9] should ensure that when passage planning, due allowances are made for the vessel to be able to safely turn at the West Bramble taking into account sufficient reserve of speed in the prevailing weather and traffic conditions.*

As vessels entering Southampton became larger, it was recognised unofficially by the port's pilots that vessel passes needed to be performed further east than the requirement stipulated in the Port Users Information and Navigational Guidelines. This became known locally by the pilots as a *PC pass*; where PC is the Prince Consort buoy.

Guidance on the use of the Precautionary Area, particularly by larger vessels, was provided by the port in its Notice to Mariners No.03 of 2016: *Port of Southampton – Precautionary Area (Thorn Channel)*. The notice included specific guidance on the typical inbound tracks to take for varying tidal conditions **(Figure 15)**. For a flooding tide the notice advised that:

> *…in vicinity of the Prince Consort buoy, the ship will make a substantial alteration to port, of up to 40 degrees to the southwest towards Gurnard buoy, in order to give the maximum turning area into the Thorn Channel. The turn to starboard may not be commenced until the ship is very close to or just passed Gurnard buoy…*

For an ebbing tide, the guidance said:

> *…the ship will be set to the west in the turn and thus the turn to starboard into The Thorn Channel will commence much earlier and as much as 4 – 5 cables from Gurnard buoy.*

[9] Vessel Traffic Services Watch Manager

For the purpose of indicating the presence of the MPZ the master of any vessel of **over 150 metres length overall** shall display on the vessel, where it can best be seen, by day, a black cylinder, and by night, 3 all round red lights in a vertical line.

Chartlet 1

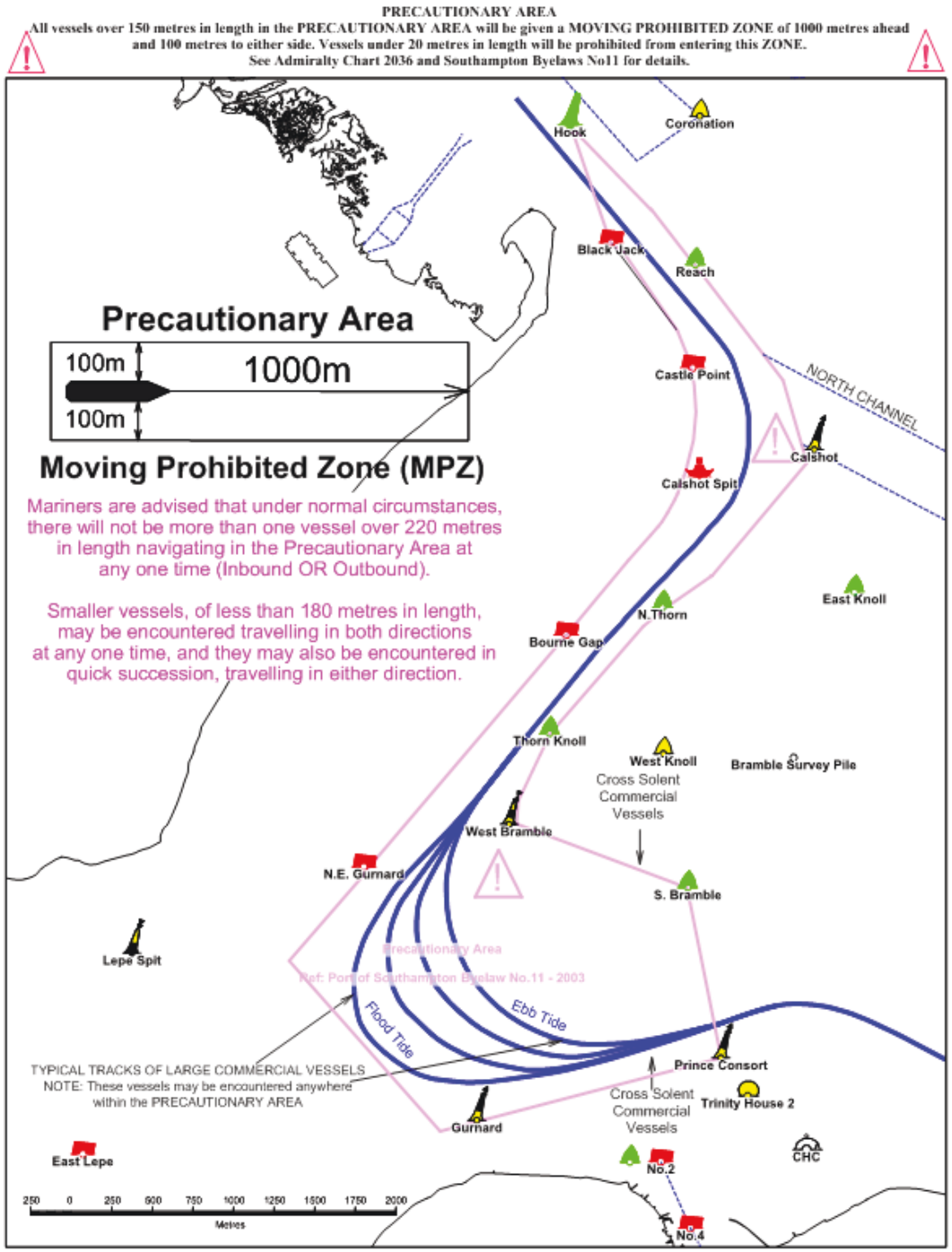

Figure 15: Typical tracks of large container vessels illustrated in ABP Southampton's Port Users Information and Navigational Guidelines

Similar guidance was also available in the Southampton Port Users Information and Navigational Guidelines and on Admiralty Chart 2036 **(Figure 4)**.

CMA CGM Vasco de Gama's course alteration to port in the vicinity of the Prince Consort buoy was about 30°. It was achieved over a 4-minute period by the lead pilot ordering the helmsman to steer successive courses of 280°, 270° and 260°. During the execution of his orders, the helmsman applied a maximum of 10° port helm to achieve an average ROT of about 10° per minute. *CMA CGM Vasco de Gama* was about 3.8 cables to the north of the Gurnard buoy when the course alteration to starboard was initiated.

1.7.3 Rate of turn

The ROT that a vessel can achieve is determined by its design characteristics **(Figure 16)**, its speed, and angle of the rudder. ROT is affected by environmental conditions acting on the vessel such as strength and direction of wind and tidal stream. The amount of this effect is governed by the volume of the hull, superstructure and deck cargo above the water, and the volume of the vessel underwater. For example, a large deep draught tanker will be less affected by windage than a large fully loaded container vessel.

Additionally, the ROT is affected by the depth of water under the keel. The smaller

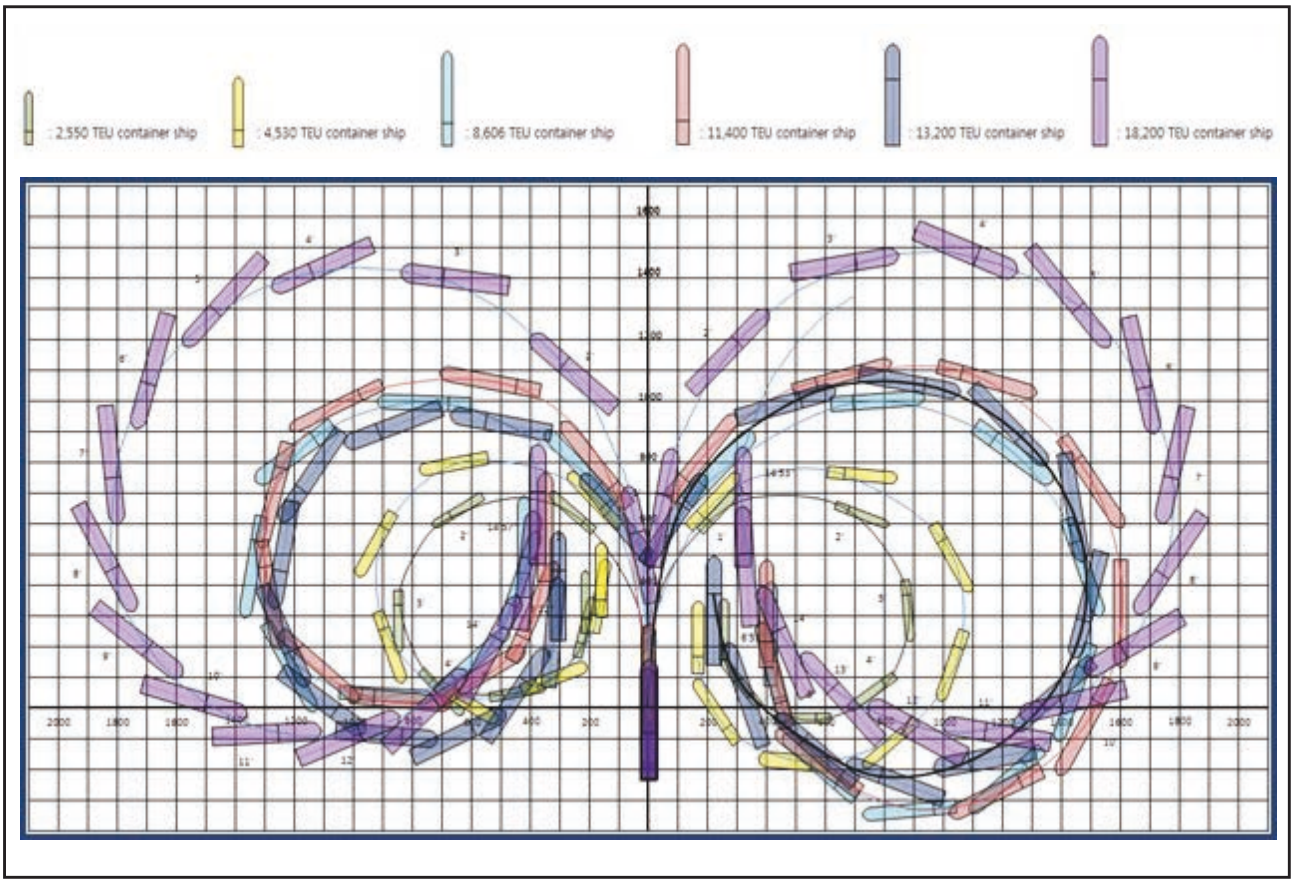

Figure 16: Illustration of typical turning circles of various sized container vessels

the under keel clearance (UKC), the greater the interaction effect with the seabed, which reduces the ROT and therefore increases the turning circle diameter.

1.7.4 Abort points

The Southampton Port Users Information and Navigational Guidelines described circumstances when the passage of a large container vessel would be aborted. It further detailed the requirement for the abort points to be part of the passage plan agreed between the master, pilot and VTS.

Abort points were not discussed on board *CMA CGM Vasco de Gama* during the master/pilot information exchange (MPX) and were not documented in the passage plan.

1.7.5 Simulation

Prior to the arrival of the Explorer class of vessels in Southampton, several of the port's specialist container group pilots visited the CMA CGM Group headquarters in Marseille to receive simulator training. As the Explorer class hull had not yet been modelled into the company simulator, the pilots used a similar vessel model to conduct ship-handling and manoeuvring trials. The results of the simulations were shared with the port's management team and the other specialist container vessel pilots.

1.8 POST-GROUNDING SIMULATED MANOEUVRING TESTS

After the grounding, MAIB inspectors attended the CMA CGM Academy's bridge simulator training centre in Marseille and witnessed several simulated manoeuvring tests. The aim of the tests was to establish if *CMA CGM Vasco de Gama* could have been safely navigated into the Thorn Channel from its start position on passing the outbound *Cap Hatteras*. To do this, *CMA CGM Vasco de Gama*'s loaded condition and the prevailing environmental conditions at the time of the grounding were programmed into the simulator.

Initially, the CMA CGM simulator staff carried out the same course and speed changes as the lead pilot; the outcome was the same, with the vessel grounding. Several different test scenarios were then run to establish the likely outcomes if the course, speed and wheel over points had been different. The test results clearly showed that *CMA CGM Vasco de Gama* would have made the turn into the Thorn Channel if the vessel had been brought further to the south and closer to the Gurnard buoy before initiating the course alteration to starboard.

The training academy report made a number of recommendations based on the simulator test results. These included:

- *The Passage Plan to be forwarded to the inbound ship at least 2 hours before pilot boarding time with indications of traffic, tidal condition, UKC calculation at each key point, with expected ship's speed all along the passage.*

- *With an appropriate briefing, Pilot to be introduced and included to the bridge team with assertiveness of each one of the actors having to share the passage including a comprehensive communication of elements to know and consider for a safe passage.*

- *(to be discuss with pilots): A good positioning of the ship prior to come to starboard in the precautionary area towards the channel entrance is paramount.*

- *This is why the NRP (Non Return Point) has to be determined with the pilot. A CONTINGENCY PLAN should be kept in mind and practicable prior to reach this NRP.*

- *A dedicated Solent ship handling training support could be put in place by the company to reinforce the support to masters and officers.*

- *ECDIS functionality optimization training. During the meeting we have observed a display configuration of the ECDIS from the VDR showing too much information. We suggest:*
  - To set the wheel over position (WOP) for each waypoint,
  - Analyze the ROT given by the passage plan on the ECDIS,
  - To use the safety parameters in order to emphasize the four shaded color pictures with dedicated setting of safety and deep contours,
  - A permanent use of safety frame. [sic]

1.9 PASSAGE PLANNING

1.9.1 General

Prior to proceeding to sea, masters are required[10] to ensure that the intended voyage has been planned using appropriate nautical charts and nautical publications for the area concerned, taking into account the guidelines and recommendations developed by the IMO. The IMO's guidelines and recommendations were set out in its Resolution A.893(21) – *Guidelines for Voyage Planning*.

The IMO guidelines explained the importance of voyage or passage planning and the continuous monitoring of the vessel's progress and position during the execution of the plan from berth to berth. The guidelines described the passage planning process in four key stages: appraisal, planning, execution and monitoring.

More detailed information and guidance on passage planning was provided by the International Chamber of Shipping (ICS) in its *Bridge Procedures Guide (fifth edition)* (ICS Guide). The ICS Guide stated[11] that:

> *The purpose of passage planning is to develop a comprehensive navigation plan for the safe conduct of the ship from berth to berth.*
>
> *The four stages to achieve a safe passage plan are:*
>
> 1. ***Appraisa**l – 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*

[10] SOLAS Regulation 34 – Safe Navigation and Avoidance of Dangerous Situations

[11] Chapter 2 section 2.1

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 ICS guide talked about planning for the ocean, coastal and pilotage phases of a passage. It acknowledged that it might be impractical to include all details in the passage plan prior to departure, particularly some of those relating to arrival, but emphasised the need for the plan to be finalised as soon as practicable. The guide went on to explain[12] that:

> *Appraisal and planning of a berth to berth passage plan should include the completion and approval by the Master of a pilotage plan. The pilotage plan may not be complete until after the Master/Pilot information exchanged (MPX) has taken place.* [sic]

Key considerations for the pilotage plan included:

- planned track with true course
- safety depths and safety contours[13]
- safe water
- decision points for critical manoeuvres
- contingency plans
- wheel over positions and turn radius for each course alteration.

The ICS guide also contained additional detailed guidance on bridge resource management and the role of the OOW.

1.9.2 Company passage planning policy and guidance

The passage planning guidance **(Annex F)** provided in the vessel's bridge manual was similar to that contained in IMO Resolution A.893(21) and the ICS Guide. The bridge manual also contained guidance and checklists for pilotage management **(Annex G)**.

CMA CGM Vasco de Gama's berth to berth passage plans were typically produced by the navigating officer. They would be validated by the master, signed by all deck officers and briefed prior to departure. The passage plan would also be loaded onto dedicated software that would allow it to be viewed by routing operators and management staff in CMA CGM Group headquarters.

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[12] Chapter 5 section 5.2.1

[13] Safety depth and safety contour are both depth parameters. The safety depth is set based on vessel draught and required UKC. The Safety contour can be set at the next available contour within the chart construction to declutter and highlight danger areas, and is used to generate alarms and warnings against the planned and monitored route. The safety contour cannot be set less than the safety depth.

ECDIS was the primary means of navigation, but because the vessel was on a liner service between regular ports of call, passage routes between these ports had been created and stored within the ECDIS. Routes were selected by the navigating officer from the pre-existing list and not newly created for each passage.

In accordance with company policy, paper charts were used as the official back-up, therefore the berth to berth passage plan created on the ECDIS was replicated on appropriate paper charts.

The purpose of the company's pilot management guidance was to help organise the integration of the pilot(s) into the bridge team, standardise the information exchange and set effective communication rules on the bridge. The company guidance described three pilotage conning methods:

1. *OOW with pilot recommendations under master supervision*.

2. *Master with pilot recommendations*.

3. *Pilot under master supervision*.

Prior to boarding a pilot, the bridge team were required to be familiar with the vessel's provisional pilot to berth passage plan (pilotage plan). The master was required to present his plan to the pilot(s) and, having considered the advice given during the MPX, agree the final pilotage plan and brief it to the bridge team. The agreed pilotage plan should include contingencies such as possible abort points and safe grounding areas in case of unforeseen events such as machinery breakdowns.

To assist in the preparation of pilotage plans, CMA Ships also provided its fleet with port cards containing information related to the safe entry, passage, berthing and stay alongside a port. The port cards had been developed by the company's masters and were regularly updated. The port card for Southampton **(Annex H)** was available for reference on board.

The port card stated that *CMA CGM Vasco de Gama*'s point of no return for entering Southampton was 1.5nm south of the Outer Nab No.1 buoy. It also identified the Solent's 'C' anchorage **(Figure 4)** as the vessel's final abort point prior to entering the Thorn Channel Precautionary Area. The port card contained the following warning and guidance for the Bramble Bank turn:

> *Approach to the Thorn Channel and in Precautionary area when turning must be performed with maximum precaution.* [sic]
>
> *…to enter the Thorn Channel is starting abeam or a bit before Gurnard buoy with aprx. speed of 10kts and ROT 20 depending on current set. With Ebb tide track should be kept more north and with Floodtide more south (see 11). Before arriving at turning point, Pilot orders the Pilot Escort Boat to run ahead 6 cbls, helping pilot for best turn and clearing channel from other small craft and pleasure boats.* [sic]

On pilotage, the port card assessment of the Southampton pilots was that they were very experienced and provided a good service with a lot of information regarding the safety of navigation through the Solent, Thorn Channel and harbour approach.

1.9.3 *CMA CGM Vasco de Gama*'s Algeciras to Southampton passage plan

CMA CGM Vasco de Gama's Algeciras to Southampton berth to berth passage plan was prepared prior to the vessel's departure. The plan **(Annex I)** was verified by the master and signed by all the vessel's deck officers on the evening of 18 August 2016. The pilot boarding to berth section of the plan was 32nm long and comprised 23 legs, two of which covered the Bramble Bank turn.

The waypoints for the pilot boarding to berth plan were programmed into the vessel's ECDIS and plotted on the paper charts. The track through the Precautionary Area was automatically plotted between the waypoints by the ECDIS computer, based on parameters set within the ECDIS programme, selected wheel over points and defined turning radii **(Figure 17)**. The track on the paper chart was plotted by drawing straight lines for the legs between the waypoints **(Figure 18)**. The course for the first leg was 273° and for the second was 037°. The waypoints and tracks plotted on the ECDIS and paper charts were not altered prior to or during the pilotage and the pilotage plan did not identify decision points for critical manoeuvres.

1.9.4 Electronic Chart Display and Information System passage plan set-up

The guidance on passage planning and navigation with ECDIS provided in the CMA Ships' bridge manual, explained that electronic charts should be marked in a similar way to paper charts, to identify radar conspicuous targets, no go areas, parallel index lines, transit marks, clearing bearings etc. The guidance also emphasised the importance of ensuring the ECDIS alarm functions were fully operational and would alert the operator to any dangers in good time. The ECDIS parameters and alarm settings discussed in the manual included: safety contour and safety depth, ship look ahead sector, track monitoring and dangerous targets. The bridge manual required that track limits[14] were set to a reasonable size and adjusted for each leg.

A *preparation for arrival* checklist **(Annex J)** was completed by *CMA CGM Vasco de Gama*'s 8 to 12 OOW and countersigned by the master prior to the vessel's arrival at Southampton. The checklist indicated that all mandatory alarms had been set in ECDIS, the parallel index had been set on the radar and the cross-track error had been set to 0.5nm. The track limits were not adjusted for each leg of the pilotage section of the passage. When the vessel grounded, it had not gone outside the set permissible track limits **(Figure 19)** and no ECDIS alarms sounded.

The ECDIS units had three display modes: *base*, *standard* and *full*. When in *full* mode, the user was able to customise the display by application of user defined settings. This could reduce the amount of information presented. The bridge manual explained that the *base* mode provided the absolute minimum level of information and that the *full* mode displayed all the information contained in the electronic chart. The bridge manual warned that the amount of data contained in the *full* mode tended to overload the screen and recommended that the *standard* mode be used for navigation. *CMA CGM Vasco de Gama*'s ECDIS units were set to the *full* mode with few user defined settings applied, and the two-colour option selected.

[14] The track limit is the corridor either side of the intended track, at a distance set by the user, which marks the limit of safe navigation and, if exceeded, triggers a warning alarm and message. It is also known as 'cross-track error'.

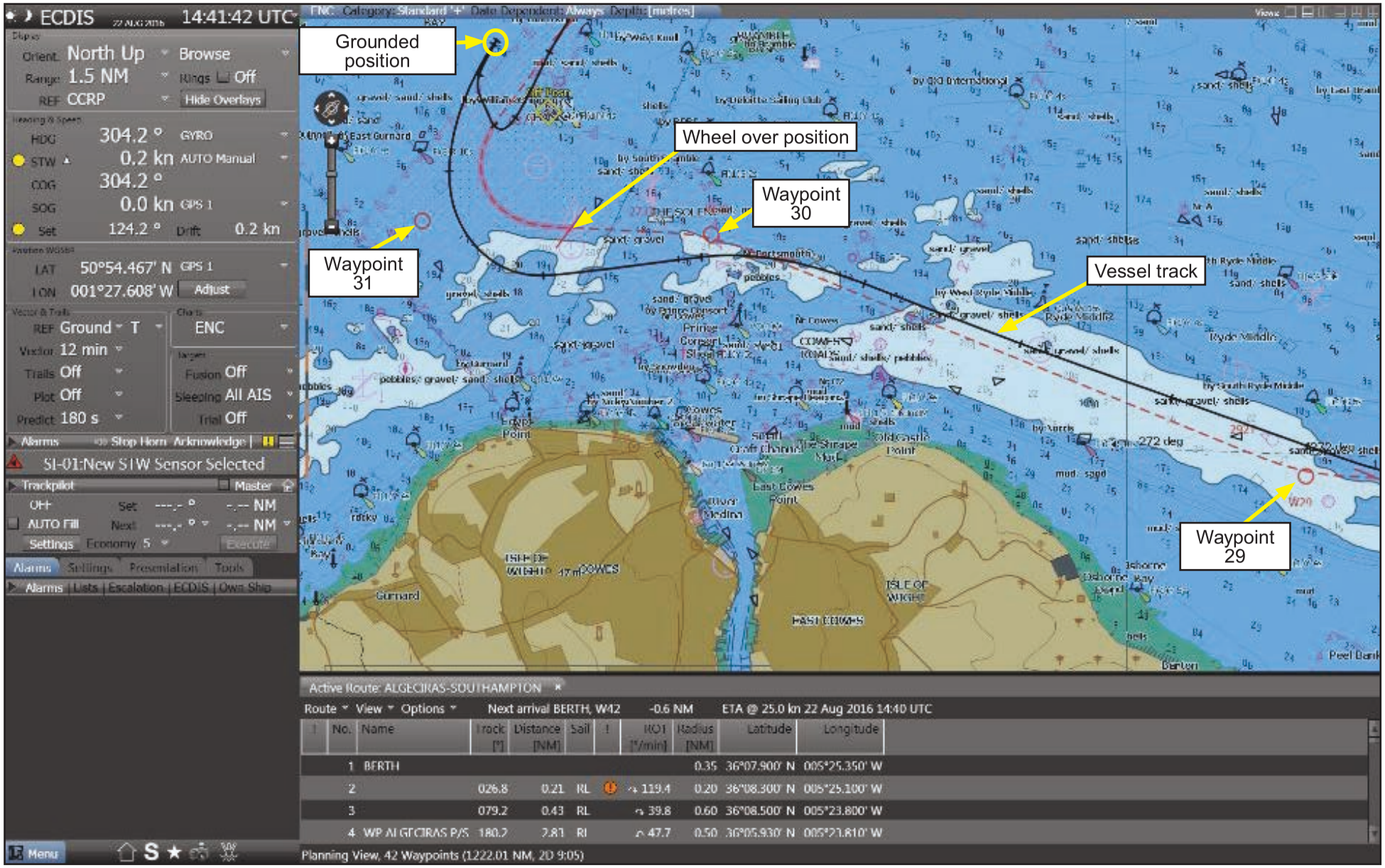

Figure 17: ECDIS screen display at time of grounding

Figure 18: *CMA CGM Vasco de Gama*'s pilotage plan plotted on its paper chart

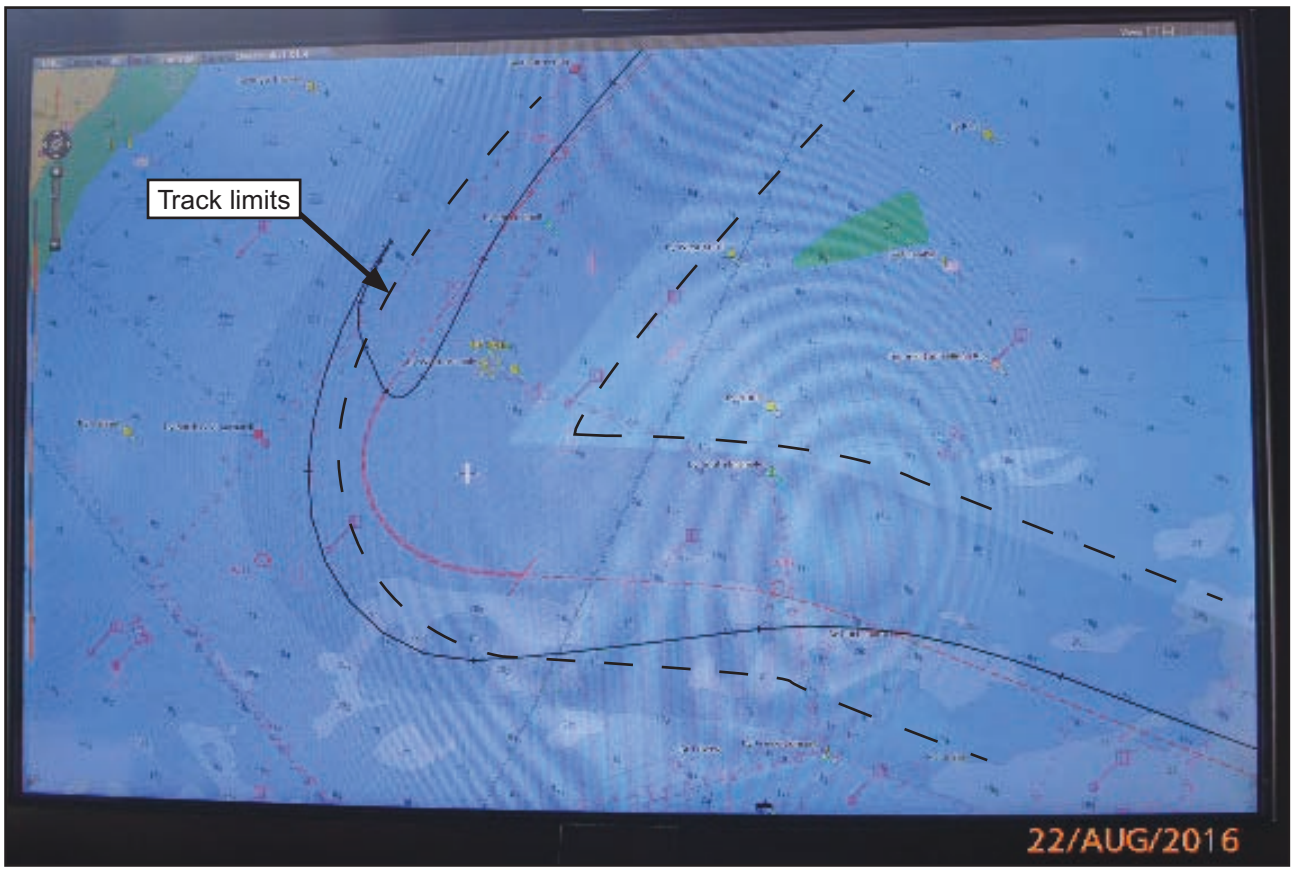

Figure 19: ECDIS track limit settings

1.9.5 Southampton port passage planning

The Southampton port passage plan consisted of two documents: the Part 1, *passage plan* form **(Annex A)** and the Part 2, *passage information* leaflet **(Annex B)**. The Part 1 passage plan form was a single page, A4 size pre-printed multi-copy document that included tabulated boxes for the pilots to manually enter vessel and passage specific information, such as UKC, passage times and tidal conditions. It was usual for the pilots to have completed most of this form prior to boarding the vessel. Copies of the completed form were given to the master and the VTS, and a copy was retained by the pilot.

The Part 2 passage information leaflet provided a fold out plan of the pilotage area, with information displayed within. This included indicative tracks for large vessels to follow though the Precautionary Area **(Figure 15)**. The leaflet had sections for the pilots to complete for both inbound and outbound passages. The Part 2 passage plan leaflet was not designed to be used for navigation, but to be used as a discussion document between pilot and master once the pilot was on board.

The Part 1 passage plan form included a declaration that the port's passage plan Parts 1 and 2 had been discussed and agreed. Both pilots completed a Part 1 passage plan form. The assistant pilot completed most of his form prior to and during the MPX. The lead pilot did not complete his Part 1 form prior to boarding; instead, he used it to log the vessel's position as it transited through the Solent. This was typical practice for the lead pilot. The lead and assistant pilots' passage plan forms were signed by the master and the pilots once the vessel was alongside.

1.9.6 Portable Pilot Unit

ABP Southampton had five *ADX XR* PPUs **(Annex K)**. They were manufactured by AD Navigation SA in Norway and were used by Southampton's pilots to provide enhanced positional accuracy for manoeuvring and berthing ultra-large container vessels and tankers. The PPU's electronic chart system operated independently of the vessel's navigation systems, with its positional and directional data being provided by three wireless pod units. A dedicated correction signal transmitted from the port allowed the PPU to provide position accuracy to within a few centimetres.

When the pilots boarded a vessel, it was typically the role of the assistant pilot to set up the PPU. This involved positioning the pod units around the bridge, inputting the vessel's dimensions and characteristics into the PPU laptop and selecting the pre-set route to be followed. Once this was done, the selected route and the vessel's course, speed, ROT and predicted track (lookahead) were displayed on the electronic chart. The pilotage track was automatically saved for each passage **(Figure 20)**.

When ABP Southampton purchased the PPUs in 2012, it provided three 2-day training sessions for all pilots. The training was delivered by pilots from Rotterdam and Antwerp. In addition to the training, the port provided instruction cards with a help manual available within the programme. The pilots were expected to engage in self-directed learning to become proficient at operating the system.

The PPU's electronic chart system contained two pre-set routes: *Southampton In* and *Southampton Out.* Advanced user rights were needed to create new routes and to alter the alerts and alarms that were displayed. The pilots on board *CMA CGM Vasco de Gama* could adjust some settings but they did not have advanced user rights; the pre-selected routes had never been changed and the PPU safety parameters had not been altered from their original factory settings.

1.10 BRIDGE RESOURCE MANAGEMENT

1.10.1 General

The essence of bridge resource management (BRM) is a safety culture and management approach that facilitates communication, co-operation, and coordination among the individuals involved in a vessel's navigation. Its focus is the effective management and utilisation of all available resources, both human and electronic, by the navigational watch team to ensure the safe navigation of the vessel.

The ICS Guide provided detailed guidance on effective bridge organisation and BRM, and emphasised that:

> *An effective Bridge Team will manage efficiently all the resources that are available and promote good communication and teamwork*[15]

CMA CGM Vasco de Gama's bridge procedures manual also contained instructions and guidance to help promote BRM.

[15] ICS Bridge Procedures Guide section 1.1

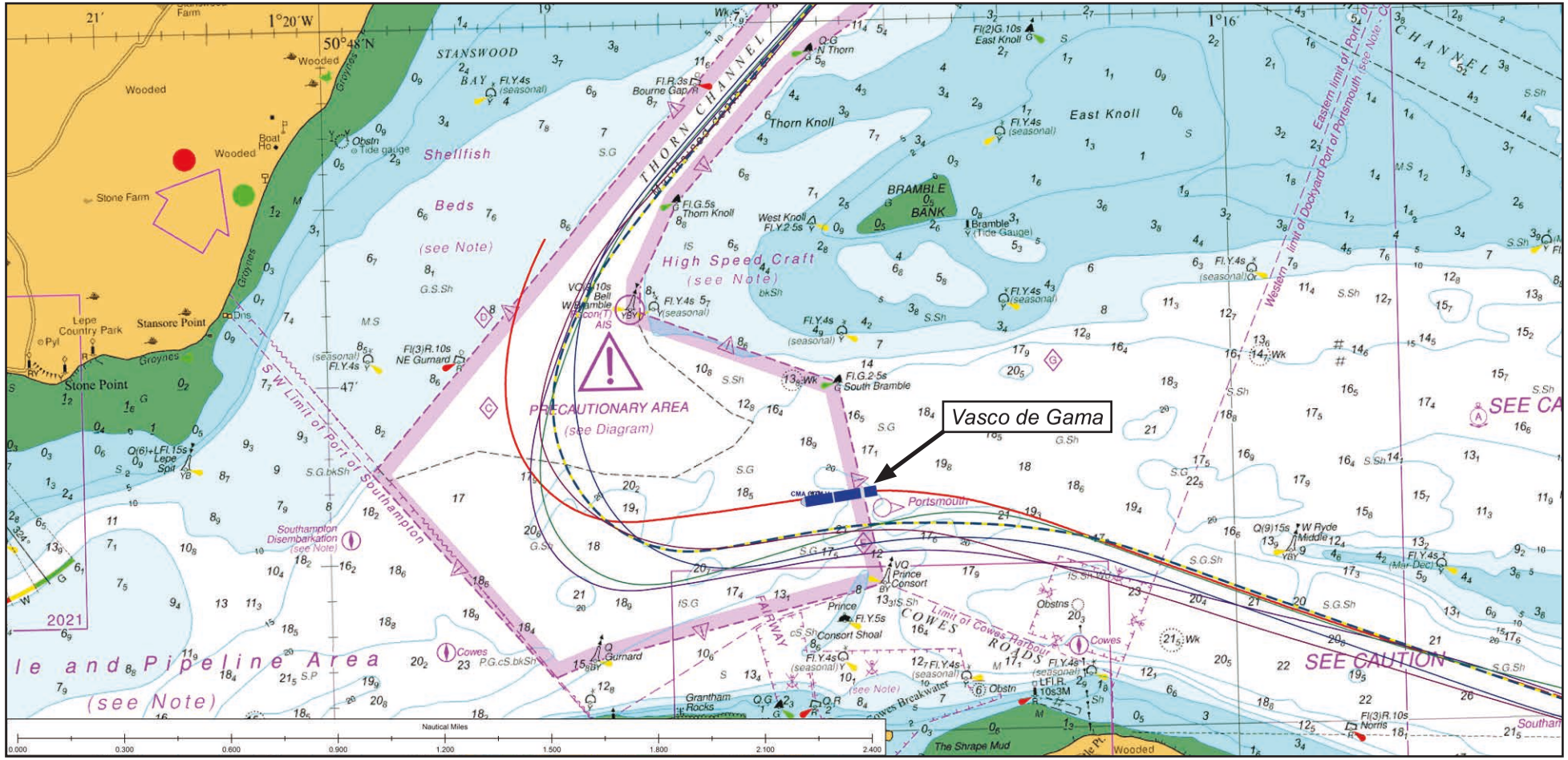

Figure 20: Tracks recorded on the PPU for the execution of the lead pilot's previous transits through the Precautionary Area on board Explorer class vessels

1.10.2 Working with a pilot

The bridge card for pilotage management contained in *CMA CGM Vasco de Gama*'s bridge manual was intended by CMA Ships to facilitate the integration of pilots into the bridge team, standardise information exchange and set effective communications rules on the bridge. The bridge card also explained that a pilot's presence on board did not absolve the master or the OOW from their duties and obligations for the safety of the vessel or pollution prevention.

The ICS Bridge Procedures Guide provided a diagrammatic example **(Figure 21)** of the lines of communication and roles and responsibilities of the bridge team when a pilot is on board. The ICS guide also stated that:

> *effective coordination between the master, other members of the bridge team and the pilot is a prerequisite to safe pilotage.*

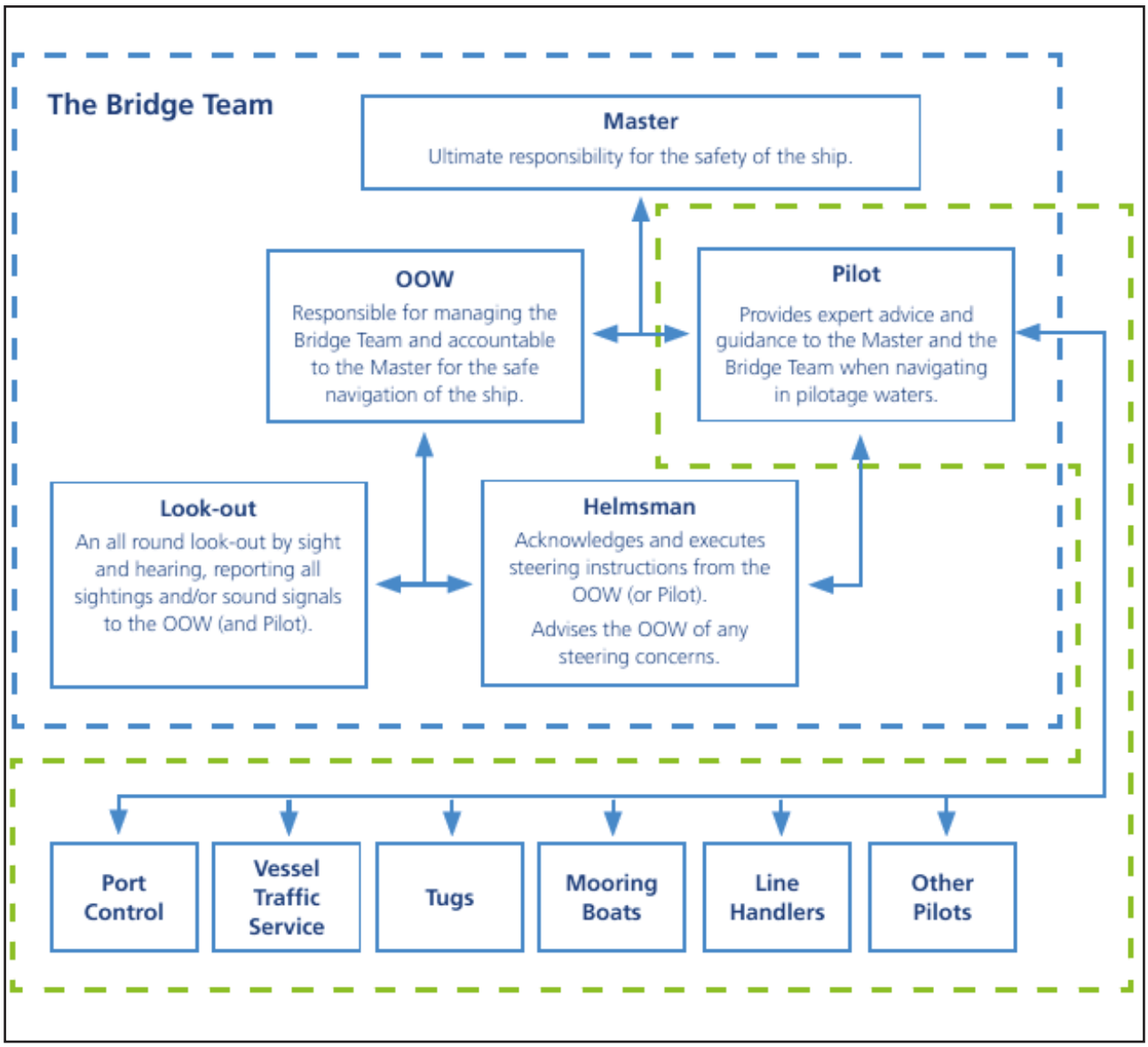

Figure 21: ICS guidance on the roles and responsibilities of the bridge team when a pilot is on board

An article published by the Nautical Institute in its *Seaways* magazine in October 2016, based on a presentation delivered by two Southampton pilots, also emphasised the importance of effective teamwork between the vessel's bridge team and embarked pilots. The article explained that:

> *The piloting and manoeuvring of the largest vessels in Southampton begins and ends with teamwork. The teamwork required to schedule and prepare for the ship's arrival; and the teamwork both on board the ship and with other port services during the vessel's passage through the harbour area, (VTS, tugs, linesmen etc.). The pilot is in a unique position, being an integral part of all these teams.*

1.10.3 Master/pilot information exchange

CMA CGM Vasco de Gama's bridge manual contained detailed requirements for the MPX in its various procedures. The pilot management bridge card **(Annex G)** stated that:

> *On pilot arrival on the bridge the Master must lead a briefing with the Pilot addressing the following points:*
>
> - *Bridge team management during the passage:*
>   - *Duties and responsibilities of the Master;*
>   - *Duties of the Pilot;*
>   - *Duties of the OOW;*
>   - *Duties of the OOWA[16] (if applicable);*
>   - *Coning method: OOW with Pilot recommendations under Master supervision / Master with Pilot recommendations / Pilot under Master supervision;* [sic]
>   - *Use of English language on the bridge, use of SMCP[17];*
>   - *Language with external radio stations (Tugs, VTS, Line handlers…). If not English, the Master must make clear with the pilot he will be explained all orders in advance.*
> - *Presentation and Signature of the Pilot Card;*
> - *Unusual ship-handling characteristics, machinery difficulties, navigational equipment problems or crew limitations that could affect the operation, handling or safe manoeuvring of the ship;*
> - *Any impacting Company Regulation (e.g: UKC policy, Port Card Company regulation…)*

[16] OOWA – officer of the watch assistant

[17] SMCP – Standard Marine Communication Phrases. Adopted by IMO resolution A.918(22)

The level of information expected from the pilot by CMA Ships included the presentation of a *pilot passage and manoeuvring plan*. Taking the pilot's suggested plan and the vessel's provisional pilotage plan into account, the master was expected to agree a final plan and brief it to the bridge team prior to committing to the pilotage.

The Southampton Port Users Information and Navigational Guidelines **(Annex D)** provided similar details on the information to be passed from the pilot to the master, and the information to be given by the pilot to the Southampton VTS.

The ICS Bridge Procedures Guide stated that:

> *If more than one pilot is required or supernumerary pilots board:*
>
> - *All pilots should be involved in the MPX, and*
> - *Each pilot's role and responsibility, including duty periods, should be understood by the entire bridge team.*

The initial MPX on board *CMA CGM Vasco de Gama* lasted about 2 minutes. It was led by the assistant pilot and did not actively involve the lead pilot. The vessel's initial passage plan was not altered following the MPX, and pre-set tracks on the ECDIS and paper charts were not changed during the pilotage.

1.10.4 Bridge resource management training (CMA Ships)

STCW required all navigating officers to undertake BRM training. This requirement became mandatory in 2012 and all navigating officers in *CMA CGM Vasco de Gama*'s bridge team had received BRM training.

CMA Ships used a training matrix to manage its initial and continual professional development programme. Prior to the implementation of the 2012 changes to STCW, CMA Ships had provided in-house BRM training for all its navigating officers. The training included practical exercises using the company's in-house simulators. Post the STCW changes, the company continued to deliver BRM training to its masters and chief officers serving in its fleet of managed vessels, and to all deck officers contracted to the company's French flagged vessels. All other junior officers on non-French flagged vessels were expected to have completed BRM training as part of their initial college studies, or prior to joining the company, and did not receive BRM refresher training.

CMA Ships had several bridge simulators in different global locations that it used for internal training purposes. They were primarily used to provide ship-handling training for masters and chief officers, and training for junior officers on the application of the International Rules for Prevention of Collisions at Sea. Masters were typically required to practise on the simulator before joining a new class of vessel, particularly if moving to a larger vessel. The captain of *CMA CGM Vasco de Gama* had attended a simulator course for the Explorer class vessel before being appointed to *CMA CGM Vasco de Gama*.

1.10.5 Bridge resource management training (ABP Southampton)

IMO resolution A.960, *'Recommendations on Training and Certification and Operational Procedures for Maritime Pilots other than Deep-Sea Pilots'* Annex 1 section 5.3 stated:

> *Every pilot should be trained in bridge resource management with an emphasis on the exchange of information that is essential to a safe transit. This training should include a requirement for the pilot to assess particular situations and to conduct an exchange of information with the master and/or officer in charge of navigational watch. Maintaining an effective working relationship between the pilot and the bridge team in both routine and emergency conditions should be covered in training. Emergency conditions should include loss of steering, loss of propulsion, and failures of radar, vital systems and automation, in a narrow channel or fairway.*

Section 5.5 and subsection 5.5.4 went on to state:

> *Competent pilotage authorities should be encouraged to provide updating and refresher training conducted for certified or licensed pilots to ensure the continuation of their proficiency and updating of their knowledge, and could include the following;*
>
> > *.4 refresher or renewal courses in bridge resource management for pilots to facilitate communication and information exchange between the pilot and the master and to increase efficiency on the bridge.*

In Southampton, every pilot had undertaken BRM training at some stage in their career. The periodic simulator training undertaken by ABP Southampton did not include BRM as part of the course. The last specific BRM training for Southampton pilots had been provided in 2012.

During their 6-year training to become Class 1 qualified, each pilot was subject to practical assessment. However, once Class 1 status had been attained, the annual performance appraisal of an individual pilot did not include any practical independent assessment of continued competence.

1.11 PREVIOUS INCIDENTS AND SIMILAR ACCIDENTS

On 20 February 2001, the inbound Liberian registered container ship *P&O Nedlloyd Magellan* grounded in the same vicinity as *CMA CGM Vasco de Gama* on its entry into the Thorn Channel. The MAIB investigation report[18] identified that the grounding was the result of an error of judgment by the pilot during the execution of the turn into the Thorn Channel. Contributing factors included restricted visibility, no warning of restricted visibility in the area, lack of full monitoring of the pilot's actions by the bridge team, and the pilot erroneously reading the electronic bearing line on the radar. Three recommendations were made to ABP Southampton, which were fully accepted. These included:

- *Implement a dedicated VTS service for the turn into Thorn Channel and consider using a plan imposed on the VTS radar screen.*

[18] MAIB report 18/2002 - Report on the investigation of the grounding of the Liberian-registered container ship *P&O Nedlloyd Magellan* in the Western Approach Channel to Southampton Water on 20 February 2001.

- *Send generic port passage guidance to ships visiting Southampton before they arrive (as suggested by the Port Marine Safety Code) and ensure a comprehensive pilot/master exchange of their respective specific passage plans on arrival.*

On 11 November 2008, the UK registered cruise ship *Queen Elizabeth 2* grounded on the western bank of the Thorn Channel during its inbound pilotage. The MAIB conducted a preliminary examination of the accident and identified that there was a high reliance on the judgment of the specialist pilot, the passage plan did not identify wheel over points and the effects of the tide and wind were not calculated. Following its own investigation, ABP Southampton undertook to develop a BRM training course for its pilots.

On 13 February 2016, the Singapore registered ultra-large container vessel *APL Vanda* grounded on its approach to the Thorn Channel. The vessel lost propulsion power on its approach to the Precautionary Area. The circumstances of the grounding were investigated by ABP Southampton and, because of its findings, it undertook to review the information and guidance contained in its Port Users Information and Navigational Guide.

The following container vessel groundings resulted in significant disruption to port traffic:

- 18 April 2015 - *Susan Maersk* grounded in the Suez Canal.

- 3 February 2016 - *CSCL Indian Ocean* grounded on the River Elbe during its approach to the port of Hamburg. This resulted in severe disruption to the port operations over several months. It caused extensive dredging operations to be required around the vessel to enable it to be refloated with the aid of tugs.

- 28 April 2016 - *MSC Fabiola* grounded in the Suez Canal. The grounded vessel blocked the canal.

- 6 July 2016 - *Maersk Shams* grounded in the Suez Canal. The grounded vessel blocked the canal.

All of the above cases resulted in no damage to the vessels or injuries to personnel. All vessels were refloated successfully with the aid of tugs.

SECTION 2 - ANALYSIS

2.1 AIM

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

2.2 THE GROUNDING

While inbound to the Port of Southampton, *CMA CGM Vasco de Gama* grounded in position 50° 49.4'N 001° 19.02'W, about 0.4nm north-north-east of the north-east Gurnard buoy **(Figure 11)** while under pilotage through the Thorn Channel Precautionary Area. The grounding occurred on a flooding tide, about 2 hours before high water Portsmouth. The vessel had no propulsion or steering control defects, or power restrictions.

When the helmsman steadied *CMA CGM Vasco de Gama* on a heading of 260° on the approach to the Gurnard buoy the vessel's course over the ground was 263° and it was heading directly into a fresh to strong west-south-westerly breeze. The turn towards the Thorn Channel was initiated when the VTS officer's countdown reached 3 cables. At that point, *CMA CGM Vasco de Gama* was about 3.8 cables to the north of the Gurnard buoy **(Figure 8)**.

When *CMA CGM Vasco de Gama*'s wheel was placed hard-over to starboard and the engine put to full ahead, the vessel quickly achieved a good ROT and the track predictors on both the ECDIS and PPU displays indicated that the vessel would negotiate the turn successfully **(Figure 8)**. However, as the vessel's bow turned out of the wind, the ROT began to reduce **(Figure 9)**. The decrease in ROT was initially caused by the action of the west-south-westerly wind on the exposed hull and container stack aft of the vessel's pivot point[19]. As *CMA CGM Vasco de Gama* progressed towards the western edge of the Thorn Channel, it moved into shallower waters and the ROT decreased further. With the wheel already hard-over and the engine at full, *CMA CGM Vasco de Gama* ran out of sea room and left the dredged channel.

The environmental conditions were as forecasted and were within the port's limits for ultra-large container ships. Given that *CMA CGM Vasco de Gama* had no propulsion control problems or unforeseen power restrictions, and that it and other similar sized container vessels had successfully negotiated the Bramble Bank turn in similar conditions many times before, it was apparent that the execution of the manoeuvre was causal to the grounding. Simply, *CMA CGM Vasco de Gama*'s northerly position in the Precautionary Area at the start of its starboard turn did not provide the sea room required for the vessel to enter the Thorn Channel on a flooding tide.

On the surface, it might appear that the grounding was simply the result of a misjudgment by one person, the lead pilot; however, there were several underlying factors that contributed to this accident. These included weaknesses and shortcomings in passage planning, bridge resource management and external oversight.

[19] The ship's pivot point is defined as the centre of rotation of that vessel. This is generally considered to be located at about one third of the ship's length from the bow when the vessel is moving ahead. On *CMA CGM Vasco de Gama* the pivot point would be located just forward of the accommodation block.

2.3 ABORT OPTIONS

The execution of the Bramble Bank turn was known to be hazardous for large vessels. Therefore, preparedness during the approach to the Precautionary Area should have been heightened and contingency plans understood. There were two critical decision points for the Bramble Bank turn: the first on the approach to the Prince Consort buoy and the second immediately prior to the wheel over point to starboard in the Precautionary Area.

If the pilots or the bridge team had any concerns regarding *CMA CGM Vasco de Gama*'s ability to successfully complete the Bramble Bank turn on the approach to the Prince Consort buoy they could have aborted the vessel's entry into the Precautionary Area by turning it around and proceeding to the 'C' anchorage. Similarly, had the danger associated with the vessel's northerly position in the Precautionary Area been recognised, the turn into the Thorn Channel could have been aborted by continuing ahead into the western Solent. The pilots and the master began to voice their concerns about the vessel's ability to maintain the ROT needed to enter the Thorn Channel shortly after the rudder was put hard-over to starboard. However, once the turn into the Thorn Channel had begun, it could not be aborted as there was insufficient sea room within the Precautionary Area to stop such a large vessel without tug assistance.

2.4 EMERGENCY RESPONSE

Once aground, the ship's crew responded quickly and used the company's emergency response checklist for a grounding incident to help ensure all necessary actions were taken to assess the vessel's condition and reduce the risk of pollution. The VTS officer who was monitoring the vessel's progress was quick to spot the danger and alert the tug skippers.

The consequences of this grounding were in line with the most likely scenario predicted by ABP Southampton in its risk assessment for a grounding incident. The vessel's hull was undamaged and there were no injuries or pollution. This was because *CMA CGM Vasco de Gama* grounded in fair conditions on a soft and flat seabed on a rising tide. Had the vessel grounded on a falling tide, or the tugs not been able to pull it into deeper water, the consequences could have been much more severe.

2.5 PASSAGE PLANNING

2.5.1 General

In accordance with SOLAS Regulation 34, IMO guidelines and CMA Ships' bridge procedures, *CMA CGM Vasco de Gama*'s master was required to ensure that his vessel's berth to berth passage between Algeciras and Southampton was appraised and planned prior to departure.

The guidance contained in *CMA CGM Vasco de Gama*'s bridge manual described three distinct phases for each passage: berth to pilot, pilot to pilot and pilot to berth. The grounding occurred during the pilot to berth phase of the vessel's passage. This section of the analysis will focus on the appraisal, planning, execution and monitoring of the pilot to berth phase (pilotage plan) for *CMA CGM Vasco de Gama*'s passage plan.

2.5.2 Passage appraisal

The first stage of the passage planning process, the appraisal stage, involves the collection and assessment of all information required for the intended passage. *CMA CGM Vasco de Gama*'s master and his bridge team were experienced seafarers and CMA Ships provided them with nautical publications, procedural guidance and checklists to aid the passage planning process. In addition to official nautical publications, charts and port guidance, CMA Ships provided bespoke port cards for its FAL1 route. The port card for Southampton contained guidance for both inbound and outbound passages and included supplementary information based on practical experience. Of note, the port card highlighted the complexity of the transit through the Thorn Channel Precautionary Area. This section of the pilotage was included in the syllabus for the company's bridge simulator ship-handling training course.

The Southampton pilots were also very experienced and had the resources available to fully appraise each of their pilotage acts. The port had also worked closely with the CMA CGM Group to improve its pilots' understanding of the handling characteristics of the company's ultra-large container vessels. Of note, *CMA CGM Vasco de Gama*'s lead pilot had attended a 4-day seminar at the CMA CGM Academy's bridge simulator training centre. During the seminar, the lead pilot interacted with some of the company's masters and practised several emergency response procedures on the company's bridge simulator.

CMA CGM Vasco de Gama's master and navigating officer had the knowledge and experience, and all the necessary information available on board, to conduct a thorough appraisal of the vessel's intended passage. Furthermore, the ABP Southampton pilots had the knowledge, experience and information required to conduct their own pilotage plan appraisal of the intended inbound passage.

2.5.3 Pilotage planning

The second stage of the passage planning process, the planning stage, is based on the outcome of the appraisal stage and involves the development and approval of the berth to berth passage plan. *CMA CGM Vasco de Gama*'s navigating officer planned and documented the vessel's Algeciras to Southampton passage plan using CMA Ships' standard electronic format and checklist prior to departure. The waypoints for the passage were programmed into the vessel's ECDIS and plotted on paper charts prior to the plan being approved by the master and countersigned by all deck officers. It was apparent that the 32nm pilot to berth section of the passage plan was a pre-existing sub-route that had been selected from the ECDIS menu.

The appraisal and planning stages should include the completion and approval of a provisional pilot to berth pilotage plan. The vessel's provisional pilot to berth plan should have been reviewed prior to arrival at the pilot station and a final detailed pilotage plan agreed and briefed during the MPX. These requirements were set out by CMA Ships in its bridge manual.

CMA CGM Vasco de Gama's provisional pilotage plan route for Southampton comprised 23 track legs, two of which covered the Bramble Bank turn. The course for the first leg into the Precautionary Area was 273° **(Figures 17** and **18)**. This preliminary track was 5.2 cables to the north of the Gurnard buoy and about 1.4 cables to the north of the actual track taken by *CMA CGM Vasco de Gama* immediately prior to the grounding.

The assistant pilot used his port passage plan Part 1 form to aid the MPX. However, the Southampton pilots did not produce a detailed pilotage plan prior to boarding *CMA CGM Vasco de Gama* and, like the vessel's ECDIS, the route selected on their PPU was a generic inbound track. The provisional tracks plotted on the vessel's ECDIS and paper charts, and on the pilots' PPU, were not altered prior to or during the pilotage. Furthermore, critical decision points, contingency plans and abort options were not identified or discussed.

It is accepted that detailed plans for complex pilotages cannot always be produced by navigating officers and ports prior to a vessel's arrival at a pilotage station, and that vessels often need to deviate from planned tracks in busy and congested waters. However, realistic intended tracks need to be plotted and key decision points identified. The Bramble Bank turn was known to be difficult for large vessels and it needed to be properly planned and the intended route understood by all the bridge team.

2.5.4 Execution of the pilotage plan and the Bramble Bank turn

The third stage of the passage plan process, the execution stage, involves briefing the bridge team on the plan and navigating the vessel in accordance with it. *CMA CGM Vasco de Gama*'s bridge team had all signed the vessel's provisional passage plan prior to departing Algeciras but were not briefed on the intended pilotage plan following the MPX. A couple of minutes before passing the outbound *Cap Hatteras*, the lead pilot told the master that, because of the strong flood tide and the prevailing winds, he was going to take the vessel deep into the Precautionary Area before initiating the turn into the Thorn Channel.

The lead pilot's intentions appeared to be in accordance with the port guidance for large inbound vessels negotiating the Bramble Bank turn on a flood tide. The guidance described two substantial course alterations: the first to port of up to 40° at the Prince Consort buoy, and the second to starboard at the Gurnard buoy. The aim of the first course alteration was to manoeuvre the vessel close to the Gurnard buoy and provide the maximum amount of sea room to execute the turn into the Thorn Channel. This was to mitigate the risk of grounding due to vessels being set to the east by the flood tide.

The lead pilot's execution of the Bramble Bank turn appeared in some ways to be similar to the majority of his previous inbound pilotage acts on board the Explorer class container vessels **(Figure 20)**; he made a course alteration to port of about 30°, brought *CMA CGM Vasco de Gama* on to a heading of 260° and started his turn into the Thorn Channel 3 cables from the Gurnard buoy. However, the vessel's actual track into the Precautionary Area was much further north and more closely resembled that recommended for a strong ebbing tide.

The passing of *Cap Hatteras* conventionally port to port, just east of the Prince Consort buoy, probably put *CMA CGM Vasco de Gama* further north on its approach to the Precautionary Area than the lead pilot initially intended. However, this deviation did not appear to cause any concerns to him, the assistant pilot or the bridge team, and subsequent contingent actions were not discussed. The lead pilot had been in similar positions before, but on those occasions he executed bigger alterations of course to port and/or achieved a greater ROT to travel further south into the Precautionary Area.

Passing *Cap Hatteras* on the approach to the Precautionary Area might have made the Bramble Bank turn more complicated, but did not cause the grounding. Post-accident simulations **(section 1.8)** showed that, had the pilot ordered a bigger course alteration to port and achieved a higher initial ROT to port on passing the outbound vessel, he could have generated enough sea room for *CMA CGM Vasco de Gama* to make the subsequent turn to starboard around Bramble Bank.

The wheel over point on the approach to the Precautionary Area and speed of bringing the vessel onto the planned course were fundamental to *CMA CGM Vasco de Gama*'s successful execution of the Bramble Bank turn. It took about 4 minutes to complete the 30º alteration of course to port after passing the outbound *Cap Hatteras*, with the lead pilot giving a series of courses to steer. This was because the helmsman used a minimum amount of port rudder to bring the ship slowly onto the heading ordered by the lead pilot. In giving the helmsman courses to steer, the lead pilot increased the risk of the vessel being set to the north, and it might have been more appropriate to have given helm orders in this case.

It is unclear why the lead pilot did not do what he appeared to indicate to the master, and take *CMA CGM Vasco de Gama* deeper into the Precautionary Area before initiating the turn to starboard. He was a vastly experienced specialist pilot and was familiar with the vessel, and there were no distractions, equipment failures or evidence of fatigue. It is possible that he temporarily lost his situational awareness or simply misjudged the initial turn into the Precautionary Area. What was clear, was that the Bramble Bank turn was not executed in accordance with the guidance provided by ABP Southampton and CMA Ships, or the intent expressed by the lead pilot to the master.

2.5.5 Monitoring the vessel's progress through the Precautionary Area

The final passage planning stage involves the monitoring of the vessel's progress against the passage plan. This is principally undertaken through the comparison of the vessel's charted position to its intended charted safe route. Importance should be given to monitoring the vessel's position on its approach to wheel over points and checking its safe transit to the next leg of the track after each course alteration.

Masters and bridge officers have a duty to support the pilot and to ensure that his/her actions are continuously monitored. One of the OOW's primary roles should be the conduct of regular position fixing. Traditional methods of periodic position fixing on a paper chart have been superseded on some vessels by continuous tracking on an electronic chart using satellite systems. However, the vessel's position should still be compared to the charted safe route.

As the intended track courses, wheel over points and required turn radii for the transit through the Precautionary Area were not agreed and charted there was no charted safe route against which to monitor *CMA CGM Vasco de Gama*'s progress. This meant that the vessel's master, his bridge team, the assistant pilot and the VTS officers could not effectively monitor the lead pilot's actions.

2.6 BRIDGE RESOURCE MANAGEMENT

2.6.1 General

Effective BRM requires the efficient use of all available resources, both human and electronic. On any vessel, the most dangerous parts of a voyage are the coastal and pilotage sections. As a vessel closes to the coast, the effectiveness of the bridge team is tested, and its resources are put under scrutiny.

The effectiveness of a bridge team is dependent on several factors; these include:

- Each team member fully understanding their role.
- All team members being fully aware of the passage plan, and having dynamic awareness of any changes.
- Good information exchange and pro-active communication.
- All team members being empowered to seek clarification and to challenge where necessary.
- Best use of electronic navigation aids.
- Integration of pilots into the bridge team.

CMA CGM Vasco de Gama's bridge team was well resourced for its inbound passage to the Southampton container terminal. The master and OOW were very experienced and were supported on the bridge by a helmsman, a lookout and two specialist container vessel pilots. In addition, assistance was available from the port's VTS officers. The bridge was equipped with a modern suite of electronic navigation aids and enhanced positional awareness was provided by the pilots' PPU.

2.6.2 Roles, responsibilities and communication

The guidance provided by CMA Ships in its bridge manual reflected the importance placed on BRM and the need for effective teamwork, good communication and an understanding of individual roles and responsibilities. The guidance also emphasised the need to integrate embarked pilots into the bridge team.

The bridge manual described three distinct methods of conning the vessel during pilotage. These were: *OOW with pilot recommendations under master supervision*; *master with pilot recommendations*; and *pilot under master supervision*. Prior to the grounding, the lead pilot had the con and it was the role of the master, the OOW and the assistant pilot to monitor his actions. This was typical for large container vessels entering and leaving Southampton.

ABP Southampton did not provide clear guidance on the role and responsibilities of an assistant pilot and the roles of *CMA CGM Vasco de Gama*'s lead and assistant pilot were not pre-set by the port management. Instead, the pilots, who both held Class 1 unrestricted licences and had a similar level of experience, agreed their roles between themselves prior to boarding. The pilots considered the role of the assistant pilot to be that of back-up to the lead pilot in case of mishap, and to provide help where needed.

The lead pilot took the con almost immediately on his arrival on the bridge and left the responsibility for the MPX to the assistant pilot. The role given to the VTS officer by the lead pilot was to provide traffic information and a 6-cable countdown to the Gurnard buoy.

The MPX on board *CMA CGM Vasco de Gama* was brief and the lead pilot was not fully engaged. Furthermore, the discussions between the master and the assistant pilot focused more on the berthing operation than the passage to the berth, and specific roles were not explained. During the passage through the Solent there was little communication between the bridge team and the pilots. Important decisions made during mobile phone conversations between the lead pilot and the pilot on board the outbound *Cap Hatteras* were not discussed with the master, and concerns discussed between the master and OOW in Romanian were not raised with the lead pilot. When passing the Prince Consort buoy, the assistant pilot went onto the port bridge wing to check the vessel's distance off, but did not mention his concerns to the lead pilot.

All personnel on the bridge should have known the lead pilot's intended route through the Precautionary Area and the position of the wheel over points for the key course alterations. Had this been the case, there would have been a shared mental model;[20] the vessel's progress and the lead pilot's actions could then have been monitored properly. Furthermore, the implications of passing *Cap Hatteras* just east of the Prince Consort buoy could have been dynamically assessed by the whole bridge team and the initial plan adjusted to ensure sufficient sea room to make the subsequent turn successfully. However, this was not the case. The lead pilot's description of going deep into the Precautionary Area was vague and unmeasurable. He should have clearly explained what he meant by 'going deep'; equally, the master should have challenged the lead pilot and asked him to clarify his intentions. Instead, the master, the assistant pilot and the bridge team became disengaged from the pilotage process and allowed the lead pilot to become an isolated decision maker and a single point of failure.

The failure to effectively utilise the resources available and ensure the pilotage was properly planned, executed and monitored, was almost certainly the result of complacency brought about by familiarity and over confidence. It was clear, from the information contained in the port card, that the masters on board the CMA CGM vessels had a high level of confidence in the professional standards of the Southampton pilots and the general levels of information they provided. It was also apparent that the Southampton pilots felt confident enough to bring ultra-large container vessels into the port with minimal prior planning and limited interaction with, and assistance from, the bridge team.

Pilots need to be confident in their role, particularly given the challenges they often face with language barriers, cultural differences and varying professional standards among bridge teams. However, teamwork and BRM are essential to safe navigation. It is evident that steps need to be taken to redress the power balance on the bridge and ensure bridge teams remain fully engaged when under pilotage, and fulfil their responsibilities.

[20] A shared mental model is the notion that team performance improves if team members have a shared understanding of the task that is to be performed, and of the work involved.

Effective BRM during pilotage depends largely upon the quality of the initial MPX and the levels of continual communication between the pilot, the master and the bridge team. A good MPX and continuous communication through the verbalisation of intentions and thinking aloud will help ensure a shared mental model and empower bridge team members to challenge actions and to voice concerns. In this case, *CMA CGM Vasco de Gama*'s master and pilots had an abundance of resources that were either not effectively utilised or not used at all.

2.6.3 Bridge resource management training

Strong BRM and whole crew resource management are essential to the efficient operation of a vessel and the promotion of a strong safety culture. It is apparent from this investigation that both CMA Ships and ABP Southampton should seriously consider the introduction of in-house BRM refresher training programmes. This would help ensure that effective planning, good communication and efficient use of resources remain the focus of the bridge team and reduce the likelihood of pilots taking total control of the safe navigation of a vessel.

In accordance with the requirements of the STCW Code and recommendations contained in IMO Resolution A960(23), *CMA CGM Vasco de Gama*'s master, OOW and pilots had all received BRM training. CMA Ships provided in-house BRM training to the officers on board its French registered ships. However, it expected the navigating officers on its other vessels to have received the mandated training prior to joining the company. IMO Resolution A960(23) recommended BRM refresher training for pilots. CMA ships and ABP Southampton did not provide periodic BRM refresher training.

Many companies consider BRM such a priority that they exceed the minimum mandated requirements and deliver regular BRM refresher training. Some companies go even further to promote BRM and whole crew resource management by sending their navigating officers and engineering officers together to simulator training centres to undertake bespoke crew resource management training.

2.7 THE USE OF ELECTRONIC NAVIGATION AIDS

2.7.1 Electronic Chart Display and Information Systems

ECDIS was the primary means of navigation on board *CMA CGM Vasco de Gama*. The vessel had two independent ECDIS units and, in addition, paper charts were used as a backup. The vessel's bridge manual contained general guidance on the use of ECDIS for passage planning and equipment-specific operational guidance for setting the units up. The company guidance required the electronic charts to be marked in a similar manner to paper charts, with safety parameters and alarms being set for each leg of the passage. It also recommended the use of the standard display screen mode.

The checklists completed by the bridge team prior to and during the passage to Southampton indicated that the vessel's ECDIS units had been set up and were being used in accordance with the company's procedures. However, this was not the case. Of note:

- Accurate pilotage routes were not charted. Specifically the planned route for the Bramble Bank turn was not achievable given the vessel's manoeuvring characteristics, the effects of the tidal current and the wind.

- Safety parameters and alarms were not used to help monitor the vessel's progress or warn of its proximity to danger.

- Display screens were not adjusted to provide the optimum level of detail and definition.

Adjusting the berth to berth passage plan and charting the agreed pilotage plan on an ECDIS should not be a difficult evolution. In most circumstances, it should simply involve the repositioning or addition of waypoints and the adjustment of desired turning radii. As a regular visitor to Southampton, *CMA CGM Vasco de Gama* could have had several generic pilotage sub-routes for varying tidal conditions stored in its ECDIS. This would not have obviated the need to adjust the intended pilotage route following the MPX. However, it would have provided the opportunity for the vessel's navigating officer to select a more realistic sub-route for his provisional plan.

No ECDIS alarms sounded prior to or after the grounding and the display screen, which had been set to the full mode, was overly cluttered **(Figure 17)** and was therefore difficult to use for effective navigation in restricted waters. Had the safety contour depth been adjusted and the screen set to display four colours instead of two, this would have resulted in the identification and clearer definition of safe waters. Furthermore, the displayed picture would have been a lot easier to view **(Figure 22)**.

CMA CGM Vasco de Gama's deck officers had all received generic and equipment-specific ECDIS training, and all were experienced navigators. Despite this, the vessel's primary means of navigation was not being utilised effectively, or in accordance with company policy. It is therefore evident that CMA Ships needs to conduct a thorough review of the way ECDIS is being used on board its vessels and take appropriate actions to address the shortcomings identified in this report.

Many of the procedural omissions and navigation shortcomings associated with the use of ECDIS seen in this case have been regularly identified by the MAIB in previous investigations. These issues need to be addressed globally by the maritime industry. There is a strong case for the commissioning of an industry-wide study into the reasons why masters and bridge teams are choosing not to use many of the safety features offered by modern electronic navigation aids.

2.7.2 The Portable Pilot Unit

ABP Southampton's PPUs had one inbound and one outbound generic route for the Solent and Southampton water. Its pilots used the PPUs primarily as an aid for berthing, and typically used the vessel's ECDIS, radar and visual references to gain situational awareness and for navigation. The port's management of the PPUs relied on one *super user*, the PPU administrator. The pilots did not have administrator rights and therefore could not make alterations to the PPU set-up, including the pilotage routes.

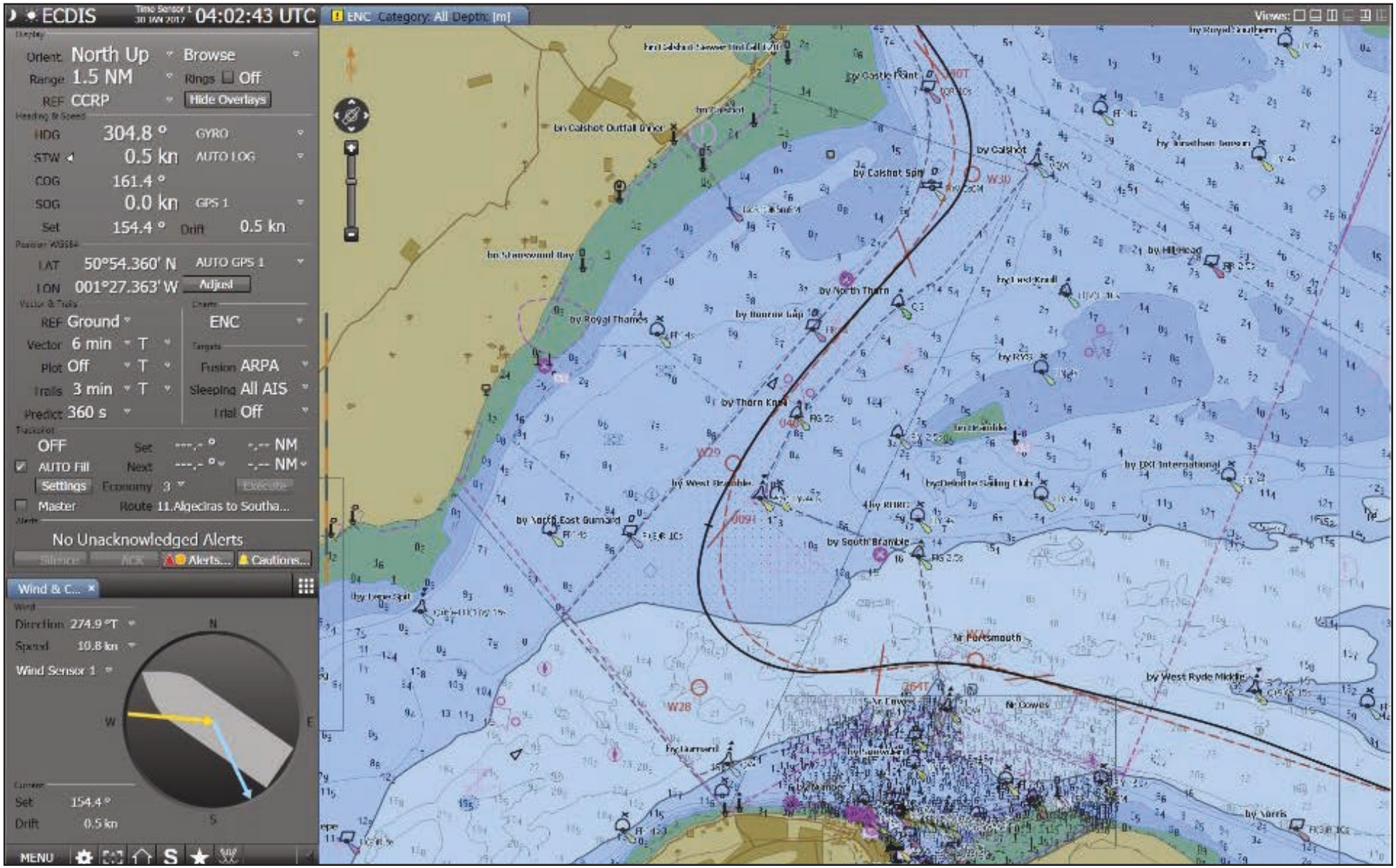

Figure 22: Example of ECDIS display screen with safety contour adjusted and in four colour mode

If the PPUs had several generic tracks that reflected the port's advice for rounding Bramble Bank in varying tidal conditions, the pilots could choose the most appropriate route for the intended act. Furthermore, if the pilots were given the appropriate levels of training and administration rights, they could finely adjust their pilotage plans on the PPUs during or following the MPX. This would benefit the pilotage planning process and MPX, and help the pilots monitor the vessel's transit to the berth.

2.7.3 Vessel Traffic Services radar overlay

During this pilotage, the VTS officer provided a countdown to the Gurnard buoy. The countdown lines displayed on the VTS officer's radar screen were spaced at 1-cable intervals and drawn perpendicular to a baseline between the Gurnard and Prince Consort buoys **(Figure 7)**. The countdown did not include the vessel's distance to the north of the baseline, and therefore did not serve to alert the lead pilot that *CMA CGM Vasco de Gama* was well to the north of his intended position.

2.8 COMPANY OVERSIGHT

2.8.1 CMA Ships

CMA Ships had developed a comprehensive IMS that was designed to fulfil the requirements of the IMO, its vessels' Flag States and various ISO standards, and to promote best practice. The company also conducted periodic internal audits and its management staff conducted ship visits and undertook sea voyages.

It was apparent from this and previous investigations **(section 1.11)** that many shortcomings of the pilotage planning process and levels of BRM in this case, had become normalised on board *CMA CGM Vasco de Gama* and other CMA CGM vessels. However, the company's last internal audit found no navigation non-conformities and made no observations regarding the execution of pilotage and management of bridge resources.

A basic review of *CMA CGM Vasco de Gama*'s bridge logbooks, completed checklists, and recorded passage plans may well indicate that the vessel's bridge team were fully complying with company procedures, but this was clearly not the case. CMA Ships needs to understand why *CMA CGM Vasco de Gama*'s well trained and well-resourced bridge team was not implementing its policies and procedures, or meeting the standards it set. As explained in previous sections of this report, many of the issues identified during this investigation are not unique to *CMA CGM Vasco de Gama*, or the CMA CGM Group. However, CMA Ships needs to investigate the underlying factors that contributed to this accident and take steps to improve the levels of engagement of its bridge teams during pilotage acts.

2.8.2 ABP Ports

ABP Southampton formed part of one of the UK's leading port operators and had declared itself compliant with the DfT's PMSC. The planning and execution of *CMA CGM Vasco de Gama*'s pilotage act fell short of the procedures contained in the port's SMS, particularly regarding pilotage planning and interaction with the vessel's master and bridge team.

Many of the issues raised in this report had not been highlighted as shortcomings within either ABP Southampton's internal or its external audits. It has been identified that several steps to ensure that ABP's pilots do not work in isolation, and that they are engaged collaboratively within the bridge team, have not been implemented. These are inter alia:

- The provision of periodic BRM refresher training for all its pilots.
- Annual assessments - including check rides - for its Class 1 unrestricted pilots.
- The provision of more detailed instructions and guidance on the roles and responsibilities of pilots, particularly on those vessels requiring two pilots.
- The enhanced use of PPUs.

The CMA CGM training academy's report on the results of the simulator tests and their own analysis of the accident, identified that the distribution of the pilot's preliminary pilotage plan to the vessel (and to VTS) prior to its arrival would be useful, particularly as time for detailed planning and discussion can be limited once the pilots have boarded the vessel. In particular, this would allow vessel masters more time to consider the pilot's proposals and, where appropriate, make amendments to the vessel's own passage plan and to the information drawn on electronic and paper charts.

SECTION 3 - CONCLUSIONS

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

1. *CMA CGM Vasco de Gama* grounded because the track taken to negotiate Bramble Bank did not allow for the environmental conditions and manoeuvring limitations of the vessel. [2.2]

2. The vessel was too far to the north when its turn into the Thorn Channel was commenced, and was unable to sustain the rate of turn required to stay within the dredged channel. [2.2]

3. The pilotage between the Nab Tower and Southampton container terminal was not properly planned, the intended route through the Thorn Channel Precautionary Area was not charted, and key decision points, wheel over points and abort options were not identified. [2.5.3]

4. The provisional pilotage plan was not properly reviewed prior to arrival, or amended during *CMA CGM Vasco de Gama*'s inbound pilotage to reflect the lead pilot's intentions. [2.5.3]

5. Neither the route plotted on the vessel's ECDIS and paper charts, nor on the PPU was achievable given the environmental conditions. [2.5.3]

6. The Bramble Bank turn was not executed in accordance with the guidance provided by the port or the intent given to the master by the lead pilot. [2.5.4]

7. The absence of a charted pilotage plan meant that the master, his bridge team and the assistant pilot were unable to monitor the lead pilot's actions and the vessel's progress during the execution of the Bramble Bank turn. [2.5.5]

8. Significant weaknesses in the management of bridge resources were evident on board *CMA CGM Vasco de Gama*. Poor levels of information exchange and communication meant that the bridge team and lead pilot did not share the same mental model. [2.6.2]

9. The lack of a shared understanding of the pilot's intentions prevented the bridge team from providing the support to challenge or seek to clarify the pilot's actions. [2.6.2]

10. The master, the assistant pilot and the bridge team became disengaged from the pilotage process and allowed the lead pilot to become an isolated decision maker and a single point of failure. [2.6.2]

11. *CMA CGM Vasco de Gama*'s primary means of navigation, ECDIS, was not being used effectively or in accordance with expected standards. Accurate pilotage routes were not being charted, safety parameters and alarms were not set up and the most appropriate display screen setting was not being selected. [2.7.1]

3.2 SAFETY ISSUES NOT DIRECTLY CONTRIBUTING TO THE ACCIDENT

1. It was fortunate that *CMA CGM Vasco de Gama* grounded in fair conditions on a rising tide, and that tugs were quickly on the scene to help refloat it. Had the vessel grounded on a falling tide, or the tugs not been able to pull it into deeper water, the consequences could have been much more severe. [2.4]

2. The position of *CMA CGM Vasco de Gama* further north of the Prince Consort buoy was affected by the passing of the outbound vessel *Cap Hatteras* too close to the Prince Consort buoy. [2.5.4]

3. ABP Southampton's PPUs were used primarily as an aid for berthing. However, the PPUs had the functionality to create and display the pilotage plan and therefore could have been used to assist the master/pilot exchange and provide additional situational awareness. [2.7.2]

4. The countdown provided to the lead pilot by the VTS officer did not include the vessel's distance to the north of the baseline, and therefore did not serve to alert him that *CMA CGM Vasco de Gama* was well to the north of his intended position. [2.7.3]

5. Although checklists had been completed, neither CMA Ships nor ABP Southampton had sufficient oversight of the pilotage acts taking place to ensure that their requirements were being implemented across the fleet or within the Port of Southampton. [2.8]

SECTION 4 - ACTIONS TAKEN

4.1 MAIB

The MAIB has embarked on a detailed safety study into the human factors issues associated with the use of modern electronic navigation aids and the implementation of mandated navigation standards.

4.2 ACTIONS TAKEN BY OTHER ORGANISATIONS

CMA Ships has:

- Distributed a safety bulletin to all of its larger vessels reminding them of the hazards associated with the execution of the Bramble Bank turn.
- Implemented mandatory computer-based bridge resource management training for all bridge officers at the start of each vessel contract.
- Implemented 'Port Approach Training' for its masters and chief officers.

ABP Southampton has:

- Reviewed its Port Users Information and Navigational Guidelines and undertaken to update the requirements for large vessels passing each other prior to entry into the Precautionary Area.
- Documented the role and function of the assistant pilot.
- Introduced a process for the continual assessment of Class 1 pilots; including annual check rides.
- Introduced a line on the VTS radar in order to give a distance north of the baseline.
- Commenced work toward implementation of bridge resource management training for all pilots.
- In addition to the ADX PPUs in service, issued each pilot with a tablet computer pre-loaded with piloting software, linked to a dedicated server with information accessible to the VTS watch manager for remote monitoring.

SECTION 5 - RECOMMENDATIONS

CMA Ships is recommended to:

2017/141 Conduct a thorough review, through its internal audit process, of the implementation of company procedures for pilotage planning, use of ECDIS and bridge resource management, and take steps to improve onboard standards and levels of compliance.

2017/142 Include standards of pilotage and bridge team/pilot integration as specific items for assessment and comment in its internal navigation audit reports.

2017/143 Work closely with ABP Southampton to address the safety issues identified in this report.

Associated British ports is recommended to:

2017/144 Conduct a thorough review, through its internal audit process, of the implementation of company procedures for pilotage planning and bridge resource management at all its UK ports, and take steps to improve standards of communication and levels of compliance.

2017/145 Provide refresher training to all pilots in bridge resource management and implement a periodic bridge resource management training programme.

2017/146 Consider providing provisional pilotage plans to vessels and VTS prior to pilot embarkation.

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

Marine Accident Report

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