How a ship´s bridge knows its position – ECDIS assisted accidents from a contemporary human factors perspective

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ABSTRACT

The technological artifacts used in ship navigation have undergone substantial changes during the last decades, and real-time digital navigation is a reality with the introduction of the ECDIS. Despite the obvious merits of this new navigation mode, and the imagined improvement in safety that it theoretically should bring, ECDIS has in recent years been associated with several accidents. The term *ECDIS assisted accidents* has emerged in official accident investigation reports and is widely used among the applied technology community as well as having led to the term reverberating the RADAR assisted accidents that the maritime industry has used following the introduction of the RADAR. Despite the focus on the causal contribution from the interplay between the ECDIS and the navigator, the conclusions in the official accident investigation reports are predominantly directed towards the abilities of the ECDIS operator to use the equipment properly, and to a lesser extent on the features of the ECDIS. The reports do not at all investigate how the equipment could have helped navigators, by offering better support in reaching their contextual goals, i.e., to remain in control of the ship and to maintain safe navigation. Parallel accounts emanating from the applied community of ship navigation seem to suggest that functioning of the ECDIS is far from perfect, and at times is considered suboptimal by navigators.

The ambition driving this thesis work was to explore these second stories about navigation with ECDIS, based on operator experiences, in order to gain leverage for new ways to inform future development and design of ECDIS, which to a higher degree would need to take into account the contextual conditions and demands that operators experience in the field of practice, and thereby to minimize the gap between how designers, and other remote stakeholders, imagine ECDIS operations, and how these actually play out.

Naturalistic research was carried out by attending three ships´ bridges while the ships were operating. Insights were gained into what sometimes make work difficult during navigation by ECDIS. The findings were juxtaposed with information found in three official accident accounts of ECDIS assisted accidents, and finally the results were discussed based on a theoretical framework based on contemporary human factors and systems safety research literature, including Cognitive Systems Engineering. Thus, it was concluded how the methods applied in this thesis work, and its findings, could be useful to future ECDIS design and development.

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ABBREVIATIONS AND MARITIME TERMS USED

ECDIS (Electronic Chart Display and Information System) - Navigation equipment that represents the ship´s position on a computer screen, using approved charts. Further, data on weather, traffic, tides, voyage etc. can be processed and integrated by the system.

ENC (Electronic Navigational Charts) - Official charts produced by hydrographic offices, for use with the ECDIS when this is to be used as the primary means of navigation.

GPS (Global Positioning System) - From satellite derived information, the system automatically calculates the ship´s position as coordinates in a receiver device on the bridge, and presents the position numerically, or graphically on an electronic (chart) display.

Dead Reckoning - Should the GPS receiver lose its input from satellites, it may continue to calculate the ship´s position based on the devices' last known parameters.

IMO (International Maritime Organization) - United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships.

E-navigation - Defined as "The harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment."[1]

RADAR (Radio Detection And Ranging) – An essential piece of on board navigation equipment that provide bearings and distances to other ships and land targets in vicinity from own ship. Used for collision avoidance and navigation at sea.

[1] Source: http://www.imo.org/en/OurWork/Safety/Navigation/Pages/eNavigation.aspx

AIS (Automatic Identification System) – A system that automatically sends and receives data from ship to ship and shore, for identification, position indication and voyage particulars of ships within radio reach.

VTS (Vessel Traffic Service) - Shore based service that monitors shipping in a particular area, and provide services in assistance of safe navigation and traffic execution.

Pilot - Advisor with special and/or local knowledge that boards the ship to assist the master and crew during passage of particular waters, or when entering into harbors.

Paper chart - The common means of navigation prior to, or besides, electronic charts. Position obtained by GPS or terrestrial methods is manually plotted in the chart, and passage plans are manually drawn on the chart.

Terrestrial navigation - Techniques for position determination that relies on land based reference points, in opposition to satellite navigation. Instruments used are for example RADAR, and compass, in opposition to GPS.

Passage plan – A ship´s voyage in details, including waypoint positions, intended track and calculations of distances, times etc.

Route checking - Verification of a passage plan to ascertain that this corresponds to vessel particulars and operating parameters. For example, water depths appropriate for vessel draught, compliance with rules and procedures etc.

Safety depth - An operator defined depth that corresponds to the desired under keel water clearance of the ship.

Safety contour - An operator defined marginal depth contour that triggers an alarm by the ECDIS if the ship crosses this (if nothing is chosen by the operator, the IMO performance standard requires a default safety contour of 30 m.). Upon route checking the system monitors if the ship will pass over objects shallower than the defined safety contour.

XTD settings (Cross Track Deviation) - An operator defined boundary on each side of the intended track. If the ship moves outside the track an alarm is triggered by the ECDIS.

Chart scale – ENCs allow different chart scales (zoom levels) on the same chart, with different data to be displayed at the different chosen scale levels. The ECDIS will indicate if the chosen level is not found appropriate.

ECDIS training - Two types of training schemes are mandatory in accordance with IMO regulations: Generic ECDIS training is a scheme that aims to provide the operator with basic and general competencies. Type specific ECDIS training is a scheme that aims to provide the operator with competencies specific to a particular ECDIS make and model. The latter can be completed both as class room (simulator) training and distance learning (for example on board).

Master´s standing orders - A set of guidelines and/or preferences put out by the master of a ship for his/her officers to follow.

Bridge console - The console where the main bridge equipment is installed, and from where the ship is normally conned.

Autopilot - Equipment that allows the ship to automatically steer a crew ordered course or to keep a heading. Some autopilots can automatically follow a planned track.

1 INTRODUCTION

The introduction of the sea chart may be viewed as the single most important milestone, and the beginning of ship navigation as we know it today, dramatically enhancing the ability to determine the central question of "where am I?" (Hutchins, 1995, p. 12).

The progress in techniques to enhance precision of the ship´s position, which is an advanced process of data integration, can be largely ascribed to the progress in (computer) technology in general. Particularly the introduction and development of satellite based navigation systems has increased navigation performance. Work has changed from a manual process, done by the navigator, to the reading of readily calculated coordinates off a display. While manual skills, valued by older generations of navigators, are still taught at nautical colleges their practical application diminishes with each new generation of navigators.

The development in navigation equipment however transforms navigation into an ever more hermeneutic discipline, where the complexity of determining the ship´s positon is *hidden* behind the equipment interface. Thus, the navigator, then, must rely on the equipment´s ability to communicate adequate information, effectively, at the right time. A now classic example of a communication breakdown between navigational equipment and bridge crew is the grounding of the passenger ship The Royal Majesty (NTSB, 1997). The crew did not recognize a GPS mode change into dead reckoning, i.e. it determined the position based on historical info instead of fresh satellite information.

The perceived benefit of the current era of electronic chart navigation, besides capability to process ever larger amounts of various information, is that the navigator may follow the electronic representation of the ship´s position and its surroundings, and heading, practically real-time with no manual, and supposedly little cognitive, effort. However, *ECDIS assisted accidents* have entered the scene of maritime misfortune. This suggests that the technology we introduce, thus, is not *value neutral*. It "creates new human work, new pathways to success and failure, and new capabilities and complexities" (Dekker, 2015, p. 207). Despite the hopes and dreams expressed for ECDIS navigation in the IMO performance standard[2], regarding safety, reliability,

[2] ANNEX 24 RESOLUTION MSC.232(82)

simplicity and easing of the workload on the navigator, several such accidents where the ECDIS has played a significant role have occurred in recent years.

Official post-accident responses are often filled with human error labels using different words, attributing the problem to the human operator. A prime example is found in the following quote, responding to the grounding of the chemical tanker Ovit:

> […] despite dedicated training ashore on the system they were to use, the operators' knowledge of the ECDIS and ability to navigate their vessel safely using the system were wholly inadequate […] Unfortunately, the current generation of ECDIS systems, though certified as complying with regulatory requirements, can be operated at a very low level of functionality and with key safety features disabled or circumvented. Training and company culture may mitigate these shortcomings to some extent, but can only go so far […] While systems allow individuals to operate them in a sub-standard manner, there are those who will do so: such is human nature […] For all shipping companies navigation is a safety-critical function and failure to navigate effectively can and does result every year in pollution, loss of vessels, and loss of life. It is to be hoped, therefore, that the next generation of ECDIS will embody features making them less vulnerable to the vagaries of human performance to achieve a better level of assurance that safe navigation is being consistently achieved. (MAIB, 2014)

According to Heede (2012), Foucault warns against society´s use of absolute categories, like "such is human nature" (MAIB, 2014), arguing that these rather reflect discourses created and conditioned by historical development, and, thus, cannot reflect any objective truth or describe a fundamental law of nature. A different, but parallel, portrayal of issues related to ECDIS assisted accidents is found in a growing number of articles from the applied community of ship navigation and management. This testifies to a pattern in feedback on the usability of the ECDIS equipment, hinting at the presence of an alternative to the canonical human error explanation. A recent example is found in the following quote from a column in The Nautical Institute´s journal *Seaways*, titled "We might be ready for ECDIS but is ECDIS ready for us?":

> Given the primary function of ECDIS is to contribute to safe navigation, and that extremely sophisticated navigation technology exists, why are we so reliant on ECDIS

with so many flaws, weaknesses and limitations? (McDonald, A., Seaways, February 2016)

Currently, a global implementation process, running until 2018, makes the installation of ECDIS mandatory[3] on most ships on the high seas. The issues we experience are, thus, likely to gain further momentum as ever more ships will have the potential for ECDIS assisted accidents. Furthermore, the large-scale concept of E-Navigation, currently under development, will demand processing of ever larger amounts of electronic shore to ship data, on the ship´s bridge. In this context, ECDIS is thought to play a significant role; it has been suggested that ECDIS can become "a suitable platform for decision making in everyday ship navigation" (Bistrovic & Komorcec, 2015).

1.1 Thesis research question

In the light of the ECDIS assisted accidents, and the issues that exist concerning their causal factors, it would be useful to look at the less studied *second stories*, i.e., a story that is in opposition to, or challenges, a commonly accepted story told previously, about ECDIS and navigator interaction that flourishes in the operational community. This may challenge a seemingly quick and easy resort to human error and nuance the debate on the challenges of future ECDIS development and design.

The questions that will be examined in this thesis are:

How do official stories about ECDIS assisted accidents match insights derived from normal work contexts of ECDIS use? How can these insights inform future design & development of ECDIS?

[3] SOLAS Chapter V – Regulation 19 – Carriage requirements for ship borne navigational systems and equipment

2 LITERATURE REVIEW

A theoretical position about conditions related to ECDIS assisted accidents and future design and development will be outlined below:

Achievement of the bridges´ collective goal of safe navigation is effectively supported by addressing local, contextual, operational demands at the equipment and work design phases. Goals-means dependencies (Woods & Hollnagel, 2006) between navigator and ECDIS, crucial for process control, will manifest itself during everyday operations, rather than during post-accident investigations.

A framework for better understanding of the goals-means dependencies is sought through a review of pertinent literature from the field of human factors and systems safety.

2.1 Researching Maritime Contexts

Lützhöft, Grech, and Porathe (2011), suggest that the maritime domain has been a bit slow to pick up developments in HFE (human factors and ergonomics), compared to other high-risk domains such as aviation and nuclear. The eventual spark for HFE in the maritime domain was the frequent use of the label human error following accidents and incidents, providing an incentive to address the human element.

The authors assert that accident and incident statistics reveal a positive trend in shipping, in recent decades, but many future challenges remain to be solved and "while the systems become more integrated and complex, the handling and understanding [still] have to be adapted to the human element, the seafarers on board" (p. 285). The authors argue that previous problems of sparse information available to the navigator, to support decisions and maintain control of navigation, have now been replaced by information overload. Simultaneously the previous role of the navigator, i.e. active conning of the ship has changed into one of monitoring automated technology. It is emphasized that it is important to; *integrate the end user into the bridge system* and *to provide intuitive information at the right level of complexity at the right time*.

Several other researchers in the maritime domain have pointed to this, sometimes, cumbersome relationship between ships´ crews and the technology provided to assist them in their daily work on board:

Schröder-Hinrichs, Praetorius, Graziano, Kataria, and Baldauf (2015), argue that the concept of

resilience might be fruitful in trying to make progress in safety, in the maritime domain. As an example of how history has proved it to be difficult to anticipate the effect of even small changes, on overall system performance, they note that with the introduction of new enhanced technologies; RADAR-assisted collisions occurred as an unanticipated side-effect of the new handling possibilities, facilitated by the technology, for operations with a smaller safety margin. For example, this led to closer calls between ships, and higher ship speeds in risky situations. They point to similarities with more recent technological advances, including ECDIS and AIS.

In developing a *safety II perspective*, per the authors associated with *resilience*, in the maritime domain, the authors suggest two examples of how to move forward. Both emphasize the need to engage stakeholders and operators, and one of them highlights the currently ongoing CyClaDes[4] project aiming directly at the development of a framework so as to obtain user feedback for the design of ship board equipment.

Another effort, aimed at exploration of resilience in the maritime domain, was undertaken by Praetorius, Hollnagel, and Dahlman (2015), in a study of on-shore VTS operations. Through engagement with the VTS operators, by interviews and observation, and subsequent analysis, i.e., by using FRAM (Functional Resonance Analysis Method), the researchers can provide insights on *work as done* (Hollnagel, 2012), revealing how the studied system had been adapted to the operational context, by inventing new functions to cope with these contextual demands. Thus, creating "a strong case for why management, rule-makers and regulators should consider how work is currently conducted before implanting changes" (p. 19).

About the current fast-paced technology changes in VTS operations, including the introduction of E-Navigation, the authors assert that new technology is not value neutral, but new technology can change how work is done in the natural context. They cite Wiener (1988): "Progress imposes not only new possibilities for the future but new restrictions", which fits the RADAR-assisted collision phenomenon mentioned by Schröder-Hinrichs et al. (2015). In relation to understanding why ECDIS operations sometimes prove cumbersome it may be necessary to understand the contextual demands and the adaptations done by the navigators, in response to the technological breakthroughs.

[4] www.cyclades-project.eu

Lützhöft and Dekker (2002) revisited the grounding of The Royal Majesty to demonstrate how a second story can reveal more about the relationship between navigators and their technological tools, and so can challenge the conventional story about human error. The official case of "lost position awareness" (NTSB, 1997) following an unrecognized mode change to dead reckoning on the GPS was put into a systems perspective in this article, demonstrating how the technology may play an active role in the confusion of navigators. The authors explain why actions (and inactions) were sensible from the view point of the involved crew members. Several the features of the navigation systems were identified as problematic, leading to the miscoordination and miscommunications between humans and machines, evolving and deepening throughout the events that led to the grounding. For example, *automation surprise* (e.g. Woods, Dekker, Leila, Cook, and Sarter, 2010) was identified, i.e. when automated systems unexpectedly act on their own, i.e., when there is a mismatch between operators´ ideas about the functioning of the technology, and the actual functioning, and feedback provided by the technology, to the operator, about its functioning. The central message delivered by this alternative analysis, potentially relevant in relation to the challenges that we now see manifest themselves from the use of ECDIS, is:

> The question for successful automation is not "who has control" (and then giving automation more and more control as technological capability grows or economic imperative dictates). The question is "how do we get along together". Indeed, what designers really need guidance on today is how to support the coordination between people and automation. (p. 12)

Lützhöft and Nyce (2006) studied the art of piloting in the Baltic archipelago. Based on ethnographic research the researchers could construct a highly detailed account of work as done in piloting. Some interesting conclusions were drawn here about the integration of navigational methods used to determine ship position. The intertwined information environment that makes up the ship´s bridge is made sense of by the pilot, by forming a personal chart, which is not entirely a tangible artefact, but rather a personal construct. This process transforms a simple sea chart into a representation useful for piloting. Thus, the actual sea chart (electronic or paper) is only one part of the picture needed to navigate safely and effectively, and the information provided by the chart is continuously evaluated against this construct:

> We have found two conditions when personal chart and plan and ship can essentially disconnect, one when plan and reality don't "look" like each other anymore, the other

when plan and reality become out of synchronization with each other. (p. 13)

The mariners studied are, thus, not just passive receptors (Norros & Salo, 2009) of the information provided by the chart, but rather active planners and integrators of information:

> Cross referencing between the world, chart and course book allows these pilots to build up, through experience, a model that allows them to get the job done. It helps them answer the question that informs almost all bridge work, 'what do we need to do next´? (Lützhöft and Nyce, 2006, p. 16)

2.1.1 Integration Work

Lützhöft (2004), in a comprehensive study of mariners´ use of technology derived from four years doing *problem-oriented ethnography*, concluded that navigators all too often must do *integration work* to make the interplay between equipment and the operator work. Her observations of integration work are expressed as follows:

> Integration work is about coordination, co-operation and compromise. When human and technology have to work together, the human (mostly) has to co-ordinate resources, co-operate with devices and compromise between means and ends. (p. 57)

Lützhöft concluded that the need for integration work, to be done by the mariners, is a result of more or less successful integration of the technological devices into the bridge as a socio-technical system:

> Many ostensibly technically integrated maritime systems are neither well integrated from a human co-operative point of view, nor from a technical point of view […] Mariners have to bridge these gaps of integration by performing integration work, by adaptation, tailoring and shedding. (p. 88)

In integration work a new sort of work load is created by having to deal with, or to anticipate, the shortcomings of the technology, or its limited success as an integrated entity of the collective human-machine ensemble that makes up the ship´s bridge. The navigators now must orchestrate coordination acts between themselves and their *non-human ship mates*. Such coordination work is particularly difficult because "machines cannot communicate in ways mariners see as useful". (Lützhöft, 2004, p. iii).

About integration work and the role of Human Factors and ergonomics Lützhöft continues: "To be able to integrate on any level, humans must perform adaptations […] Whether this means humans adapting themselves or their surroundings, the job of Human Factors and ergonomics researchers should be to make this adapting easier." (Lützhöft, 2004, p. 57-58). Adaptations, or performance variability, resulting in work-arounds, are a necessary contributor to many a technological and task success, but it also holds the potential for negative outcome (Woods et al., 2010).

2.1.2 Cognition in the Wild

Hutchins (1995) argues, based on his ethnographically inspired studies on board a naval ship, that the discipline of navigating such ships could be seen as a number of events where cognitive functions, *computation*, a socially distributed set of events which takes place among the members of the navigation team, and the artefacts they use in order to reach the common goal of determining the ship´s position, relative to the surroundings. About the previous research of the cognitive sciences, which were mainly preoccupied with cognition as a phenomenon that took place inside the mind, Hutchins asserts:

> The emphasis on finding and describing "knowledge structures" that are somewhere "inside" the individual encourages us to overlook the fact that the human cognition is always situated in a complex sociocultural world and cannot be unaffected by it. (Hutchins, 1995, p. xiii)

According to Hutchins, gaining an understanding of why, when and how navigational activities are carried out, is best done by studying *cognition in the wild*:

> It is notoriously difficult to generalize laboratory findings to real-world situations. The relationship between cognition seen as a solitary mental activity and cognition seen as an activity undertaken in social settings is not at all clear. (Hutchins, 1995, p. xiii)

Similarly, Lützhöft (2004) concluded that the phenomena she was interested in were too complex to study in a simulator. Hutchins´ distributed cognition theory, thus, gives further leverage to the idea of studying the use of ECDIS in the operational setting.

In discussing navigation as a form of computation and cognition, Hutchins applies a framework developed by neurophysiologist David Marr in the 1980´s (Hutchins 1995). This framework consists of three levels of abstraction, with the highest level being the computational level: "This describes the goal of the computing system, why this goal is the appropriate one, and the basic logic of the strategy by which the computations are carried out" (Hardcastle & Hardcastle, 2015, p. 261).

The next abstraction level is the level of representation and algorithm. This level provides an additional level of understanding "at which the character of the information-processing tasks carried out [...] are analyzed and understood in a way that is independent of the particular mechanisms and structures that implement them in our heads" (Marr, 1982, p. 25, as cited by Hardcastle & Hardcastle, 2015, p. 261). This level, thus, also explains how the computational level can be modelled.

The final level of abstraction is the level of implementation, where the "representations" are physically realized in the brain.

The framework was developed to explain cognitive processes that take place inside the individual, but Hutchins believed that there was no reason, in principle, to confine it to such an "internal" conception of cognition:

> In order to understand navigation practice as a computational or information-processing activity, we need to consider what might constitute an understanding of an information-processing system. (Hutchins, 1995, p. 49)

With this, critics accused Hutchins of retaining focus on the cognition at a component level, rather than the quality of action and the ability of a system to stay in control (Hollnagel & Woods, 2005). In other words; it can be argued that Hutchins used a model of the individual to explain larger scale, more complex events like history, culture, society and context.

2.2 JCS (Joint Cognitive Systems) and CSE (Cognitive Systems Engineering)

JCS theory shares with cognition in the wild the belief that the research object should be situated action. It is about "listening to, eliciting, and collecting stories of practice" (Woods & Hollnagel,

2006, p. 44). Woods and Hollnagel argue that such methodology will provide a safeguard against what was termed *the Psychologist's Fallacy*, articulated first in 1890:

> Updated to today, this fallacy occurs when well-intentioned observers think that their distant view of the workplace captures the actual experience of those who perform work in context. Distant views can miss important aspects of the actual work situation and thus can miss critical factors that determine human performance in that field of practice. (Woods & Hollnagel, 2006, p. 44)

The paradigm of information processing, or computation, Hutchins picked up, is discounted by JCS and this model instead attempts an integrated view that avoids separating cognitive functioning, i.e. humans and machines, into different parts, but focuses on co-agency; "Agency is here used as a verb describing the state of being in action or how an end is achieved, i.e. what a system (an *agent*) does." (Hollnagel & Woods, 2005, p. 19).

Hollnagel and Woods define a *cognitive system* as follows:

> A cognitive system is a system that can modify its behavior on the basis of experience so as to achieve specific anti-entropic ends […] Systems that are able locally to resist the increase in entropy are called anti-entropic. In basic terms it means that they are able to maintain order in the face of disruptive influences, specifically that a cognitive – and therefore also a joint cognitive system – is able to *control* what it does. (2005, p. 22)

If one chooses to define the ship´s bridge as a cognitive system, it may indeed match neatly with the definition provided in the above.

2.2.1 Patterns in a JCS

Studying work in context, in this case the use of ECDIS, is about capturing how behavior and strategies are adapted, and shaped by the artefact (the ECDIS), in order to reach the goal of safe navigation. The end purpose, one at least, is to plant *design seeds* (Woods & Hollnagel, 2006) for next generation of systems that will make a JCS more capable of attaining its goals.

Woods and Hollnagel argue, unlike in more contextual approaches, that the search for generic *patterns* in the work context, is a central activity of CSE.

> These patterns are empirical generalizations abstracted from and grounded on observations made through different studies. Patterns are a form of diagnosis that capture the essence of a problem (a hypothesis open to revision) and point to directions to be pursued to resolve the situation diagnosed (specify what could be promising directions to search for new solutions). (Woods & Hollnagel, 2006, p. 12)

This, according to Norros and Salo (2009), they believe, draws the attention to the functioning of the system rather than to its structure.

2.2.2 The concept of "habit"

Norros and Salo (2005) advocate for the study of a system´s *way of working*. Later they argue that the study should not be an expression of "a generalization of externally observed behavior but, instead, an expression of an internal regularity in the behavior of the system" (Norros & Salo, 2009, p. 49). They suggest using the semiotic concept of *habit*, in the empirical analysis of people´s usage of their tools and technology, to capture how the behavior of the system is "not just the results of repetition but what is adequate or meaningful in a particular situation, and hence worth repeating" (Norros & Salo, 2009, p. 49). This should allow actors to express their reasons for actions and assumes that users of technology, like navigators using ECDIS, are not merely passive receptors of information.

2.3 Adaptation

In order to understand how navigators adapt to their environment it is necessary to understand the demands they adapt to:

> By starting to build up descriptions of demands, one can begin to trace out the three relational properties of a JCS at work: affordance, coordination, and resilience. Each of these properties expresses a relationship between people (and other agents), artifacts (technological capabilities), and specific work settings (domains). (Woods & Hollnagel, 2006, p. 62)

Norros and Salo, (2009, p. 50) would add *communication*, and by that that communication systems make themselves *affordable* to the other. On this basis, they conclude that design should be aimed at enabling communication, reconfiguration and affordances.

Coordination highlights the contextual nature of cognition; "The idea that cognition is fundamentally social and interactive, and not private" (Woods & Hollnagel, 2006, p. 64). Work is done, and decisions are made, within a flux of multiple parties bringing different interests to the arena. Shipping is dynamic by nature, as the trading objects (ships) often physically move and are exposed to a continuously changing environment. Adaptive capacity is a precondition of all levels of ship operations to meet demands of markets, technological development and physical environments. *Resilience* represents an organizational quality that enables systems to reconfigure to meet such new and varying resource pressures and performance demands that is reflected in the *law of stretched systems* and the *bounded rationality syllogism* (Woods & Hollnagel, 2006).

Perry & Wears (2012) explore how the local (often necessary) adaptations may become problematic at the global scale in hospital emergency departments. Adaptiveness is also necessary to study to inform design that can lead to cognitive artifacts which would fall prey to *Grudins Law*: "[…] when those we benefit are not those who do the work, then the technology is likely to fail or, at least be subverted […]" (p. 260).

One adaptation strategy is system-tailoring. This means that context and devices are adapted for the practitioner, here the navigator, to preserve his/her own strategies for reaching goals (Woods & Hollnagel, 2006). This could mean physical alterations or setups of the ECDIS, different from those envisioned by system developers, or workaround procedures and instructions, to fit real world scenarios.

Task-tailoring is the opposite, i.e. instances where practitioners must adapt their own strategies to fit the constraints imposed by the technology (Woods & Hollnagel, 2006). Activities and strategies here are adjusted in accordance with the characteristics of the devices that they use; for example, the navigator´s working preferences cannot be met by the equipment available, and he/she must resort to whatever support is available as offered by the device.

Both examples of tailoring may be interpreted as an expression of a mismatch between the means and ends, leading to an operator's *integration work*:

> There is (1) the designers´ ideas about the artefact and the functionality it shall provide (designers´ model of system); (2) the designers´ ideas or assumptions of who the users

> are, what they want to do, and what they are capable of doing (designers´ model of users); (3) the condensed assumptions that are built into the artefact, i.e., how the artefact actually looks and functions, as different from what the designers intended it to look and function (artefact, or system´s image); and finally (4) the end users´ ideas about the artefact, what they intend to use it for and how they expect it to function (users´ model of system). (Hollnagel & Woods, 2005, p. 186)

Raymer and Bergström (2013) identified several such mismatches between the machine-embedded images and user machine images, when studying the interaction between anesthesiologists and the anesthesia monitor machine they operate.

Tailoring, the consequence of such discrepancies, may be a way to finish the design of the artefact, similar to Lützhöft´s integration work, i.e. "[…] the work that humans do to construct a system […] that helps them perform their work" (2004, p. 14).

2.4 Joint Intelligent Systems

Following the publication of one of the first coherent works on CSE; "Joint Cognitive Systems: Foundations of Cognitive Systems Engineering" (Hollnagel & Woods, 2005), critique was raised about its practical utility. The theoretical application, as treated in the book was perceived of little practical use to ergonomists and engineers (Bye & Naweed, 2008-1). The critics, in their review of the next volume "Joint Cognitive Systems: Patterns in Cognitive Systems Engineering" (Hollnagel & Woods, 2005), recognize "a myriad of different observational tools of an empirical endeavor that may generate data" (Bye & Naweed, 2008-2). Still, they assert that they find it to lack real prescription for research and development. *The Law of Requisite Variety* (e.g. Woods & Hollnagel, 2016, p. 19) among other things makes it clear however that a very prescriptive manual for design could easily end up being too narrow to handle the problems at hand. Norros & Salo (2009) present an argument for the need of a new design approach, which takes this critique into account: The approach, consisting of five steps, was developed by a multidisciplinary group, with diverse theoretical orientations, including both researchers and designers as well, who frequently discussed their work with an industrial reference group. The aim was to outline a new design approach based on *ecological systems thinking* (e.g. Amalberti, 2013). The resulting steps were presented as follows:

1. The object of design changes from product to *intelligent environments*:

Instead of being used one stop one shop equipment-like products, technology becomes ubiquitous and part of a new type of intelligent environment. In this context, intelligence is not an attribute of technology or the human element as such but, instead, it refers to the appropriate functioning and adaptation of a system. The whole system, or intelligent environment, becomes the object of design.

2. The new object brings design tensions:
   Intelligent environments bring both broader and deeper problems than those which designers are used to deal with. Five trends are identified, creating tension that influences the direction and philosophy of design.

Table 1

Tension that influences the direction and philosophy of design (Norros & Salo, 2009, p.45)

Technology driven design	←	Technology tension	→	Technology averse design
Radical innovations	←	Innovation tension	→	Evolutionary innovations
Researcher designers	←	Competence tension	→	User designers
Plug-in readiness	←	Readiness tension	→	Do-it-yourself readiness
General enabling design	←	Generality tension	→	Design for specific practice

3. Coping with tensions creates new design activity:
   While product design as the core practice of design will remain relevant, two complementary design modes will emerge. These are labelled *immediate design* and *remote design*. Immediate design is concerned with sensitiveness to the users´ current or expressed future needs, the context dependency and intensive utilization of layman designers. Remote design aims at structural changes, focuses on possibilities and is typically formative i.e. outlines general adaptive solutions.

4. Characteristics of design knowledge:
   The epistemological basis for design is divided into two complementary modes, the first one, the more traditional one, resembles academic knowledge production, i.e. science. In the second mode, knowledge is created in the context of its application and crosses disciplinary borders. It is reflexive and dialogic rather than strictly objective or empirical in that sense. Both are necessary to fulfil the knowledge demands of all three design modes outlined in step 3.

5. New concepts to tackle the design object:
   The methodological principle that human and environment form a functional unity is one of the important new ideas.

The steps, thus, can lead to a new design model that joins more traditional approaches with new ones, to synthesize the remote and immediate design modes. The resulting design model suggested by Norros and Salo they term *Joint Intelligent Systems*.

3 Thesis Research Design

3.1 Methodological considerations

3.1.1 Ontological point of departure and epistemological consequences

An important point made by Nyce, Talja, and Dekker (2015), will be addressed initially. They assert that:

> We need to turn the mirror back on ourselves and address not only the question of who holds the pen but what ontology are we committed to and what consequences this has for the kind of ethnography we wish to do. (p. 92)

This research did not qualify as ethnography per se, but it included the use of naturalistic methods (Kirk & Miller, 1986). Furthermore, ethnographic methods largely influenced and inspired the investigator´s research efforts. Therefore, it was found appropriate to address the issue raised above, to promote transparency regarding both analysis and inference. This section aims to discuss the ontology underlying this study.

A qualitative approach was suitable, because this thesis is about identification of presences and absences, rather than measuring the *degree* of a quality in the system, in a classic quantitative sense (Kirk & Miller, 1986). The research further aimed to use systemic and analytic categories such as resilience, affordability and coordination. This means picking up qualities that need interpretation rather than measuring to provide sensible input that may inform future design. The stories behind the phenomena was key.

Lützhöft (2004) reminds us about the epistemology associated with qualitative methodology; that human observers are not just field recorders. Rather, observers are interpreters capable of going further than the face value of the data perceived. Raw data, however, regardless of how it is collected, is not self-evident or meaningful but itself requires the careful interpretation and analysis by the researcher.

It is an ongoing debate whether human beings enjoy privileged access to their own cognition, i.e. the issue of whether phenomenal consciousness could be so divorced from cognitive access that a subject can have an experience that he does not and cannot think about (Block, 2008). This is an important issue in relation to the definition of the role of the observer as an interpreter, and in

answering the question of whether the informant statements about their own experience can be taken at face value (Nyce et al., 2015). In either case, the analysis of the collected data carried out by the interpreter will always carry his/her mark. Recalling Nyce et al. (2015), an indication of quality here was believed to be how transparent, or in contrast hermeneutic (Hollnagel & Woods, 2005), the transformation process of raw data into a representation of meaning is. The quality hallmark is, thus, an analytical trace demonstrating how data becomes data as there will always be a transformation of meaning in the processing of raw data into representation, and that:

> […] ways of getting access to empirical reality are infinitely negotiable, and their acceptability is a function of how well they conform to the worldview of those to whom the researcher makes his appeal. (Dekker, 2015, p. 203)

The cognition accessibility debate leads to an important ontological and accompanying epistemological question about whether there exists a *ground truth,* one external to the human perception/interpretation, and in such case if it is accessible to the researcher and/or designer (Dekker, Nyce, van Winsen, and Henriqson, 2010). Again, this philosophical, rather than practical, issue was not attempted to be resolved here either. In continuation of the remarks about the observer´s role as interpreter, it will suffice to describe that the author assumes that any such objective facts, or a ground truth, about the subject under study is out of reach of any researcher or designer. To this end, physicist Thomas Kuhn noted in the postscript to his *The Structure of Scientific Revolutions* (2012):

> There is, I think, no theory-independent way to reconstruct phrases like `really there´; the notion of a match between the ontology of a theory and its "real" counterparts in nature now seems to me illusive in principle. (p. 205)

In the introductory section to this thesis, the investigator argued for a way to address the issues of ECDIS assisted accidents and development of ECDIS, one different from the commonplace official view of the causal mechanisms that underlie these challenges, which largely assumes that human operators are the fundamental issue (using different labels and words), and that in the newer technology lies the remedy, i.e. the more we automate and restrict the safer we become (Grote, 2012). Supporting the existence of second stories, a substantial body of contemporary literature points to fallacies associated with the assumptions about technology being able to serve this role. A well-known example being the "substitution myth" e.g. Dekker and Woods, (2002),

Woods and Hollnagel, (2006), Lützhöft, (2004), Amalberti, (2013). The investigator departed from this stance; that humans more often provide the solution to poorly designed and integrated technological systems, through their extraordinary cognitive and adaptive capacities (Hollnagel, 2014).

3.1.2 Methodological inspirations

The introduction to this thesis further underlined the relevance of the issues currently experienced with use of ECDIS, and the phenomenon of ECDIS assisted accidents. The literature review served to illustrate how a theoretical framework may help identify the underlying mechanisms in socio-technical systems, contributing to the creation of preconditions for the phenomenon we wish to study here.

To address these theoretical issues, the following assumptions developed by Lützhöft (2004) provided the principles that guided the research for this thesis:

- "If context and meaning are not taken into account when designing new technology, there is a risk that a device or system does not fit the users and their tasks." (p. 17)
- "Using tools or methods designed to quantify behavior or to write laws will not yield the richness and complexity of the work situation, and will seldom tell technology designers or manufacturers what they need to know about the 'human element'. (p. 18)

Problem-oriented ethnography

Lützhöft (2004) studied mariners´ use of technology using ethnographically inspired methods. The approach, she termed, echoing Nyce, `problem-oriented ethnography´ and the idea was to directly focus on selected parts of a context in order to understand the ways that the studied operators saw, described and understood their work and their tools:

> The ways artefacts are used can only be observed and their significance discovered in actual use. It may seem, to an engineer, that there is no harm in changing the look of a display or changing the underlying metaphor for an instrument's display of information. However, if we do not know enough about how technology is used in practice, what added functionality end users may have discovered or adapted the technology to afford,

and what work-arounds they have devised, we may lose many direct and indirect emergent effects. (p. 11-12)

Shadowing

In another field study of mariners at work (Ljung & Lützhöft, 2014) the researchers used what they refer to as *shadowing*, i.e. "[…] a method within participant observation […] where the researcher can meticulously observe real-time situations […] in order to understand how respondents behave in a given context." (p. 5).

The method is like that used in management research during the early 1970´s (Mintzberg, 1970). The method offers a compromise between using structure and excluding it. It couples the flexibility of open-ended observation with the discipline of seeking certain types of structured data. But the categorization of the findings is done based on how the observations develop, rather than based on the standing literature and previous research experiences.

Informal interviewing

Lützhöft (2004) used what she terms *informal interviewing* often as a main data source. The idea was that interviewing should be contextual, i.e. the informant is working while the interview is undertaken; this allowed here stories to be shared about the use of ECDIS. However, despite the best efforts to create an informal environment of trust, it cannot be escaped what Kvale (1996) asserts about the asymmetry of power in such interviews: "The professional is in charge of the questioning of a more or less voluntary and naïve subject." (p. 20).

3.2 Methods

The research method in this thesis was to collect multiple case studies (here two cases), embedding multiple reports and accounts to be analyzed (three in each case). The first case was an ECDIS assisted accident, and the second case involved the everyday use of ECDIS. The navigators´ use of the ECDIS was the focal point for analysis in both cases. Yin captures the researcher´s motivation for choosing the case study research style, in the following quotation:

> […] you would want to do case study research because you want to understand a real-world case and assume that such an understanding is likely to involve important contextual conditions pertinent to your case. (p.16)

The study design was structured around the two cases, to compare an official account of operator´s use of ECDIS following accidents, with insights collected about operators´ use of ECDIS during everyday operations.

The data collection and subsequent analytic treatment was primarily qualitative in the sense that the data was subject to interpretation. Evidence collected was anchored in the theoretical basis of the reviewed literature and the theoretical models found there.

The study protocol used, is portrayed in the figure below:

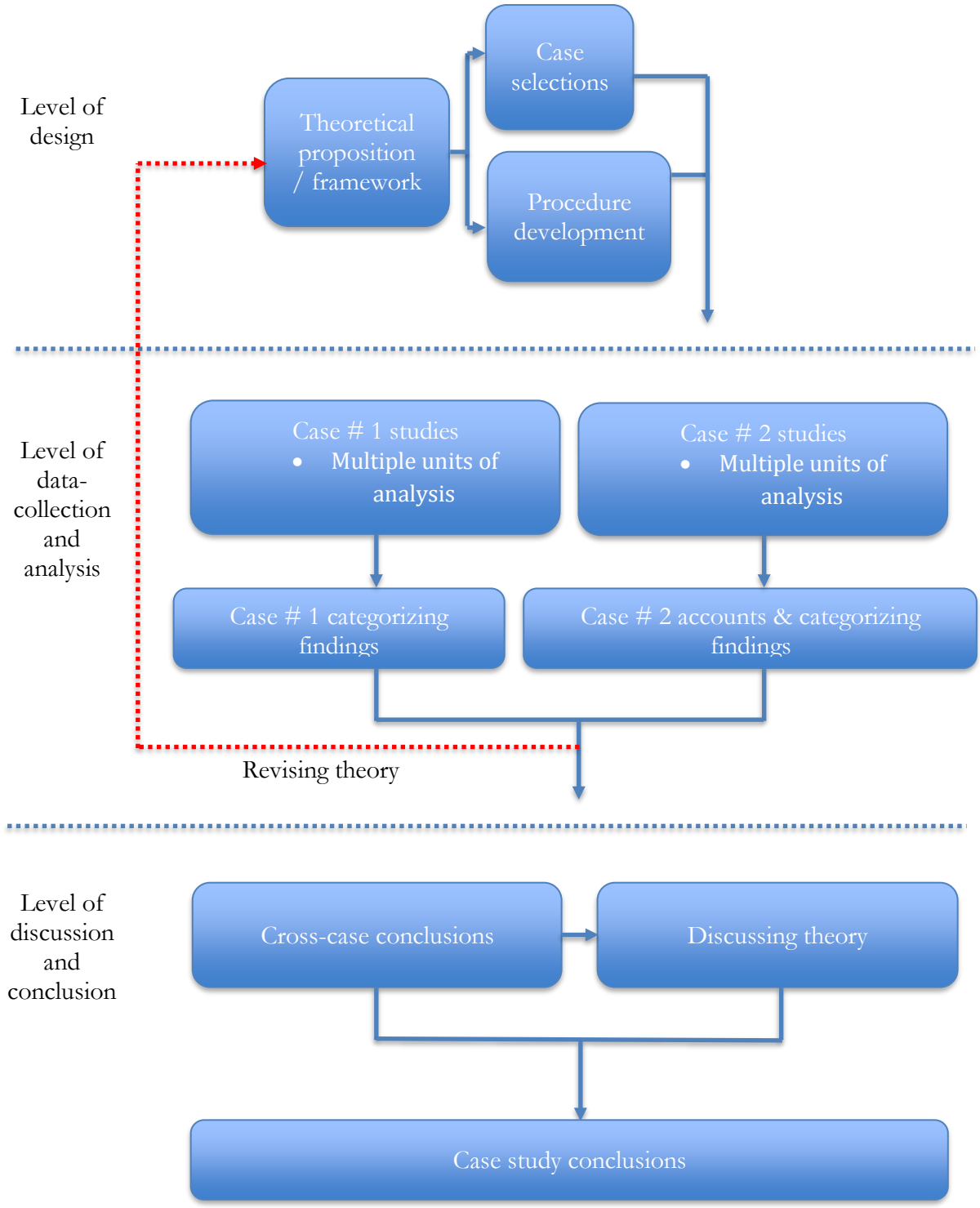

Figure 1: Study protocol.

The following instruments and data sources were used to build the thesis' empirical data set:

- Analysis of official accident investigation reports, accounts of ECDIS assisted accidents.
- Semi-structured (reflexive) observations of navigators using ECDIS for navigation under natural work conditions.

- Informal (dialogic) interviewing of navigators while using ECDIS for navigation, under natural work conditions. An interview guide was developed for support (included in appendix C, in its original, i.e., Danish language).
- Extensive note taking on the bridge while a ship is underway. The evidence collected, using multiple methods, from the multiple data sources, was triangulated (see below):

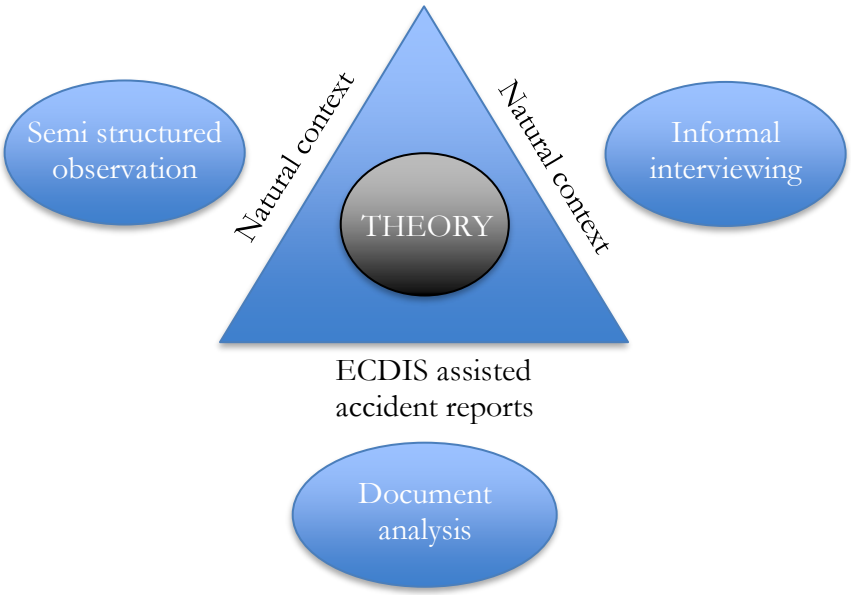

Figure 2: Triangulation of methods and data sources.

3.2.1 Case # 1 - "ECDIS assisted accident" reports

Document analysis of accident investigation reports were used here to explore pertinent features of the system during a *control break down*. As accidents are indeed rare such events was not expected to be observable during field work, and so insights were sought from these publicly available accounts. Furthermore, they offered insights into the common treatment of ECDIS assisted accidents, by researchers as well as officials, which often inform the widely accepted truth about the accidental events among the public.

The main criterions for selection of the accident investigation reports was that the ECDIS was actively used for navigation at the time of the accident, and that the ECDIS technology is given attention in the report.

The aim of analysis, thus, was twofold:

- To learn about the aspects of ECDIS use and technology which played some role in that accident.
- To explore the nature of the *official story*, i.e. how these ECDIS was treated in these narratives.

3.2.2 Case # 2 – Everyday use of ECDIS

The researcher aimed for a variety of ship types and trades, to obtain an as nuanced and multi-faceted experience of ECDIS use as possible. The focus on use of ECDIS, though admittedly represents one narrow slice of situated action that takes place within the broader context of navigation, and ship operation.

The interviews were intended to be dialogue between the investigator and the informants. Questions asked were open ended, and so were the dialogues. In that way, the informants were not forced to construct answers to pre-determined questions, but the ongoing dialogue could develop as naturally as possible. As the investigator spent relatively long hours on the bridge, the conversations between informant and researcher sometimes stretched far beyond the scope of the study and the questions prepared. This may have, partly, remedied the power asymmetry issue raised by Kvale (1996).

The aim of exploring natural contexts was twofold:

- To learn about the aspects of ECDIS use that was found cumbersome, and helpful, in relation to the everyday work carried out on the bridge.
- To be able to juxtapose these findings with those found in the ECDIS assisted accident cases analyzed.

On-board naturalistic data collection was carried out from February to April, 2016. Evidence was collected from the following sources:

- *Ship #1*: A cargo ship trading internationally with a fully compliant ECDIS installed. However, parts of its trading area were not covered by ENC charts and therefore paper charts was carried also and used too.
- *Ship #2*: A passenger ship trading internationally on a regular route and schedule. The bridge navigation system offered full integration between ECDIS, RADAR, AIS and autopilot.

- *Ship #3*: A domestic ferry on a regular route and schedule. The bridge navigation system offered full integration between ECDIS, RADAR, AIS and autopilot.

A data collection log was kept (included in appendix D) during attendance on board each ship. This is illustrated below.

Table 2

Data collection subject distribution

Ship #	Days on board (number)	Interviewees (number)	Observation time (hours)	ECDIS model
1	3	4 (Respondents A, B, C & D)	12 ½	Transas NS 4000
2	3	4 (Respondents E, F, G & H)	15	SAM Electronics Multipilot Premium
3	2	6 (Respondents I, J, K, L , M & N)	19 ½	SAM Electronics Multipilot Premium
Totals:	**8**	**14**	**47**	

The successful visit to a ship´s bridge enabled the construction of a narrative accounting for the ways that navigators use ECDIS to pursue the goal of safe navigation.

3.3 Data quality

Neuman (1997) warns that the quality of data derived from qualitative research cannot be assessed by the positivist standard of reliability and validity, i.e., in terms of precise, consistent measures of some objective truth. Rather, high-quality field data aims to capture processes of sense making. Therefore, the investigator did not aim to eliminate neither the subjective nor the objective elements of sense making related to ECDIS use.

3.3.1 Generalizability

No statistical generalizations were pursued in this study. Furthermore, the studied cases are not sampling units like experiments or surveys (Yin, 2014), and numbers derived from the study would be too small anyways to serve as an adequate sample to represent any population. Rather, what was pursued here was lessons learned, and analytic generalization going beyond the cases studied, i.e. "[…] to shed empirical light about some theoretical concepts or principles" (Yin,

2014). Thus, it was the aim of this thesis to expand and generalize the theoretical foundation underlying the thesis work, not to extrapolate probabilities.

One potential weakness in this study is the numerous ECDIS models and makes available on the market, and far from all could be included in this study. The same challenge can be raised given that this study only looked at several ECDIS on the bridge activities and accident reports.

3.3.2 Biases

With his master mariner background the investigator should be considered an insider (Yin, 2014) when studying navigators at work. However, because of working ashore for more than four years, at the time when the study was undertaken, some distance to the practical disciplines of navigation had been obtained. As accident investigator, at the time of writing, the role as insider was similarly assumed in the analysis of accident investigation reports.

The insider role offers the advantage of knowing the environment researched, thus, being able to identify relevant cues. One potential pitfall is however the thinking that one understands what is going on, so that there is no need to record or analyze it (Lützhöft, 2004). Furthermore, personal experience and opinion largely biases choice of research topic, questions asked and observations made, and subsequently the analysis of the findings. However, the basis for treatment of data was consistently based on the answers provided by informants, rather than the questions developed by the investigator, and it was the answers that informed the meaning of observations.

Then there is the issue of confirmation bias, i.e. the investigator sees what he expects to see, which can be an issue in qualitative research: How can one distinguish data saturation from confirmation biasing during later natural context data collection sessions? For example, are findings like those discovered at previous data collection sessions, or are they recognized as such only because they are now familiar to the investigator? Also, the investigator´s participation itself may have imposed biases, as events may be unintentionally and/or unknowingly manipulated or altered by the presence of the investigator, or by the ideas about his professional status as marine accident investigator. These conditions can be considered weaknesses in the chosen method. But they are a necessary trade-off that allowed the investigator to collect the data through participation in the natural context. With other methods, like simulation experiments, the sacrifice would have been that contextual inferences might have been missed regarding the

phenomena of interest. The participant observation method was chosen precisely because contextual conditions are exactly the object of interest in the study.

3.3.3 Reliability and Validity

"Reliability is the degree to which the finding is independent of accidental circumstances of the research, and validity is the degree to which the finding is interpreted in a correct way." (Kirk & Miller, 1986, p. 20). Kirk and Miller assert that perfect validity would mean having access to the complete and exact truth, and as this is not possible, validity as such cannot be used to challenge qualitative studies, while it can be easier to obtain something close to perfect reliability in both qualitative and quantitative studies. Validity and reliability, thus, are by no means symmetrical.

However, the case study research design chosen for this thesis work aimed to address validity and reliability in terms instead, of four quality measures; construct validity, internal validity, external reliability and repeatability (Yin, 2014). These measures were applied as follows:

- Triangulation of evidence from multiple data sources, and multiple evidence collection methods (figure 2)
- Application of theoretical propositions and a coherent theoretical framework
- Exploration of rival explanations (theory vs. natural context derived insights vs. official truths)
- Definition of data points in terms of specific concepts (abstract level) and operational measures (interview guide)
- Key informants offered the opportunity to review and comment on draft report.
- Identification of patterns, matching and categorizing
- Maintaining a clear chain of evidence
- Providing detailed descriptions of the methods, inspirations and the ontological position, and the provision of visible argument and evidence paths for the reader to follow.

3.4 Research ethics

The researcher was concerned mainly with two ethical issues in connection to this study:

- The fact that the researcher was employed as a marine accident investigator with an official accident investigation board.
- The fact that the main objects of study in the one case were human subjects that were not supposed to be at risk of incrimination of any kind if they participated in this research.

This was dealt with by emphasizing to potential informants and their organizations that the researcher´s professional status is irrelevant in relation to his academic studies, and that strict confidentiality would be maintained always. Later, during the data collection and subsequent analysis and processing, these principles was to be enforced.

Ship owning organizations found to be appropriate research subjects was addressed at both management level and operator level regarding participation. It was emphasized that both levels needed to express sincere interest, and no further plans were made before this two-level consent had been obtained. After these consents were obtained, subjects were familiarized with study objectives, ethics and *rules* (the letter of request for participation, in Danish, is included in appendix A). Included here was the right to refuse participation, both prior to any on-board visits and while data collection was ongoing, and the right to refuse to discuss any subject matter. This was further emphasized when informed consent was obtained from every informant involved (informed consent form is included in appendix B).

One rule was emphasized throughout this research, because the natural context studies were carried out during live operational conditions: A clear agreement and understanding between researcher and informant that all interviewing and observation activities were to be done at the discretion of the ships´ crews to not interfere during operations requiring full attention on navigational activities.

The accident investigation reports analyzed was freely available and in the public domain. Therefore, no ethical concerns were considered necessary to address regarding these reports.

3.5 Analysis

Analysis was started already before the research was undertaken, when the perceived issues of ECDIS assisted accidents as a potential function of mismatches between design and operational features, was defined as the problem to be treated in this thesis work.

The following analytical stage was initiated once on board carrying out the naturalistic research. Inputs in the form of statements from respondents and observed actions were, from start to end, subject to the researcher's interpretation, based on the actual context in which they occurred. Both the statements, observations and ideas were noted separately, immediately as they occurred

during the field work. These on-site analytic inferences also helped shaping the actual on board experiences as they inspired the further courses.

Immediately following the on-board sessions, the experiences and impressions were synthesized and patterns related to how use of the ECDIS proved cumbersome, and how it supported daily navigation practices, were identified and extracted for further analysis. This was done manually through a review of field notes and partly through audio recordings of the sessions. At one stage, the researcher found that many of the stories told by the respondents were connected to the *status* of the information derived through the bridge windows versus the information derived from the ECDIS. It was interpreted, by the researcher, as an underlying condition to the perceived problem to be treated in the study, and therefore it was decided to make this condition a subject for an elaborate analysis on its own.

The identified patterns were compared to concepts and information derived from the theoretical framework used in this thesis work, as found pertinent from the researcher's interpretation of events and statements. Based on how the theoretical insights connected to the practical problems encountered on board, and how these are thought to inform possible mitigation strategies, issue categories at an abstract, or higher order, level was formulated along with the researcher´s suggestions on how to address, or at least think about, the issues when these are viewed through the lens of a human factors and systems safety lens.

The analysis results were framed so that they could be compared with insights derived from official accident investigation reports, and form the basis for a further discussion about future design and development of ECDIS.

3.6 Research Procedures

Analysis of ECDIS assisted accident reports were carried out as follows:

- Official government funded accident investigation unit websites were searched to obtain published reports on ECDIS assisted accidents.
- Three sample reports that matched the selection criterions were chosen as a basis for analysis. Accounts were available from multiple investigation units, demonstrating similar structures and conclusions. However, reports published by one, world leading, unit were ultimately selected, to discuss here.

- The sample reports were reviewed, with a focus on the causal explanations related to use of ECDIS.
- The analysed data was synthesised and abstracted.

The natural context research was carried out as follows:

- Danish ship operators were approached and presented with a brief description of the research topic. A request for participation was also forwarded.
- Interest in participation was expressed by all approached ship operators. A letter describing the aim of the study, the proposed methods and approach was then sent to each contact point with the ship operators. They were asked to forward the letter to potential ship crews, requesting participation and seeking preliminary consent.
- When consent had been obtained from subject ships, arrangements were made for visits.
- Upon arrival on board the ships, objectives and rules were explained and consent forms were signed by all parties.
- The investigator was present during navigation duties on the bridge, observing activities involving ECDIS. Informal interviewing about the research topic was kept going, supported by the interview guide. As much observation time, as possible (practical), was logged, and in all cases, every navigation officer on board at the time of attendance was observed and interviewed. The observations were in most cases sound recorded (subject to informant permission), and field notes were made (done during breaks in the conversation, mostly away from the informant, in order not to disturb focus).
- The stories collected from the respondents and the observations made by the researcher during the on-board sessions was synthesized and a narrative was constructed on this basis, which accounts for the experience on board. Field notes were given the highest priority in informing this storytelling process (Neuman, p. 368). The accounts were constructed immediately following the on-board sessions, to ensure accuracy.
- The accounts functioned as a basis for the analysis, which resulted in the extraction of issue categories at two abstract levels. This means that the respondents´ perceived issues with ECDIS navigation, and those issues perceived by the researcher were sorted under common denominators, characterizing the core of the issues encountered.
- The abstracted issues were tabulated for comparison purposes.

4 FINDINGS AND ANALYSIS

4.1 Accident report analyses

Evidence was collected from the sources referenced below. The accidental events are briefly summarized here, and the accident investigation reports, in their full lengths, are included as appendices E, F & G.

ECDIS assisted grounding #1 - Commodore Clipper (MAIB, 2015)

In the morning on 14 July 2014, the Bahamas flagged Ro-ro passenger ferry, Commodore Clipper, departed Portsmouth, UK, bound for St. Peter Port, Guernsey, on the continental side of the English Channel. The ship used its ECDIS as the primary means of navigation, backed up by paper charts. On approach to St. Peter Port, the ship was navigating slightly off the planned track. As it passed close to the Roustel Beacon light house a noisy shuddering vibration was felt reverberating through the ship. The bridge team observed nothing unusual and convinced themselves that they had just caught something with the propellers. The master was sure that the under-keel clearance had been sufficient, and that it would have been safe to pass even closer to the light house. Therefore, the vibration felt in the ship was not thought to be the result of contact with ground. However, during a routine inspection of the hull, after arrival in port, it was established that the ship had touched bottom, and suffered significant damage and hull penetration.

ECDIS assisted grounding #2 - Ovit (MAIB, 2014)

In the morning on 18 September 2013, the Maltese chemical tanker, Ovit, was underway from Rotterdam, Netherlands, to Brindisi, Italy, when it ran aground on the Varne Bank, in the English Channel. The ship was being navigated by the chief officer at the time of the grounding, by using the approved ECDIS solely for position monitoring. The passage planning had been carried out, using the ECDIS, prior to departure of the ship by the ship´s third officer. No significant damage occurred and there were no injuries because of the accident.

ECDIS assisted grounding #3 - CSL Thames (MAIB, 2012)

In the morning on 9 August 2011, the Maltese bulk carrier departed from Glensanda, UK, bound for Wilhelmshaven, Germany. A pilot was on board to assist on departure. After the pilot had disembarked the ship, it continued on track, out through a relatively narrow sound. The master had handed over the watch to the ship´s third officer. Navigation was undertaken by means of

the instruments including two radars, but the ECDIS was considered the primary means of navigation. To steer clear of a recreational craft that was navigating in the sound, at an approximately opposite course, the third officer altered the ship´s course so that it deviated from the planned track. As his initial maneuvers proved ineffective, because the third officer became aware of the presence of a third vessel, he continued to alter the ship´s course to starboard. Eventually the ship grounded and only narrowly avoided a collision with one of the other vessels. Substantial damage occurred to the ship.

4.1.1 Patterns derived from the report findings

From the report analysis, several *issues* could be identified, which are here interpreted as indicators of how the phenomena of ECDIS assisted accidents are treated in these investigations. Below, the researcher has abstracted these issues so that they reflect the recommended preventive actions, expressed in the reports:

1. **Reliance on the visual representation provided by the ECDIS – mitigate complacency, discipline operators.**

   Ovit´s position was monitored solely against the intended track shown on the ECDIS. Consequently, situational awareness was found to be poor, as this track did not provide a safe passage, and not all means of navigation was (could be) considered.

2. **Use of ECDIS functionality – enhance training and procedures.**

   On board Commodore Clipper, specific passage planning actions were routinely not taken; route checking, ECDIS safety depth, safety contour and XTD settings were not adjusted to reflect the safe water, based on height of tide, available for the passage. The ECDIS safety frame is a feature that offers forewarning of danger, primarily intended to prevent grounding, but this feature was switched off.

   The operator-defined settings applied to the ECDIS fitted on board Ovit were unsuitable, and the route, planned by the third officer, was unsafe and had never been properly checked.

   The safety alarm parameters (safety contour) of the ECDIS fitted on board CSL Thames were not corresponding to the vessel configuration (draught).

3. **Chart scale / zoom function - enhance training and discipline operators.**

   On board Ovit, the scale of the chart shown on the ECDIS was inappropriate.

4. **Audible alarm not used or inoperative – discipline operators.**

   On board Commodore Clipper the audible alarms had been disabled because of frequent alarms, and consequently the crew did not respond to the alarm warning about risk of grounding.

   On board Ovit the ECDIS audible alarm did not work.

   On board CSL Thames the audible alarm of the ECDIS was inoperative.

5. **Training as ineffective mitigation – improve training regime.**

   Although training in the use of the ECDIS fitted on board Ovit had been provided, the master and deck officers were unable to use the system effectively.

   Despite the mandatory training, the crewmembers on board CSL Thames were found to have difficulties operating the ECDIS.

6. **Automatic functions not operating as expected – improve ECDIS functionality/reliability.**

   The safety contour alarm should have activated shortly before Ovit crossed the 30m contour.

7. **Formal integration of ECDIS – enhance procedures.**

   No guidance on the use of ECDIS was included in the master´s standing orders on board Commodore Clipper.

   The company operating CSL Thames had not provided any instructions or guidance on the use of the ECDIS fitted to the ship.

8. **Basic ergonomics – improve design.**

On board Commodore Clipper, the ECDIS display screen was located on the starboard side of the central bridge console adjacent to the starboard side (master´s) chair. It was not accessible from the port chair.

Several of the features of the ECDIS fitted on board Ovit were either difficult to use or appeared not to comply with international standards.

On board CSL Thames the ECDIS was installed so that the operator needed to stand facing sideward relative to the forward direction of the ship to use it. As the third officer was preoccupied with anti-collision activities at the time of the accident, facing forward, it was difficult to operate the ECDIS effectively at the same time.

9. Information presented by the ECDIS not acknowledged – enhance training.

The XTD alarm on the ECDIS on board Commodore Clipper was active for 10 minutes prior to the grounding without being recognized by the bridge crew.

After the course alterations were made by the third officer of CSL Thames, he did not monitor the position and projected track of the ship on the ECDIS. Neither did he recognize the grounding warning alarms on the ECDIS. This had activated approximately 7 minutes prior to the grounding.

The abstractions are ascribed to three higher order categories of *training/discipline, procedures* and *design* as shown below.

Table 3

Accident report analyses patterns

Patterns			
Training/discipline		**Procedures**	**Design**
1	Reliance on the visual representation provided by the ECDIS – mitigate complacency, discipline operators.		
2	Use of ECDIS functionality – enhance training and procedures.		
2			

3	Chart scale / zoom function - enhance training and discipline operators.
4	Audio alarm inoperative – discipline operators.
5	Training as ineffective mitigation – improve training regime.
6	Automatic functions not operating as expected – improve ECDIS functionality /reliability.
7	Formal integration of ECDIS – enhance procedures.
8	Basic ergonomics – improve design.
9	Information presented by the ECDIS not acknowledged – enhance training.

4.2 Natural Context Studies

4.2.1 The bridge windows or the ECDIS?

A theme that reverberates throughout the natural context accounts derived from the studies is connected to the *bridge windows* and how these relate to ECDIS navigation, i.e. data input origin and processing. This theme is here found to be a manifestation of the hermeneutics associated with ECDIS navigation, and, thus, also the complexities that arise from it, hidden behind the seemingly ease of use offered by the visual real-time navigation mode that the system provides. This condition is exemplified, for example, in the following:

> The crew members did however have a hard time figuring out why navigation information such as particular navigation marks and depth contours were not represented at certain chart zoom-levels at certain positions. (Respondents E & F)

With the introduction of ECDIS navigation there has been a shift that moves data input towards a conflation of sea chart and the bridge windows. Thus, the windows may seize to be thought of as a representation of *the real world* which the charts are checked against, while the charts may be thought of as an automated representation of *fact* rather than a reference that verifies the observations made, manually/visually, by the navigator. Statements made by respondents, point towards this condition, exemplified in the following:

> You tend to look less through the windows, the more information that is put on the screen in front of you. What is gained from looking out the windows basically seems less pertinent. (Respondent H)

Such a shift fundamentally changes work on the bridge and the role of the navigator in navigating the ship. From being a manually controlled task (naturally within the limits of the navigators´ individual capacity and capability) of determining the ship´s position this is now done automatically with seemingly limited needs for insights about functioning. The role of the navigator, in navigating the ship, has effectively been reduced to a supervisor of the technology while this is performing the navigation. This relationship reveals how determining the ship´s position changes towards a social collaborative relationship between human and the technology.

With this changing of the role of the navigator there will, inevitably, occur an erosion of the manual skills that was necessary to the navigator during eras of navigation prior to ECDIS, confirmed by opinions expressed among informants to this study. However, it also suggests that while the future may look sinister with regards to preservation of more traditional disciplines of navigation, we may currently find ourselves in an implementation phase, not just with regards to the fitting of ECDIS on board most ships, but, perhaps to an even larger degree, regarding how the ECDIS is used on board.

Scepticism towards the system was found with many of the informants, and the ECDIS´ competition with the windows for the navigator´s attention is not unproblematic. In the following statement, it is particularly clear how a mismatch between data from the bridge windows and the ECDIS (in this case operating without the availability of ENC) can have a shattering effect on the navigator´s mental model of ship positioning, in the current implementation phase where many navigators find themselves in a borderland between what came before the ECDIS, i.e. input from the windows among other, and the new functionalities:

> On approach to port, following a turn, the representation on the ECDIS screen suddenly did not match the visual representation obtained from looking out of the window. An island was on the "wrong side" of the bow. This was highly confusing. (Respondent D)

With the technology, unable to make decisions beyond the integrated algorithms it must be assumed that the human navigator is still in control of navigation, ultimately. In the situation described in the statement above there was a need to quickly reconstruct sense making that could be used to rapidly make decisions that would allow the bridge crew to regain control over manoeuvrings, which required the integration of information from sources external to the

electronic chart system. Hermeneutic functioning of the ECDIS, in combination with eroded manual operator skills, may hamper the ability to reconstruct sense-making when the JCS is challenged. An example of how the hermeneutics associated with ECDIS operation may confuse operators is found in the following:

> Unaware of the fact that representations of chart details at different zoom levels was determined by the system itself as a feature in the default setup, the crew members did however have a hard time figuring out why navigation information such as particular navigation marks and depth contours were not represented at certain chart zoom-levels at certain positions. (Respondents E & F)

Despite the impact from the technology, towards an erosion of the way that instrument derived data used to be cross checked with visual observation, the scepticism expressed by respondents in the study was often closely connected to how the world was perceived through the windows. In continuation of the previously quoted statement made by respondent D, such scepticism is exemplified in the following:

> It [the ECDIS] often functioned only as a secondary reference, subordinate to other more basic methods [terrestrial/visual]. During critical manoeuvring, for example navigation close to shore, the use of ECDIS was directly abandoned. (Ship # 1)

On one ship scepticism was low if the waters were known, i.e. felt familiar to the navigators because they had recognized the limitations of the ECDIS, e.g. by knowing from visual observation that sea marks were in place despite that they were not represented on the ECDIS, in the applied system configuration. In contrast, scepticism was high when the ship was navigating in unfamiliar waters, and even traditional sea charts were consulted (ship # 2). On board another ship it was similarly what was observed through the windows that enabled the bridge crew to manually correct their ECDIS chart representation so that it could be used for docking: "the crew *finished the chart design* by manually drawing a virtual line that matched the ship´s contour and indicated when the ferry had docked" (ship # 3).

Perhaps paradoxically, it can be said that while bridge cognition, in relation to position referencing, has become ever more distributed, in the sense that the human navigator used to be central to making sense of data on the bridge, originating from a variety of sources, but has now

turned over this position to e.g. the ECDIS, the data source representations has become more and more integrated. Common strategies, observed during the study, was to collect navigation information from devices on a central representational unit, with the ECDIS as the background:

> A common strategy was to integrate all the systems´ information (RADAR, ECDIS and AIS) on the screen in front of the chair where the navigator was sitting. This was where the primary attention was directed, and the other screens, were glanced at only occasionally. (Ship # 2)

This is potentially the future *technological window*, should the scepticism towards the technology decline with the next generations of navigators, and the borders between what can be seen through the windows and what can be obtained from the technology dissolve. The question that must be asked, however, is how it affects safety of navigation and/or the resilience of the navigation system, i.e. its ability to reconfigure to remain in control of safe navigation in the face of disruption? Not to argue against the technological development, but rather to gain a better understanding of the implications of the technology, here considered useful when tomorrow´s systems are designed and developed.

4.2.2 Patterns derived from the findings

From the empirical evidence, common elements could be extracted across the units of analysis. The findings are assigned to abstracted categories below along with proposed action points. Several findings would overlap categories, but have been placed in the one found more pertinent, by the researcher.

1. Mistrusted, technology – enhance ability to determine system reliability.

The crew on board ship # 1 experienced that there was a mismatch between satellite derived positions, i.e. their representation on both ECDIS and paper charts, and the correct spatial position of the ship, which could be verified from terrestrial observation methods. This was the reason for *a sound skepticism towards the ECDIS* as it was expressed by several crew members (Respondents A, C & D). From the crew members´ point of view, the conditions made it necessary to use terrestrial techniques on many occasions to obtain a trustworthy representation of the ship´s position, and plot this in a traditional sea chart. One account of a near-miss was given by a crew member:

> On approach to port, following a turn, the representation on the ECDIS screen suddenly did not match the visual representation obtained from looking out of the window. An island was on the wrong side of the bow. This was highly confusing. (Respondent D)

The mental model of the situation was instantly shattered and required a rapid reconstruction. This incident was an overarching barrier hindering the ECDIS in becoming a fully integrated, or trusted, element in the bridge´s system of position referencing, therefore it often functioned only as a secondary reference, subordinate to other more basic methods. During critical maneuvering, for example navigation close to shore, the use of ECDIS was directly abandoned.

Although ship #2 was fully ECDIS compliant, additional paper charts were kept, although they were not updated regularly, so they served as an additional, unofficial, reference in case the ship needed to make voyages beyond its regular trading routes. Two elements were emphasized as the reason for this; the first being a matter of trust (the level of trust in the ECDIS was high if the route sailed was well known from previous experience and cross referencing between terrestrial data and ECDIS data, but declined as the waters navigated became less familiar), and the second being that the crew members found it easier to obtain an overview on a traditional paper chart, also during route planning. Furthermore, regular IT issues were experienced (infrequently though). The latter included loss of system sensor input and system freezes. Normally the issues could be resolved by restarting devices, or the system, but until the reboot was completed; "we have practically no navigation aids" as a crew member expressed it (Respondent F).

The perceived benefit however of the bridge systems integration on board ship #2 was that different representations could be cross-referenced instantaneously; "does RADAR and AIS tracks correspond, and land features or navigational marks shown on the ECDIS can match the RADAR echoes?" (Respondent E). Thus, terrestrial and satellite information was used to verify each other at a glance.

On board ship #3, uncertainty about the trustworthiness of the data quality presented by the system was expressed. Sources of uncertainty comprised discrepancies observed from comparison between instruments, at certain instances: During berthing the ship contour did

not match the berth represented on the chart. Thus, the crew *finished the chart design* by manually drawing a virtual line that matched the ship´s contour and indicated when the ferry had docked. The ECDIS did not communicate to the crew, it was imprecise in its representations and, thus, it was left to the crew to assess the reliability of the representation provided, by integrating other information, and personal/collective experience. One crew member expressed: "I can only use it for *approximation*, when I ought to be able to use it for *navigation*" (Respondent I). Another crew member expressed that the ECDIS was not found to provide the same level of overview as the traditional paper charts offered (Respondent J).

2. Hermeneutic mode of operation – enhance system communication and transparency.

The crewmembers on board ship #1 found the ECDIS very useful (Respondents A,B,C & D), but knowledge gained from experience was necessary, to determine when the data on the screen could be trusted as the system did not communicate to the user when the position representation displayed was unreliable, and thus it was found ignorant of its own incapacity to show true location. The usefulness of the system in terms of real-time position representation and ease of route creation, and deviation from a route, which was often necessary, made the crew pick from among the ECDIS functionalities the ones they found feasible and integrate the perceived benefits with those of other strategies deployed for navigation.

Due to the trade pattern of ship #2, the crew members seldom had the need to plan new routes as these were re-used. Further, an effect of the trade pattern was that the crew members were very familiar with the routes sailed, including any navigational obstructions and dangers, and new crew members were quickly familiarized with the trade. This meant that any perceived shortcomings of the ECDIS were compensated for by integrating the information provided by the system with the individual experience, and the collective knowledge present on the bridge (experience sharing), and thereby the crew members could fill in the blank spots. An example of this was the missing representation of known navigation marks on the ECDIS chart. Unaware of the fact that representations of chart details at different zoom levels was determined by the system itself as a feature in the default setup, the crew members did however have a hard time figuring out why navigation information such as particular navigation marks and depth contours were not represented at certain chart zoom-levels at certain positions (Respondents E & F). Thus, a slight mistrust in the processes behind the electronic chart construction had developed on board.

3. Automation vs. Operator control – understanding of limitations in various contexts.

The auto scale function on the ECDIS on ship #1, choosing the most appropriate chart scale, as programmed into the system, was deselected because it was annoying and attention demanding when scale shifts occurred that was not found pertinent. One crewmember expressed that; "I don´t need the machine to decide what I need to see" (Respondent H). Furthermore, the rationale behind the system´s choice of chart scale was not communicated effectively to the users, leaving them in the dark regarding *the logic of the machine*.

One crewmember on board ship #2, recalled an experience on board another of the company´s ships:

> We were crossing into an offshore wind farm under construction, which had not been represented on the ECDIS at the selected chart zoom level. Some of the turbine foundations were already installed. When we zoomed in on the ECDIS, the wind farm suddenly appeared, and we were inside of it". (Respondent G)

The representation selection on the ECDIS, which made sense to the crew at the time, did not hold the relevant information, at the time, needed for safe navigation and created a near miss situation.

Different settings for sensor input to the system could be selected on board ship #3. One setting that automatically switched between the two GPS receivers fitted on board was deselected by crew members. This was because during switching between receivers the representation of the ship contour, on the chart, *jumped* because of a proximal difference in position; "It is difficult to work out the exact parameters that determines the switching between GPS receivers", as it was expressed by a crew member (Respondents J & K). This was found cumbersome while maneuvering narrow waters.

4. Alarm functions disturbing, not helpful - address operator goals and sense making.

The navigational alarms offered by the ECDIS on board ship #1 was deliberately deselected by the crew members as part of a common strategy among all navigators on board. One crewmember expressed that; "the amount of alarms is often unmanageable, and too much

time is needed to sort out, acknowledge and cancel them" (Respondent A). Thus, the alarms were perceived as a nuisance, borderline hazard, rather than as supportive. Despite automatic selection of all alarms by the system, upon start-up, they were systematically deselected by the crew. A crew member told that:

> At one time, following a chart update where the alarms were reactivated, deselection was forgotten afterwards and immediately after switching back to navigation mode, "navigational warnings" and "safety contour" alarms activated visually and acoustically. However, it was not clear exactly what on the chart had activated the alarms and therefore highly confusing. (Respondent D)

This information was not communicated effectively by the system. A crew member expressed that; "the alarms are difficult to derive meaning from. It is not clear why the alarms appear and elaboration on them (information on this) is not offered by the system" (Respondent A).

On board ship #2 all ECDIS alarms that could possibly be disabled had been so. Furthermore, the speaker creating the audible signal had been blocked by a piece of adhesive tape. The reason for this was that the alarms were perceived as annoying, with little or no perceived value offered to the crew (Respondents E,F,G & H). Alarms that offered specific information about the state of the system, such as a GPS information failure alarm, was, however, considered useful and so were alarms that clearly communicated an important state, e.g. a lost target alarm (on the RADAR). Most of the alarms produced by the system was perceived to offer little or no information that supported navigation. This was so, partly because of poor communication, i.e. the source of the alarm was not specific enough and they were too frequent to deal with.

As part of a process to screen out what was perceived as irrelevant information provided by the system, all possible alarm functions had been disabled on the ECDIS fitted on board ship #3. The audio speaker had also been blocked to silence, as much as possible, the alarms that could not be disabled. A crewmember noted that:

> It is difficult to determine the origin of several alarms, and it is distracting to have to attend to these, (and) trying to work out what they mean, when attention is demanded on maneuvering and such. (Respondent I)

Maneuvering constituted a substantial part of the daily operations on board.

5. **Clumsy information representation and potential clutter - take holistic approach to needs for information.**

   On ship #1 it was noted that many pieces of information, represented on the ECDIS screen, was overrepresented in the sense that this information was also represented on other instruments on the bridge console, in some instances on several other displays: "I don´t need that information several places" one crew member noted (Respondent C).

   On ship #3 the same point was made; too many information-doublets (Respondent M).

6. **Complex user interface - address specific ship operations and individual operator needs to customize ECDIS functionality.**

   A crewmember on ship #1 expressed that "it is not expedient to need to have the manual ready for reference during navigation" (Respondent A). Neither should one have to navigate sub-menus in the ECDIS system while navigation is ongoing; "an extra man is required, then" was further expressed (Respondent A). This, led to little interest in setting up the system to individual preferences, following shift handovers. One crewmember expressed that; "you count on the settings to be appropriate when you take over the watch" (Respondent D).

   The ECDIS on ship #1 was integrated with an early E-navigation trial platform, which, among other, allowed the ship to communicate its routes with other parties, including other ships trading in the area, and authorities ashore and at sea. This basic concept was much appreciated by the crew members who were often trading in remote locations, but due to technical difficulties in the system (failure to connect to the internet properly and poor integration with other systems, e.g. AIS) they only used the system infrequent. The actual words from a crew member was; "it is great when it works" (Respondent A). Similar, chart updating was perceived as annoying because of only unstable connection to the internet.

   The crew members on board ship #2 had different preferences with regards to the level and layers of information they wanted represented on the screen. One strategy was to select as

much information as possible, in order not to miss anything (Respondent A). Another strategy was to select only what was perceived as strictly necessary (Respondent H). The latter strategy was connected to how the equipment was integrated and represented. The integrated navigation system consisted, on the console where navigation was done, of four monitors, which were interchangeable in terms of what was shown on each screen. This could be selected by the navigator on watch. A common strategy was to integrate all the systems´ information (RADAR, ECDIS and AIS) on the screen in front of the chair where the navigator was sitting. This was where the primary attention was directed, and the other screens, were glanced at only occasionally. With the RADAR echoes represented on the same screen as the chart, the danger of not noticing small echoes that did not simultaneously show AIS information, was perceived by one crew member to be quite possible, based on his experience: "once I missed one echo belonging to a small craft" (Respondent G). The screen was considered too cluttered with all the representations of data. Another crew member, who also pursued this latter strategy of information sorting, said that "the feature that allows customizing of the information representation are useful" (Respondent H). This was preferred over the predefined layer selections offered by the system, but a need for even further options of individual information selection and setup was expressed, to truly match individual preferences and strategies.

One disadvantage, as expressed by several crew members on board ship #2 (Respondents E, F & G), was that basic chart information, including navigation light characters and bottom characters were difficult to obtain as several sub-menus needed to be scanned, and then the information found was ambiguous. A crew member stated that "sometimes you give up before you end up at the desired piece of information" (Respondent F). The menu system was in general perceived as *complex*, i.e. too many layers and not very intuitive.

Due to the short crossing trade of ship #3 only one fixed route was used during daily operations. New route planning was only relevant in relation to dry-dockings. The functionality needed from the ECDIS to undertake the daily operations was basically the ability to follow the course line plotted, and to have AIS targets represented visually for anti-collision purposes. "Many of the functions offered by the system are irrelevant", was the opinion expressed by one crew member (Respondent J). However, the few functions used, for example full AIS target information was found cumbersome to retrieve, because several sub-menus had to be navigated. As expressed by another crew member: "further options for

customization to the individual users´ preferences and needs would improve on these conditions" (Respondent M).

7. **Prosthetic use of systems – maintenance of basic skills.**

It was a common opinion among the crew members on board ship #2 that the ease of use offered by the ECDIS, and the integrated system gradually disconnected the crew members from basic navigation skills. The youngest of the crew members expressed that:

> You tend to look less through the windows, the more information that is put on the screen in front of you. What is gained from looking out the windows basically seems less pertinent" (Respondent H)

8. **System as means to predict and plan future actions – develop further predictive functionality.**

A major benefit provided by the ECDIS fitted on ship #2 during manoeuvrings in narrow waters with sharp turns, was the ability to *look ahead* by using the system´s curved heading line and predict functions, said one crew member: "This gives a good indication of the ship´s current capacity to make a planned turn and to see where the ship will end up after turning" (Respondent A).

9. **Skills difficult to transfer across systems – enhance functional transparency.**

One crewmember who had recently joined ship #2, came from another ship within the company, expressed the difficulties in changing from one ECDIS system to another:

> There is a low level of standardization and it is only very general knowledge that is transferrable. It feels a bit like starting from scratch again with a new system. (Respondent H)

10. **Operator/system preference mismatch – align *work as imagined* with *work as done*.**

The availability of ENC charts on the ECDIS on board ship #1 did not lead crewmembers to trust the positional representation(s) on the screen, and at times the unofficial charts were

chosen over the available ENC charts. The ECDIS could automatically prioritize ENC charts, and automatically load these when available, but this function had been deactivated, deliberately. The crew members gave two main reasons for this; "the unofficial charts visually resemble the traditional paper charts more" (Respondents A & C), which were used in navigation strategies that was trusted more, and "when using ENC charts there sometimes comes jail bars all over the screen (vertical lines all over the chart)" (Respondent A & B), which was perceived as disturbing, and partly incomprehensible to the crew members (they believed it to somehow relate to temporary chart corrections loaded in the system). Thus, the officially, and vendor, perceived advantages of ENC charts did not match those as perceived by the navigators.

The strategies used for positional representation on ship #1 were to a large degree dependent on both the collective and individual experiences available on the bridge. Functions and features delivered by the ECDIS was continuously cherry picked, to make the functionality of the system fit multiple strategies in the joint navigation system. This also gave the crew members a sense of ease of use despite the limitations and incompleteness of the ECDIS, in meeting the operational demands. In this way, they themselves *finished the system design*.

On board ship #3, the chart scale was frequently adjusted to suit the navigators´ strategies at different parts of the routes. On several occasions the ECDIS warned that the chart was *overscaled*. This indicated that the chart representation preferred by the system was inconsistent with that preferred by the navigator. The preferences of the latter were based on context, i.e. traffic situation, current operation (maneuvering or crossing), environmental factors etc. The ECDIS did not account for any of these factors, illustrating the context independent nature of the automated system. The crew members preferred to determine the level of automation themselves, as expressed by one crew member; "I´d rather decide for myself" (Respondent L). However, crew members were not aware of the fact that representations of chart details at different zoom levels was determined by the system itself as a feature in the default setup (Respondents I, J, K, L, M & N). The representation automatically chosen by the system often made little sense to the crew members.

The abstractions from crew interview are ascribed to three higher order categories of *adaptation, mismatch* and *communication/coordination* as shown below.

Table 4

Natural context studies patterns

Patterns			
Adaptation		**Mismatch**	**Communication/coordination**
1	Mistrusted technology – enhance operators' ability to determine system reliability.		
2	Hermeneutic mode of operation – enhance system communication and transparency.		
3 **3**	Automation vs. Operator control – understanding of limitations in various contexts.		
4 **4**	Alarm functions disturbing, not helpful - address operator goals and sense making.		
5 **5**	Clumsy information representation and potential clutter - take holistic approach to needs for information.		
6 **6** **6**	Complex user interface - address specific ship operations and individual operator needs to customize ECDIS functionality.		
7 **7**	Prosthetic use of systems – maintenance of basic skills.		
8	System as means to predict and plan future actions – develop further predictive functions.		
9	Skills difficult to transfer across systems – enhance functional transparency.		
10 **10** **10**	Operator/system preference mismatch – align *work as imagined* with *work as carried out*.		

4.3 Comparing the two cases

From a comparison of the post-accident accounts and normal work context accounts it is found that the issues with ECDIS in each case are interrelated. The abstracted patterns stand, however, in opposition to each other but can be said to represent two sides of the same coin, as shown below.

Table 5

Interrelation between accident report analyses and natural context studies patterns.

Pattern interrelation		
Adaptation & Communication/Coordination	VS.	Training/Discipline & Procedures
Mismatch	VS.	Training/Discipline, Procedures & Design

The explanatory frame used in the two sets of cases vary substantially, spanning from mainly being an issue of poor operator training and discipline, or poor instructions, to a variety of insights that points towards issues with co-agency and communication. These issues affect how interaction between the navigator and the ECDIS plays out, including work-arounds and tailoring to make the system fit the operator in ways that does not seem to be accounted for at a design stage. An example of this is found in the following two representations of the same basic element, i.e. the selection of chart scale:

> On board Ovit, the scale of the chart shown on the ECDIS was inappropriate vs. On board ship #3, the chart scale was frequently adjusted to suit the navigators´ needs at different parts of the routes. At several occasions the ECDIS warned that the chart was `overscaled´. This indicated that the chart representation preferred by the system was inconsistent with that preferred by the navigator. The preferences of the latter were based on context, i.e. traffic situation, current operation (maneuvering or cruising), environmental factors etc. The ECDIS could not account for any of these factors, illustrating the context independent nature of the automated system.

The two representations of the issue consequently prompt different mitigation strategies. One is, better training, procedures and operator discipline, alternatively (the other) is a better understanding of contextual demands which could minimize potential mismatches between the designer, operator and machine images, embedded in the ECDIS.

The post-accident accounts primarily reflect WAI (*work as imagined),* i.e. the idealized way that a system is thought to work through governing in legislation, standards, procedures, design etc.,

and the accident reports seem to aim at restoring a disrupted system by identifying how the situation did not match the imagined scenario and gives suggestions to how to obtain a future match. WAD (*work as done)* is reflected in what crews can tell about their everyday work, i.e. how the idealized conception of functioning is distorted by contextual demands and inferences, in the field of operation and, therefore, how workarounds are deployed.

In all the reviewed reports on ECDIS assisted groundings there has been an emphasis on a need to improve (amostly) operator capacity or moral, so they use the functionalities of the ECDIS properly, or the focus has been (to a lesser extent) on tweaking functions of the ECDIS in order to minimize a perceived risk of operator error. None of the reports focus on the actual coordination of the means-goals, i.e. making integration of human and machine more successful by exploring what would have helped the crews to make optimal use of the data available from the system, to avoid the accidents.

The study illuminates some of the gaps that exist between the outsider interviewing in hindsight and the operator performing actual work in an everyday context, and demonstrates how this gap can be explored and minimized. Future system developments can be influenced by system functionality feedback, from the regulatory level that creates performance standards, legislation etc., to the manufacturer level where standards are implemented along with other vendor and industry ideas about functionality and features. Accounts from the applied community are often seen as not as relevant or important when compared to the official truth established by formal accident investigations. However, this study demonstrates that findings that help us to understand the use of artefacts, and thereby also safety, can be derived from the natural working context. Further, this information is most valuable if we are to successfully design safety into the technological artefact.

About training issues, in most of the reviewed accident cases formal training in the use of ECDIS had been completed by the involved crew members. But the accident investigation reports show that this was not sufficient mitigation against operators getting lost in their systems. Therefore, it can be argued, training is not necessarily a complete solution to dubious designs, and that current ECDIS training regimes themselves could be another pertinent research area.

5 Discussion

5.1 Why Human Error?

The researcher´s intention, here, is not to portray formal accident investigations as conspiracies against alternative ways to understand operating environments. These may, however, often seem so but the author believes that they merely reflect an established tradition rooted in the history of modern society. Growing bureaucratization in society in general, and bureaucratization of safety (Dekker, 2014-1) have led to a perceived need for parenting institutions such as accident investigation entities that serve entangled societal needs, arising following accidental events. Dekker (2014-2) identified these needs as a four-component constellation:

- Establishing what happened (epistemological component)
- Identification of pathways for avoidance (preventive component)
- Tracing of transgressions committed, and reinforcement of moral and regulatory boundaries (moral component)
- Finding explanations for the suffering that occurred (existential component)

The researcher does not intend to evaluate if the official explanations are right or wrong, but rather to raise the question of how to pursue new pathways, in terms of creating tomorrow´s artifacts that will help joint human-machines systems to obtain their goals, both in terms of safety and production, which is often two sides of the same coin (Hollnagel, 2014).

5.2 What can be learnt from the natural context findings?

The insights gained from the natural context research sheds light on the flip side of the epistemological component (as outlined above), and therefore can contribute to the understanding of the system described here, and indirectly to the understanding of ECDIS assisted accidents. Second stories about properties of ECDIS use was indeed possible to extract from the research for this thesis. How the findings connect to the theoretical framework used here will be discussed in the following, to examine what clues they may hold for future design and development of ECDIS.

This research attempted to understand *what makes work difficult* (e.g. Woods et al., 2010) for any agent or sets of agents during navigation by use of ECDIS. The identification of joint cognitive system demands, helped reveal "how agents have or will adapt and how artifacts have

affordance" (Woods & Hollnagel, 2006, p. 20). This focus is believed by the researcher to promote a shift in analysis, and design, away from the fallacy of *function allocation* (Dekker & Woods, 2002) by addressing how integration and co-agency work out during ECDIS navigation. Function allocation, or *Man is Better At – Machine is Better At*, risks falling prey to a false opposition between people and technology.

The researcher found was that there was a common skepticism towards the ECDIS. The ECDIS represents only part of the input integrated by most mariners to construct their mental model, based on which navigational decisions are made. The mariners were found to be very sensitive to cues derived from the whole operating environment (the experienced mariners). However, at the same time the modern hermeneutic mode of navigation, i.e. "the operator has moved from an experience of the *world* through the artefact to an experience of the artefact embedding the world." (Hollnagel & Woods, 2005, p. 33), seems to bear the risk of decreasing this sensitivity. The risk is that silently, imperceptibly, ever more control will be given to the automated system, which relies on the embedded images and algorithms developed at a distance. So much more the reason to try to understand the environment that developers aim to model and engineer into the artifacts, to avoid what has been termed *clumsy automation* (Wiener, 1989 as cited by Woods & Hollnagel, 2006). This means that "the benefits of the new technology accrue during workload troughs, and the costs or burdens imposed by the technology occur during periods of peak workload, high-criticality, or high-tempo operations" (p. 127). In short, navigation becomes an even more hermeneutic discipline with integrated systems, providing ever more information, which may not seem problematic during normal conditions, but any negative side effects of the disconnection from more basic navigation skills reveal themselves only when operations slide out of their normal operating domains. This could be the case in some ECDIS assisted accidents.

It is of course possible to frame these issues as training and discipline challenges. Training, as a relevant issue, is not disregarded by the author of this thesis. Naturally, advanced technology such as an ECDIS requires a set of taught skills, to operate it. However, there exists a risk that training becomes a universal tool to tweak operator performance. The aspect of co-agency and affordance issues, and an understanding of local rationality and sense making, risk being neglected in this case. Furthermore, training can be dissolved into two dimensions, where the first is, legitimately, concerned with obtaining knowledge and skills in how to operate a device or system. The other dimension represents the enforcement of morale or discipline, i.e. how power and institution wants the device or system to be used (complying with *work as imagined*). Training as a concept

seems to be confused in formal accident investigations because while the first dimension is necessary (naturally), to obtain skills, which in some cases is not done well for various reasons, such as financial costs etc., the investigation reports seem to address the second dimension; the undisciplined navigators that should have acted in accordance with how the system was intended to be used (disregarding the context).

The adaptations found on the ships´ bridges, for example silenced acoustic alarms, leave a risk that the clumsy automation is not necessarily noticed until an unexpected event or system anomaly occurs, ultimately as an accident. This was termed *the Law of Fluency* by Woods & Hollnagel (2006). They assert that:

> […] adaptations often become routinized as a standard part of a task or a role, so that, on the surface, it is difficult to see how these routines are adaptive and to what they have adapted. (p. 37)

Even the informants, the navigators, at times had difficulties to see through their own routinized adaptations and habits. Perry & Wears (2012) also found that the Law of Fluency was relevant in their hospital emergency department study of adaptation (addressed in section 6.3). They noted that:

> Because *ad hoc* adaptations are for the most part tacitly introduced, systems use can easily be misinterpreted by vendors, designers and purchasers as evidence of successful design and implementation unless hidden workarounds are actively sought and studied. (p. 259)

There was a consensus among the informants; that the ECDIS could be improved if customizability is enhanced. This is interpreted here as a manifestation of the point made by for example Hollnagel & Woods (2005) and Norros & Salo (2009), as addressed in section 2.1, that a cognitive system, the human parts of the joint cognitive system, actively seek and interpret rather than passively receive information. Therefore, they may also seek and accept wrong information, and end up going in an incorrect direction if the representation does not correspond to the recipient's understanding. It is not likely that every navigator´s mental model will be shaped appropriately, if expectations rely on a standard design model aiming to capture a *remote reality*. For the information offered by the ECDIS to make sense, it is therefore necessary to be able

customize information representations so that it can be tailored locally to fit the particularities in each situation, and operator preferences. In other words: One size does NOT fit all, in ECDIS use nor should it in ECDIS design.

Furthermore, the above also has implications to the strategies that navigators apply to determine actions. These strategies can be said to consist of a combination of feedback and forward control (Hollnagel & Woods, 2005), which are, thus, highly dependent on the representation of the process to be controlled (navigation), and of how it will behave or develop, to select an appropriate action. ECDIS is clearly a preferred source of feedback information, and a very effective tool in support of forward control, because the information represented is practically real-time information about the environment to be controlled. A great incentive, thus, exists to seek out information from the ECDIS as it effectively enhances the navigator´s ability to anticipate the future conditions that the ship will encounter. However, the mismatches between navigator preferences and machine embedded images, as identified in this study, can increase the likelihood of *going in the wrong direction*. The issue becomes most apparent in ECDIS assisted accident cases where navigators was misinformed, or not at all informed, by the representation on the ECDIS, due to a mismatch between the operator preferences and corresponding settings, and the machine embedded idea about how the equipment was to be used in the particular context (a prime example is the varying representation of information at different zoom levels).

Basing action on wrong, or incomplete, information has been termed *selective use of feedback* and it was represented in this model by Hollnagel & Woods:

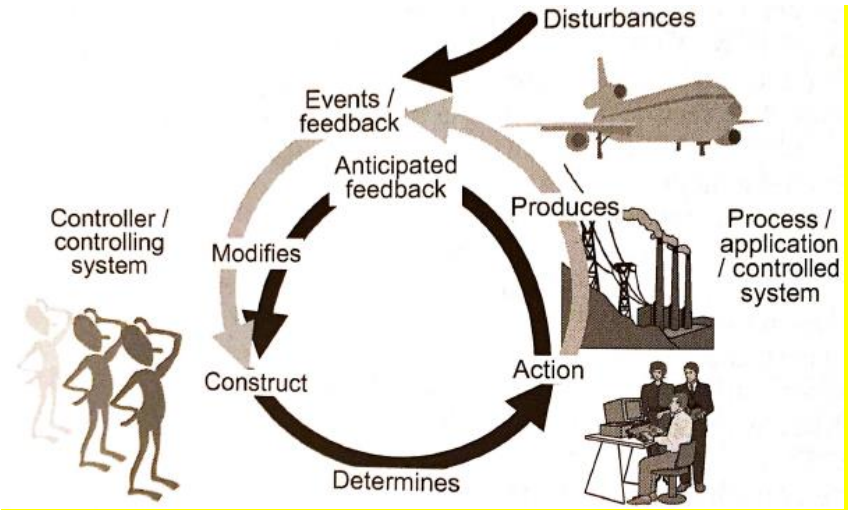

Figure 3: Cyclical Control Model (Hollnagel & Woods, 2005, p. 138).

To mitigate this potential for misconstruction of mental models, based on information originating from the ECDIS, it is necessary to understand the gap between *work as imagined* and *work as done*, and pursue design solutions that align the two dimensions.

5.3 Progressing design and development

Recalling the critique of CSE, addressed in section 2.4, the researcher here believes that this theoretical position does not compete with other design approaches, but rather it complements them in a quest to create better solutions, as the design needs change together with technology. The critics´ perceived lack of direction and proscription in the theory and methods is not thought of here as a deficiency, but rather shows that the theoretical concepts are complementary tools to think with, by designers and the developers. CSE can generate insights about systems´ ways of working, and thereby added value to a design process, when integrated with existing, and perhaps more, perhaps, pragmatic tools, and design philosophies. Thus, the insights gained in this thesis can serve as an example of a practical realization of the dimensions above the horizontal axis in the graphical representation of the Joint Intelligent Systems approach developed by Norros and Salo, as addressed in section 2.4, which is shown in the figure below.

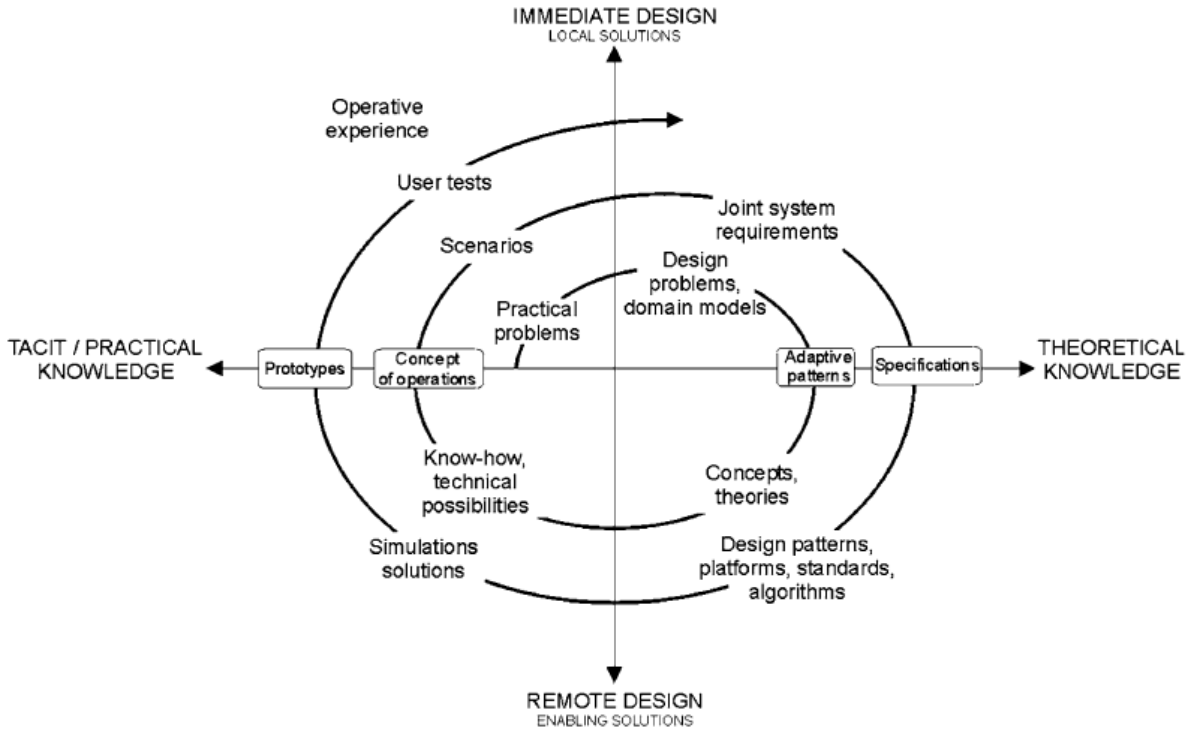

Figure 4: Joint Intelligent Systems design model (Norros & Salo, 2009, p. 53).

Four development points can be derived from the action points suggested in the findings section, especially in relation to development of operator control abilities. They may serve as an abstract for of inspiration for future design and development of ECDIS:

- ECDIS´ should be highly customizable, with the ability for the user to, to a large degree, select and set up data representation on the ECDIS screen.
- ECDIS´ should incorporate a platform for elaborate self-monitoring and clear continuous communication regarding the current system's reliability status, in a manner that reflects on the current navigation situation that the navigator faces.
- ECDIS´ should incorporate a platform for clear communication of the automation status, allowing the navigator at a glance to familiarize himself with this. Easy adjustments of automation levels should also be possible.
- ECDIS alarms should clearly communicate, specific origin and the status change that it reflects, and how this impacts on the current navigation situation that the navigator faces now. Different levels of (elaborate) information regarding the particular alarm should be easily accessible on operator request.

5.4 Further reflections on chosen methods

Valuable insights can be derived from the natural context research. However, challenges were also encountered in the study. Establishing the right environment for a fruitful dialogue and reflection was challenging, i.e. establishing a means, where the desired information was flowing, required a very thorough introduction to the study objectives. Furthermore, attendance on the bridge for long hours was found to be personally exhausting (the researcher also expected this based on his professional work with accident investigations where the challenges are similar).

The researcher experienced that operators (navigators) often have difficulties in diagnosing their own operational environment, except for the obvious annoyances and direct problems faced. Therefore, to obtain high quality data, i.e. information does not just reflect answers to questions asked, but also the integration of non-verbal cues and observations of the technology, and the subsequent transformation from data input to higher order understandings of socio-technical systems, deep immersion into the operating environment was found to be necessary, which is multi-resource demanding. Thus, it is difficult for more or less automated, *generic,* operator-feedback schemes and simpler approaches, relying on for example simulations and surveys, to tease out issues found at the higher level of abstraction while they may be successful in bringing to the surface the more obvious issues that operators face. A potential negative side effect from involving users, particularly at the level that generic operator-feedback schemes operate, may be that just because operators are involved in research and design there is a risk that they may be made partly, or indirectly, responsible for future system designs. Lützhöft expresses the same conflict in the following:

> […] users, in this case mariners, are not designers. They should not be given or left with the responsibility to come up with design solutions. Their expertise lies elsewhere, and it is this which we must tap into in appropriate ways. (2004, p. 42)

Furthermore, the researcher agrees with Norros and Salo when they note that:

> By "user designers" we denote users that contribute to the design process by understanding the usage and future needs from inside the practice. Design requires, however, also scientific and special knowledge, design skills, and mastery of whole design processes. Therefore "researcher designers" are needed. Jointly mastered vocabulary, models, and transparency of the course of design process are required for balancing between these demands. (2009, p. 45)

Ensuring such a system that empowers design through user participation is found to be crucial. At the same time, it needs to be the responsibility of system designers and developers to ensure that user-feedback is properly obtained and used, just as the responsibility for the *shape* of the end-product can never be put on the end-user.

6 CONCLUSIONS

In this thesis, the investigator explored reflexive and dialogic methods focused on natural contexts, to gain empirical insights into a field of interest. The results from the study are significant, both in themselves and when compared with findings from analyses of accident investigations reports related to ECDIS assisted accidents.

The study shows that there exist different levels of explanations regarding what sometimes make the relationship between ECDIS and the navigator cumbersome, and it allowed the articulation of second stories about ECDIS. While official accounts of ECDIS assisted accidents tend to emphasize the human operator as the most broken link in the socio-technical chain, various facets of ECDIS use offer only limited support of navigators´ goals, as they manifested themselves during every day navigation work. Thus, mismatches between causal factors derived from accident reports, and insights on how normal work is carried out, using ECDIS, was discovered. The former seems to mainly reflect society´s, complex, reaction to accidental events, while the latter is believed to provide important clues to further development and design, and thereby also safety creation.

Many challenges seem yet to be resolved, while at the same time ECDIS become an ever more central navigation tool. One possible consequence of ECDIS navigation may be deteriorated resilient capacity of the navigation system due to deteriorating manual navigation skills, which it can fall back on, as part of a reconfiguration-response to system disruption, to maintain control.

Further, it was found that addressing features, in this study related to adaptation, mismatch and communication/coordination, would enhance usability of the ECDIS, and consequently also safety by helping navigators to retain control of the navigation processes. A clear communication of system reliability would promote trust, and a platform to communicate the *system automation status*, outlining control distribution between ECDIS and navigator would significantly enhance the operator´s ability to make good decisions regarding control levels. Also, the ability to tailor the information and representation on the screen to suit individual preferences is an area that needs to be developed. Further, any mismatch between embedded images and operator image, resulting in a machine vs. operator preference conflict, needs to be recalibrated to avoid negative side effects, which could ultimately lead to the ECDIS assisted accidents. Also, there seem to be a

need to re-invent the alarm functions, to provide relevant and useful input for the navigators, i.e. alarms that you would not want to disable.

The insights gained may inform design and development processes, but at a relatively high level of abstraction. Thus, further more detailed research will be needed to arrive at any conclusions regarding the specific design, of future ECDIS units. Such research could include a detailed study of the social functions and processes, linked to ECDIS. Consequently, a cross-disciplinary, multi-level stakeholder effort is encouraged for the future ECDIS design and development processes.

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APPENDICES

Appendix A[1]: letter of request for participation (Danish, sent to ship managers).

Kære XX,
I forbindelse med mit kommende master-speciale på Lunds Universitet i Sverige, vil jeg som nævnt i telefonen, høre om i kunne være interesseret i at deltage i mine studier, som skal danne det empiriske grundlag heri.

Emnet som jeg har sat mig for at undersøge, er interaktionen mellem navigatør og ECDIS og de praktiske problemstillinger som navigatøren oplever ved brug af denne. Kort sagt: understøtter ECDIS funktionerne opfyldelsen af navigatørens behov? Dette skal gerne være med til at udfordre de konventionelle fortællinger om "ECDIS assisterede ulykker" hvor konklusionen ofte knytter sig til fejlbetjening. Jeg vil gerne bidrage til diskussionen med en ny vinkel, hvor det er "samarbejdet" mellem navigatøren og udstyret der bliver fokuseret på og således skibsbroens funktion som helhed (som moderne sikkerhedsteori understøtter).

Måden jeg påtænker at gribe opgaven an, er ved at observere en række navigatører på deres vagt, for at få et så virkeligt som muligt indblik i de strategier der anvendes ved brug af udstyret (jeg vil uundgåeligt være farvet af min egen baggrund som navigatør of ECDIS bruger). Dette skal suppleres med uformel historiefortælling om en række relaterede emner, før eller efter vagten. Der er ikke tale om en evaluering af nogens adfærd, men derimod om at skabe forståelse. Alt vil blive gengivet i anonymiseret form.

Afhængig af hvad der er muligt kunne jeg tænke mig at følge 3-4 vagter, i løbet af en periode på 1-2 dage om bord. Igen afhængig af hvad der er muligt, påtænker jeg at udføre disse "feltstudier" i løbet af marts og april 2016.

Emnet er højaktuelt i forhold til den obligatoriske implementering af ECDIS, som foregår i disse år i størstedelen af verdens handelsflåde, samt eksisterende fremtidsperspektiver der involverer ECDIS, så som E-Navigation. Håbet med projektet er at kunne bidrage med ny viden og forbedrede processer for design af udstyr som ECDIS, der i stadig stigende grad vil indgå i samspillet mellem mennesker og maskiner, således at søfolk oplever at dette i stigende grad som

problemfrit til gavn for både produktion og sikkerhed. Herigennem håbes på en mere nuanceret anskuelse af problemstillingerne, end den vi er vidne til i dag.

Jeg håber i vil finde det interessant og brugbart, og på denne baggrund har lyst til at hjælpe.

Med Venlig Hilsen,
Mads Ragnvald Nielsen

Appendix A[2]: letter of request for participation (Danish, sent to shipboards).

Kære kollegaer om bord,
Jeg hedder Mads og jeg er ansat ved Den Maritime Havarikommission som ulykkesundersøger, hvor jeg beskæftiger mig med at klarlægge omstændighederne for ulykkerne og fremme initiativer, der øger sikkerheden til søs. Jeg har desuden en fortid som søfarende. Ved siden af mit arbejde studerer jeg på andet år, på et Master program (MSc) i menneskelige faktorer og system sikkerhed, ved Lunds Universitet i Sverige. Jeg har valgt emnet "ECDIS integration" til mit speciale som jeg netop har påbegyndt.

Jeg vil anvende en systemisk tilgang (Cognitive Systems Engineering) til at undersøge samspillet mellem ECDIS og navigatører, med hovedfokus på hvordan ECDIS som instrument opfylder de behov som navigatøren har i sit daglige arbejde på broen, og hvordan ECDIS design til tider ikke understøtter navigatørens behov, i forhold til målet; at navigere sikkert. Det sidste er desværre en observeret faktor i flere "ECDIS assisterede ulykker". Formålet med projektet er overordnet at fremme design-metodologi som tilgodeser brugeren i en højere grad end det vi ser i dag.
En meget vigtig del af forskningsprojektet involverer observationer af praktisk anvendelse af ECDIS om bord, samt interviews med brugerne/navigatørerne. Derfor henvender jeg mig nu.

- Projektet søges udført bredest muligt, med deltagelse fra skibe i flere segmenter indenfor dansk søfart.
- Der er ingen kendt risiko ved at deltage i projektet. Deltagelse er frivillig og kan fra deltagerens side afbrydes når som helst. Deltagere skal være villige til at tale om deres oplevelser med ECDIS i forhold til navigatorisk arbejde.
- Ingen individer eller organisationer vil blive lagt til last for nogen forhold som jeg måtte blive bekendt med under projektet, og alt vil blive anonymiseret ved gengivelse i min opgave. Rå optagelser og optegnelser vil ikke blive delt med andre.
- Observationer og interviews foretages om bord under drift, med fuld forståelse for arbejdsopgaverne der foregår på broen samtidig, og bestræbelse på minimal forstyrrelse i forhold til disse.
- Jeg vil under tilstedeværelsen bede om lov til at foretage lydoptagelser. Dette er for nemheds skyld ved efterfølgende behandling af data, men er dog ikke obligatorisk, og deltagere har retten til at afslå.
- Alt efter mulighederne, søges at følge deltagende skibe i ca. 2-4 dage, enten med ophold om bord eller i land afhængig af drift form osv.

- Projektets observationer og interviews søges afviklet ved tilstedeværelse om bord i perioden februar-maj 2016.
- ECDIS skal indgå som en aktiv del af arbejdet med navigation på skibe som deltager i projektet.
- Der er ingen krav i forhold til ECDIS uddannelse af de navigatører som deltager da dette emne er udeladt fra studiet, som udelukkende fokuserer på den praktiske, faktiske, anvendelse af udstyret.
- Deltagere vil blive bedt om at udfylde en samtykke erklæring ved observationernes begyndelse.
- Min arbejdsgiver vil holde alle udgifter i forbindelse med projektet. Skib og reder vil således ikke opleve økonomisk last i forbindelse hermed.

Projektet vil ganske givet udfordre den gængse opfattelse af "fejlbejening" og "menneskelig fejl" som ofte bliver en stor del af fortællingen når noget går galt til søs. Fokus vil i dette projekt blive rettet mod de redskaber/instrumenter som producenterne stiller til rådighed og deres kvalitet som "hjælpemidler" for brugerne. Der vil her blive givet en unik mulighed for at komme til orde, med hvilken som helst form for observationer man som operatør må have gjort, eller frustrationer som man måtte have i forhold til brug af ECDIS. Med disse "historier" kan fremtidens udstyr blive endnu bedre og mere brugerorienteret.

På denne baggrund håber jeg i vil have lyst til at deltage i mit forskningsprojekt. Jeg ser frem til at høre fra jer.

Med venlig hilsen
Mads Ragnvald Nielsen
tlf. 25117384 / e-mail madsragnvaldnielsen@gmail.com

Appendix B: Informed Consent Form.

HOW THE SHIP´S BRIDGE KNOWS ITS POSITION – ECDIS assisted accidents from a human factors perspective

Student Investigator:

Mads Ragnvald Nielsen, Lunds University.

Project Purpose and Procedure:

A systems approach (Cognitive Systems Engineering) will be applied to investigate the interplay between the ECDIS and the navigator. The main focus will be on how the ECDIS, as a navigational instrument, meets the goals and needs that the navigator has in his/her daily work on the bridge. The overarching purpose is the demonstration of how a better understanding of ”work as done” can inform design processes, and improve design methodology that takes into account ”user information”.

Work in context (ECDIS use) will be observed and users will be interviewed in order to form the empirical foundation for the thesis project. This will be done during navigation of the ship.

The results of this study will be published as a thesis and it may also be published as articles in scientific journal(s).

Confidentiality:

Identities of all participants will remain anonymous and will be kept confidential from all other parties other than the interviewer. Notes will be taken and recordings made (optional) during the observation/interview for the purpose of recall by the researcher for future analysis. Anonymity will be further protected in any future portions of the thesis paper and any presentations that may result from this work. Participant names will be kept in a locked secure filing cabinet separate from the information collected by the researcher.

Compensation:

There will be no compensation for participation in the research.

Contact Information about this Thesis Work:

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Risks/Benefits:

There are no known risks or benefits to participating in this research.

Consent:

Your participation in this research project is entirely voluntary. You may refuse to participate or withdraw from the research at any time.

Your signature indicates that you have received a copy of this consent form for your own records and that you consent to participate in this research.

I,_____agree to participate as outline above. My participation is voluntary and I understand I can withdraw at anytime.

Participant's Signature

Date

Student Investigator Signature

Date

Appendix C: Interview guide (Danish).

Generelt

1. Hvornår / hvordan oplever du begrænsninger ved ECDIS´ens funktionalitet?
2. Hvordan oplever du at ECDIS´en ikke passer til dine behov/skibets operation?
3. Oplever du brugerfladen som værende nem eller problematisk at benytte
    a. Har ECDIS´en for mange eller for få funktioner?
    b. I hvilke situationer kommer dette til udtryk?
    c. Hvad er det bedste ved måden systemet er på (hvad hjælper dig mest)?
    d. Hvad savner du allermest ved systemet (hvad er det ringeste ved systemet)?
4. Hvilke strategier benytter du for at imødegå problematikkerne med brugerfladen?
5. Hvad er dit bedste råd til ECDIS designere, hvis de skal lave systemet bedre næste gang?
6. Er der andre problemstillinger som du oplever ved brug af ECDIS´en?
7. "Kommunikerer" ECDIS´en klart, i forhold til hvad den gerne vil præsentere af information
    a. Fortæller den for meget eller for lidt i forhold til dine behov?
    b. Er de visuelle og akustiske signaler hjælpsomme eller generende?
8. Har du været udsat for brug af ECDIS´en har forårsaget utrygge situationer (mistet kontrol/overblik) eller ligefrem near misses?
    a. Har du oplevet at ECDIS´en (automatiske funktioner) har opført sig anderledes end forventet?

Specifikt

1. Hvordan oplever du brug af systemets indstillinger for kort, valg af dataniveau/lag, alarmfunktioner, ruteplanlægning og kontrol, osv.?
2. Hvordan personliggøres systemet ved overlevering (hvilke parametre kontrolleres/ændres på, hvis det er tilfældet)?
3. Hvordan opsættes systemet til den enkelte rejse (hvilke parametre justeres/kontrolleres)?
4. Findes der tilstrækkelig vejledning/instruktion til brug af ECDIS´en (hvor findes denne)?

Er ECDIS´en placeret hensigtsmæssigt (ergonomisk) i forhold til navigationen, og øvrige opgaver på broen?

Appendix D: Data collection log.

Ship:	Dates on board:
Number of navigators:	Watch shift:
ECDIS equipment make:	Manual collected:

Observation times:					
Date & time:	Hours:	Navigator:	Date & time:	Hours:	Navigator:
Total observation time:					

Appendix E:

Marine Accident Investigation Branch. (2015). *Grounding and flooding of ro-ro ferry Commodore Clipper*. Accident Investigation Report 18/2015. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/451374/MAIBInvReport-18_2015.pdf

Appendix F:

Marine Accident Investigation Branch. (2014). *Grounding of oil/chemical tanker Ovit*. Accident Investigation Report 24/2014. Retrieved from https://www.gov.uk/maib-reports/grounding-of-oil-chemical-tanker-ovit-on-the-varne-bank-in-the-dover-strait-off-the-south-east-coast-of-england

Appendix G:

Marine Accident Investigation Branch. (2014). *Grounding of bulk carrier CSL Thames*. Accident Investigation Report 2/2012. Retrieved from https://assets.digital.cabinet-office.gov.uk/media/547c6f8240f0b60244000021/CSLThames.pdf

ACCIDENT REPORT

Report on the investigation of

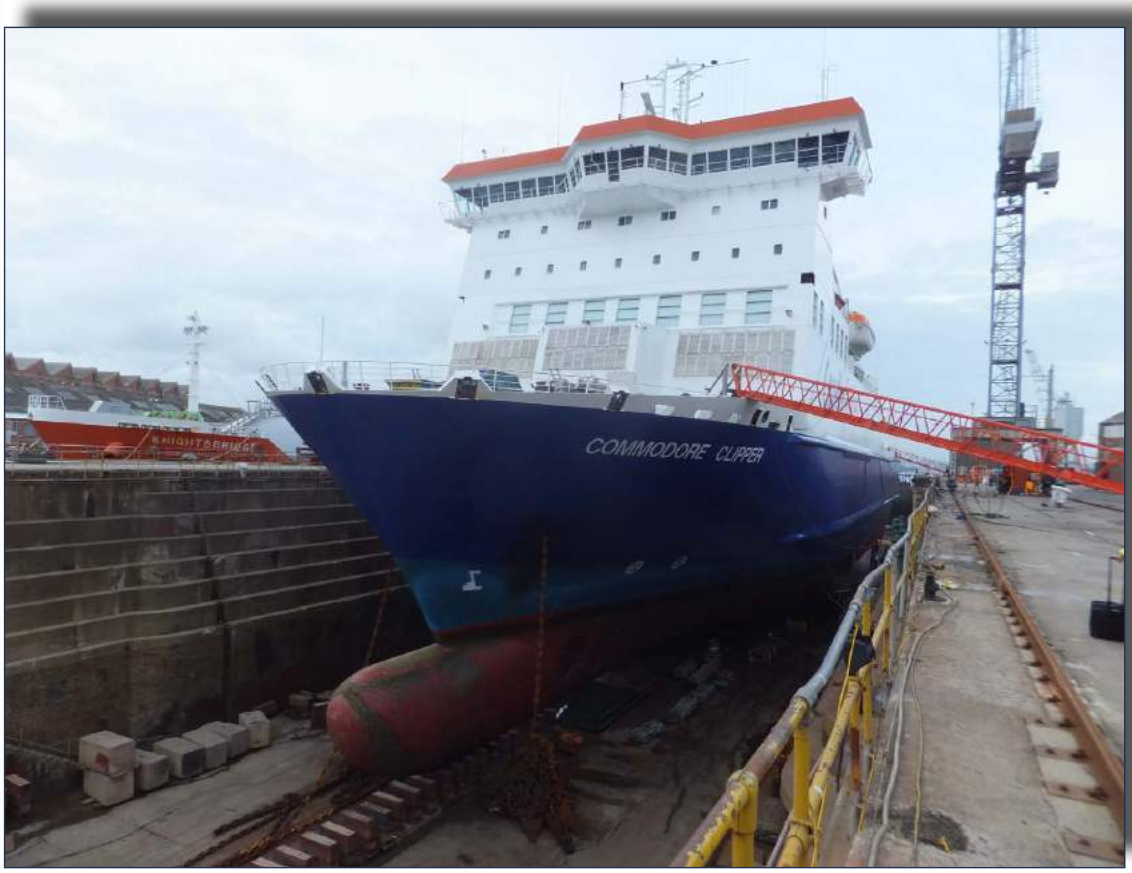
the grounding and flooding

of the ro-ro ferry

Commodore Clipper

in the approaches to St Peter Port, Guernsey

on 14 July 2014



MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

SERIOUS MARINE CASUALTY REPORT NO 18/2015 AUGUST 2015

Extract from

The Merchant Shipping (Accident Reporting and Investigation)

(Bailiwick of Guernsey) Regulations 2009

Regulation 5:

"The sole objective of a safety investigation into an accident under these Regulations 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."

This accident was investigated by the UK Marine Accident Investigation Branch at the request of the Government of Guernsey.

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 13(9) of the Merchant Shipping (Accident Reporting and Investigation) (Bailiwick of Guernsey) Regulations 2009, 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

AIS	Automatic identification system
BEAMer	French Bureau of Marine Accident Investigation
BMA	Bahamas Maritime Authority
BTM	Bridge team management
CATZOC	Category of zone of confidence
cm	Centimetre
CoC	Certificate of Competency
DNV	Det Norske Veritas
DNV-GL	Det Norske Veritas-Germanischer Lloyd
DSC	Digital selective calling
ECDIS	Electronic chart display and information system
ENC	Electronic navigational chart
GPS	Global positioning system
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISM Code	International Safety Management Code
kts	Knots (1 knot = 1 nautical mile per hour)
LDL	Limiting danger line
m	metre
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MRCC	Maritime Rescue and Co-ordination Centre
nm	Nautical miles
OOW	Officer of the watch
PMSC	Port Marine Safety Code
PSC	Port state control

PSD	Public Services Department
Ro-ro	Roll-on roll-off
SMS	Safety management system
SOLAS	International Convention for the Safety of Life at Sea 1974, as amended
STCW	International Convention on the Standards of Training, Certification and Watchkeepers 1978, as amended (STCW Convention)
UKC	Under keel clearance
UKHO	United Kingdom Hydrographic Office
UTC	Universal co-ordinated time
VDR	Voyage data recorder
VHF	Very High Frequency (radio)
VTS	Vessel traffic services
XTD	Cross track distance

TIMES: all times used in this report are UTC+1

SYNOPSIS

At 1515 on 14 July 2014, the Bahamas registered ro-ro passenger ferry *Commodore Clipper* grounded on a charted, rocky shoal in the approaches to St Peter Port, Guernsey. No-one was injured, there was no pollution and the vessel continued its passage into the harbour. However, there was significant raking damage including breaches of the hull resulting in flooding of double-bottom void spaces.

The grounding caused a noisy, shuddering vibration that reverberated throughout the ship, but the crew did not check for damage, no external report was made and no safety announcements were made to the passengers. Once alongside in St Peter Port, cargo discharge, reloading and a lifeboat drill went ahead as planned. However, a pre-planned divers' inspection of the hull soon discovered damage and the vessel was withdrawn from service.

The investigation found that there had been insufficient passage planning for the voyage; in particular, for the transit through the Little Russel, the extremely low tide and effect of squat were not properly considered. This resulted in the bridge team being unaware of the limits of safe water available and thus, despite their good positional awareness, they headed into danger without appreciation of the risk. Several course alterations intended to regain track were ineffective due to the tidal stream setting the vessel off course. Additionally, the absence of any alarm, steering and propulsion responding normally, and the master's conviction that there had been sufficient depth of water, led to a collective denial of the possibility that the vessel might have grounded.

The company's approved route for use through the Little Russel was not followed and the vessel's electronic chart display and information system was not utilised effectively because key safety features were either disabled or ignored. It was also established that Guernsey Harbours did not have an effective safety management system for the conduct of pilotage within its statutory area.

Safety recommendations have been made to Condor Marine Services Limited and the Government of Guernsey designed to ensure appropriate levels of proficiency in the conduct of safe navigation.

SECTION 1 – FACTUAL INFORMATION

1.1 PARTICULARS OF *COMMODORE CLIPPER* AND ACCIDENT

SHIP PARTICULARS	
Vessel's name	*Commodore Clipper*
Flag	Commonwealth of the Bahamas
Classification society	Det Norske Veritas-Germanischer Lloyd
IMO number	9201750
Type	Ro-ro passenger ferry
Registered owner	Condor Limited
Manager(s)	Condor Marine Services Limited
Construction	Steel
Year of build	1999
Length overall	129.5m
Registered length	118.7m
Gross tonnage	14,000
Minimum safe manning	29
VOYAGE PARTICULARS	
Port of departure	Portsmouth, UK
Port of arrival	St Peter Port, Guernsey
Type of voyage	Short international voyage
Cargo information	Road freight trailers, cars and passengers
Manning	39
MARINE CASUALTY INFORMATION	
Date and time	14 July 2014, 1515 UTC + 1
Type of marine casualty	Serious marine casualty
Location of incident	Little Russel, Guernsey 49°29.36'N, 002°28.73'W
Place on board	Hull
Injuries/fatalities	None
Damage/environmental impact	Hull damage, void space flooding
Ship operation	On passage
Voyage segment	Mid water
External & internal environment	Wind: south-westerly, force 5 Sea state: slight Visibility: good
Persons on board	39 crew and 31 passengers

Image courtesy of Mike Peel

Commodore Clipper

1.2 NARRATIVE

At 0900 on 14 July 2014, *Commodore Clipper* sailed from Portsmouth, UK, heading for St Peter Port, Guernsey with 39 crew, 31 passengers and 23 vehicles on board. The master had selected the company approved 'Route 06' **(Figure 1)** for the passage. At 0948, once clear of the pilotage channel, the master handed the con over to the officer of the watch[1] (OOW). During the handover, the master directed that the vessel's arrival time in St Peter Port should be advanced by approximately 30 minutes to allow more time in the port for a dive team to conduct a programmed underwater hull inspection and for the crew to carry out a lifeboat drill.

At 1030, the second officer (navigation) took over as OOW, and at 1452 the chief officer came to the bridge in preparation for the arrival into St Peter Port. Having apprised himself of the situation, the chief officer sat down in the port bridge chair **(Figure 2)**. When the master arrived on the bridge just before 1500, *Commodore Clipper* was on a heading of 220°, its engines were set at full sea speed and it was making 18 knots (kts) over the ground. The vessel was in the Little Russel and was approximately 1 cable to starboard of the 220° transit line[2]. The OOW briefed the master on the situation, including shipping traffic, weather and the time of low water. The master took the con and sat in the starboard bridge chair next to the chief officer. The OOW remained on the bridge to complete the pre-arrival checklist and the helmsman closed up at the main steering console and switched to hand steering.

At 1510, the master ordered an alteration to port to 215° in order to manoeuvre the vessel onto the 220º transit line **(Figure 3)**. At 1512:10[3] *Commodore Clipper* crossed the transit, and at 1512:44 the master ordered the helmsman to return to a heading of 220°. The vessel did not steady on this heading as, at 1513:24, a further alteration to starboard to 222° was ordered. Two further heading alterations were made to starboard; the first at 1513:47 to 224° and the second at 1514:25 to 226° **(Figure 3)**. As the master ordered the successive 2° alterations to starboard, the chief officer went to the centreline of the bridge to visually assess the vessel's position and the OOW went to the port bridge wing to monitor the bearing movement of Roustel beacon as it passed to port.

At 1515:36, on a heading of 226° and a speed of 18.2kts over the ground, a noisy and shuddering vibration lasting 9 seconds was heard and felt throughout the vessel. Immediately after the shudder, the master instructed the chief officer and the OOW to look astern. He then reduced propulsion power to 70% and altered course to port to 215º **(Figure 3)**. The chief officer and the OOW saw nothing unusual behind the vessel and, as there were no alarms, and steering and propulsion were responding normally, the master reselected full sea speed and continued the approach to the harbour.

The master then phoned the chief engineer, who was in the engine control room, to discuss what had happened. The chief engineer explained that the shudder felt below decks had been exceptional, surpassing anything he had ever experienced. However, the master reassured him that there had been sufficient depth of water where the vessel had just passed and explained that the vibration could only have

[1] The OOW was the second officer (safety)

[2] For vessels inbound to St Peter Port intending to pass west of Roustel, there are leading marks on a bearing of 220º when in transit

[3] Key timings prior to the grounding include seconds

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Figure 1: Company approved Route 06

Figure 2: Bridge central console

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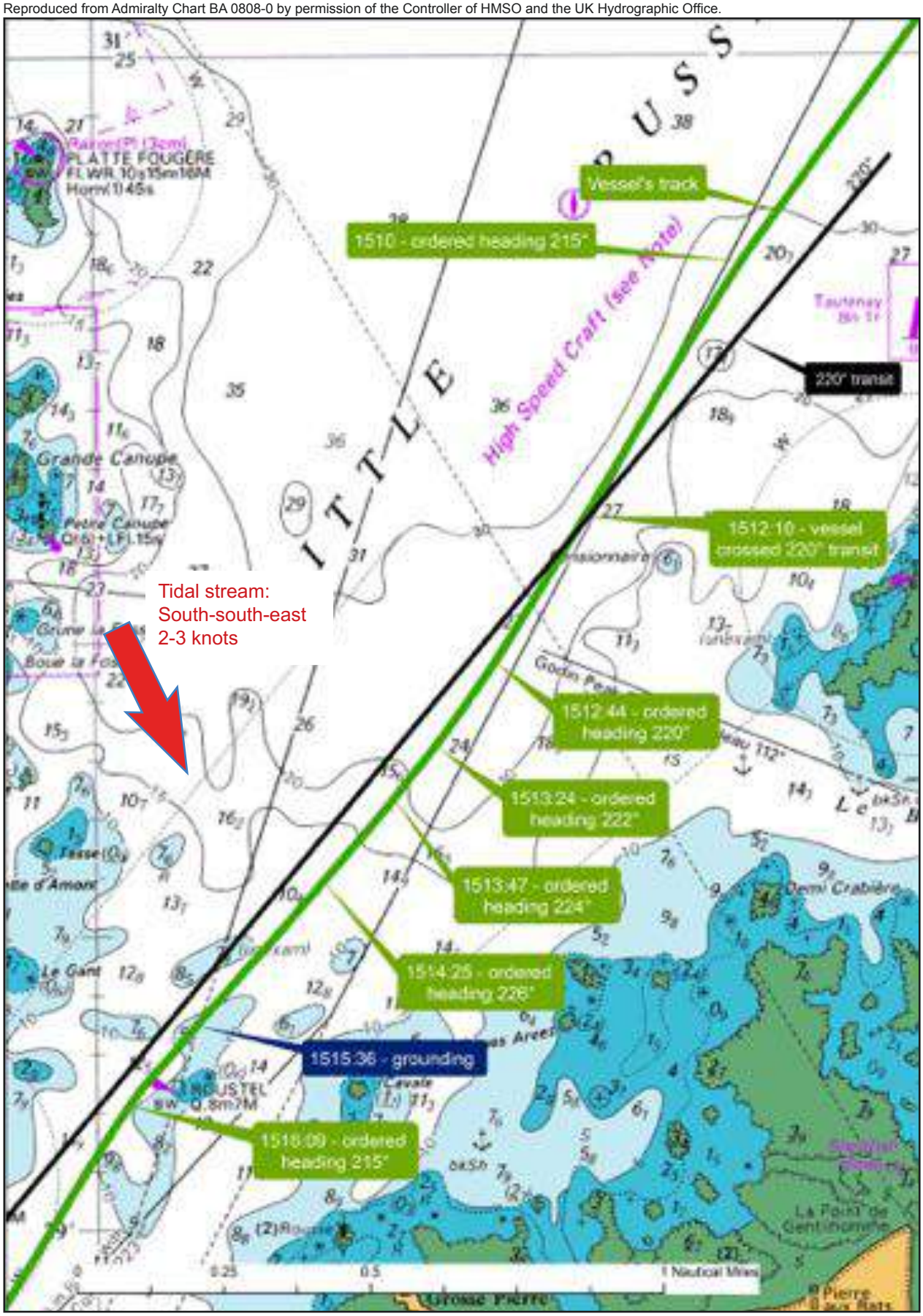

Figure 3: *Commodore Clipper*'s track in the approach to the grounding

been caused by something that the propellers had picked up, such as a string of fishing pots. The master then told the chief engineer to instruct the dive team to inspect the propellers during the planned underwater survey.

After his phone conversation with the chief engineer, the master discussed the event with the chief officer. The master restated his conviction that there had been sufficient water where the vessel had been and went on to explain his assessment that it would have been safe to have passed even closer to Roustel beacon.

Having passed the Grune au Rouge rock and Boue de la Rade shoal **(Figure 4)**, *Commodore Clipper* entered St Peter Port harbour at 1527 and proceeded alongside as planned. Once berthed, the stern door was opened and the discharge of vehicles and passengers commenced. At about 1620, the dive team arrived and the chief engineer went ashore to brief them. He explained about the earlier shudder and instructed them to inspect the propellers and to search for damage.

Once the cargo discharge was complete, the chief officer and bosun made their way to the bridge to supervise the lifeboat drill. At 1645, with the drill complete, they both returned to the vehicle deck and commenced loading the vessel in preparation for the next voyage.

At about 1700, the leader of the dive team advised the chief engineer that significant underwater damage to the hull had been observed. The chief engineer informed the master and asked him to proceed to the dockside to view the divers' video footage. Having done so, the master directed the chief officer to discharge all vehicles and passengers that had embarked. The master then returned on board and phoned the Condor Marine Services duty operations team to inform them of the situation. In the meantime, the chief engineer and chief officer instigated a thorough internal inspection of the vessel looking for damage; tank soundings of the double-bottom void spaces soon identified water ingress.

At 1730, a company representative phoned the St Peter Port harbourmaster and informed him that *Commodore Clipper* had touched the bottom and was being withdrawn from service. The harbourmaster immediately proceeded on board the vessel, where he met the master and was briefed that there were no casualties, the vessel was in a stable condition and the risk of pollution was minimal. The harbourmaster then informed the harbour director, the Chief Inspector of Marine Accidents (Guernsey) and other members of the Guernsey Pilotage Board. An immediate decision was taken by the Guernsey authorities to suspend the special pilotage licence held by *Commodore Clipper*'s master.

At 1805 the following day (15 July 2014), with all the necessary approvals in place, no cargo or passengers on board and a relief master in command, *Commodore Clipper* sailed from St Peter Port for docking and repairs in Falmouth, UK.

1.3 DAMAGE AND STABILITY

A post-accident dive survey of the seabed in the location of the grounding identified that *Commodore Clipper* had struck two granite pinnacles on a rocky shoal that was charted at a depth of 5.2m. During the grounding the tops of the two pinnacles broke away **(Figure 5)**.

Reproduced from Admiralty Chart BA 0808-0 by permission of the Controller of HMSO and the UK Hydrographic Office.

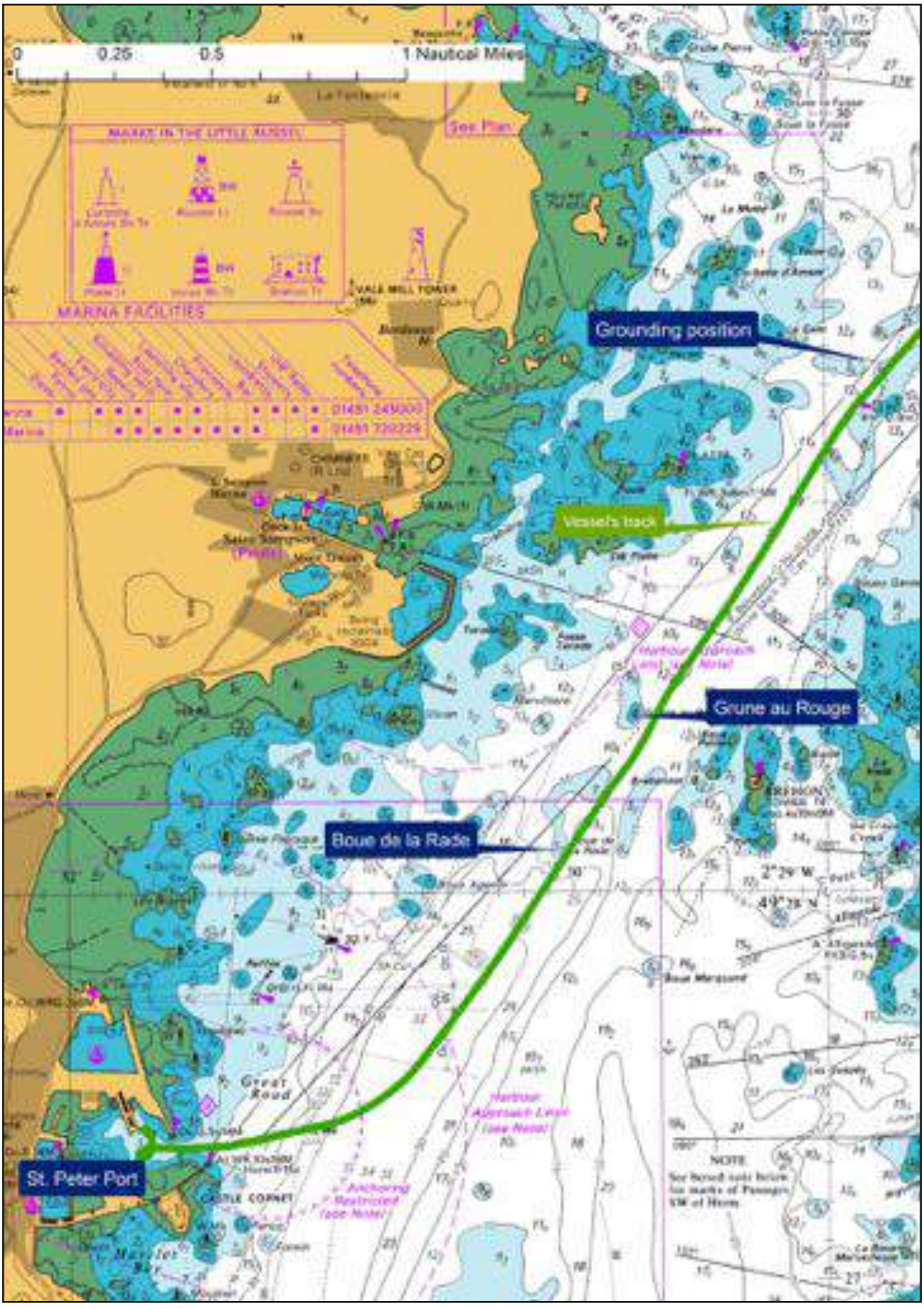

Figure 4: *Commodore Clipper*'s track from grounding to St Peter Port

Images courtesy of Captain Andy Lowe

Figure 5: Granite pinnacles struck by *Commodore Clipper*

The grounding caused significant damage **(Figure 6)** including:

- The shell plating of the hull on the port side was subject to a deep gouging distortion along approximately two thirds of its length **(Figure 7)**.
- Water ballast tank 4 was holed in two places **(Figures 8** and **9)**.
- Void space 8, void space 9 and water ballast tank 1 (port) were all breached by small holes and fracture damage to the hull **(Figure 10)**.
- Although the propellers and rudders were not struck, the skeg was damaged along its entire underside length **(Figure 11)**.

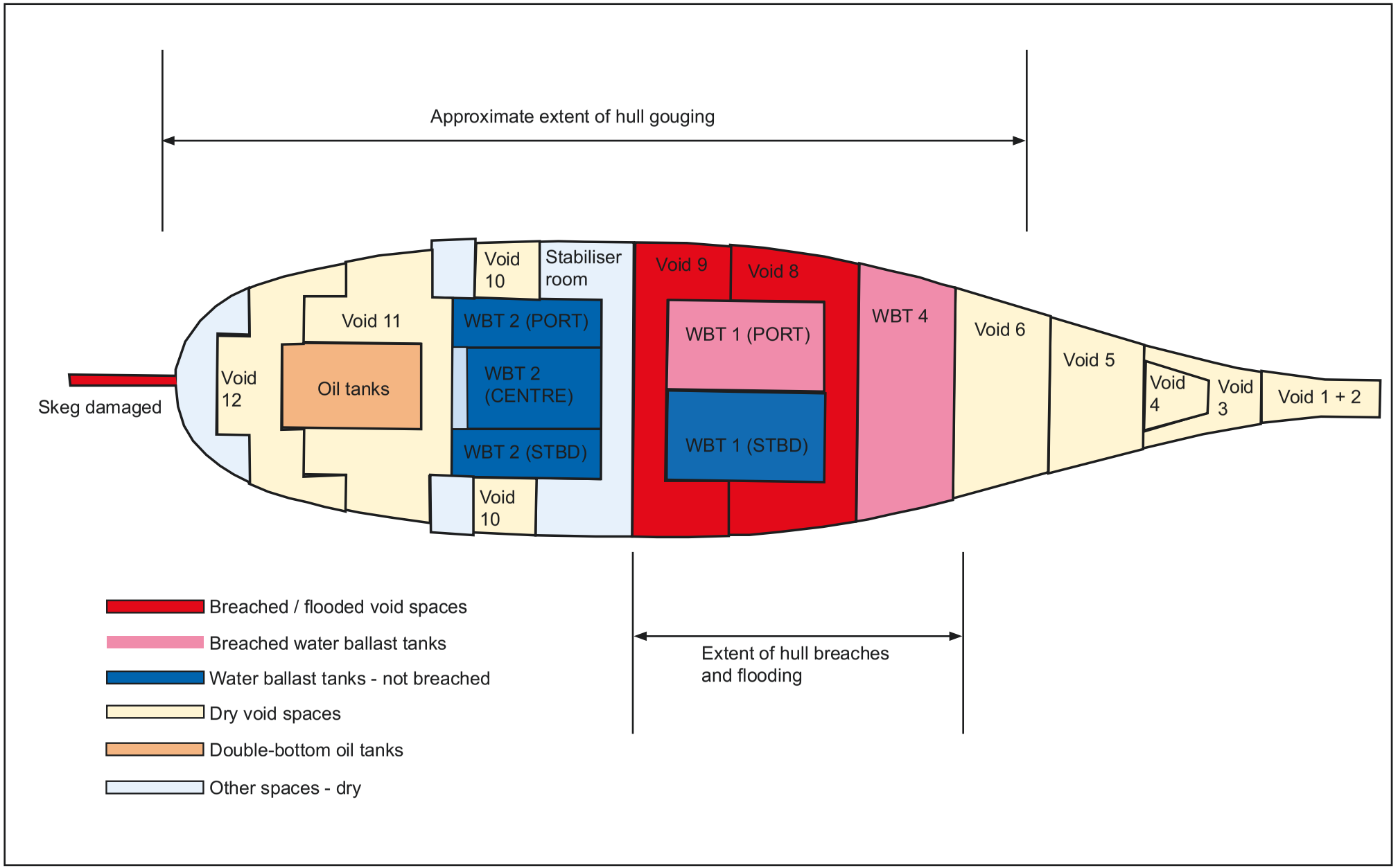

Figure 6: *Commodore Clipper*'s double-bottom general arrangement showing extent of damage (not to scale)

Figure 7: Hull gouging looking aft

Figure 8: First hole in water ballast tank 4

Figure 9: Second hole in water ballast tank 4

Figure 10: Detail of hull fracture damage

- Internal fixtures in affected areas were damaged resulting from the upward force of the grounding; an example was the distortion to a fixed ladder within a void space **(Figure 12)**.

After the extent of the damage had been fully established by internal and external examination of the vessel in St Peter Port, stability calculations were undertaken for a series of scenarios including the post-grounding 'actual' and 'worst case' conditions. This analysis showed that in each condition the minimum metacentric height[4] necessary for satisfactory stability of the vessel was maintained.

1.4 ENVIRONMENTAL CONDITIONS

1.4.1 Weather

Wind:	south-westerly, force 5[5]
Sea state:	slight
Visibility:	good, in daylight

1.4.2 St Peter Port tidal data for 14 July 2014

High water:	2105, 9.9m
Low water:	1509, 0.8m
Time and height at grounding:	1515, 0.9m
Tidal range:	9.1m (115% of mean spring value of 7.9m)
Tidal stream:	south-south-east, 2 – 3 kts

1.4.3 Guernsey tidal conditions

The waters around Guernsey are subject to unique and often extreme tidal conditions. Unusually, slack water does not coincide with high and low water times. This was the case during the grounding, where a significant tidal stream was flowing at low water. In the approaches to St Peter Port, such streams can also be difficult to predict. Additionally, the tidal ranges are large and therefore significant to navigation.

1.5 VESSEL

Commodore Clipper was a roll-on roll-off passenger ferry that was purpose built in 1999 for the Portsmouth to Channel Islands routes. The vessel was registered with the Commonwealth of the Bahamas, owned by Condor Limited and managed by Condor Marine Services Limited (the company). The vessel's Safety Management

[4] The calculation of the static stability of a floating object measured as the distance between the centre of gravity and the metacentre

[5] Beaufort wind scale Force 5 defined as 'fresh breeze'; wind speed of 17 - 21 knots

Figure 11: Detail of damage to keel skeg

Figure 12: Example of internal ladder damage in a void space

Certificate, confirming that its safety management system (SMS) complied with the ISM Code[6], was issued by Det Norske Veritas-Germanischer Lloyd (DNV-GL) on 3 June 2014 and was valid until 8 June 2019.

Commodore Clipper was of a double-bottomed construction **(Figure 6)** with 12 double-bottom void spaces and 6 double-bottom water ballast tanks. The void spaces were not fitted with bilge alarms. At the time of the grounding, all the water ballast tanks were pressed full of water except tank No.2 (starboard), which was used by the crew for stability adjustments.

The bridge navigational equipment included:

- A single Transas Navi-sailor 4000 electronic chart display and information system (ECDIS). The system was loaded with a UK Hydrographic Office (UKHO) electronic navigational chart (ENC) outfit that was up to date with corrections. Paper charts were carried as a back-up to the ECDIS and this arrangement complied with the Flag State's carriage requirement.

- Two Kelvin Hughes Manta radar systems; the port display was configured to the S-band (10cm) radar and the starboard display was configured to the X-band (3cm) radar.

- A Sperry Marine ES5100 echo sounder, which was running at the time of the accident although the safety alarm depth was set to 0m.

- Two Litton Marine LMX 420 global positioning systems (GPS).

- A 'Dive Time' draught measuring system; the recorded even keel draught of the vessel on departure from Portsmouth was 5.0m.

At the time of the grounding the company approved 'Route 06' was selected for navigation in the ECDIS and both radar systems. The ECDIS display screen was located on the starboard side of the central bridge console adjacent to the master's chair **(Figure 2)**. The display was not accessible from the port chair.

1.6 CREW

Commodore Clipper's crew of 39 consisted of 20 operational and 19 cabin staff that fully met the Flag State's safe manning requirement. The master, chief officer, chief engineer and deck officers were British nationals and the second and third engineers were Ukrainian. The remainder of the crew were British or Ukrainian except for one Polish cabin crew member.

The master was 60 years old and had been regularly in command of *Commodore Clipper* since it had entered service in 1999. He was also designated as the vessel's senior master, which meant that he held responsibility for vessel standards, crew changes and general manning issues. He held an STCW[7] II/2 master's (unlimited) certificate of competency[8] (CoC) and had been a special pilotage licence holder for St Peter Port since 1991. He had a detailed working knowledge and extensive experience of navigation in the waters around Guernsey.

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[6] International Management Code for the Safe Operation of Ships and for Pollution Prevention

[7] International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended

[8] All the crew certificates had been endorsed by the Flag State

The chief engineer was 57 years old and, like the master, had been assigned to the vessel since it entered service in 1999, thus he had a long-standing working relationship with the master. He held an STCW III/2 chief engineer (unlimited) CoC.

The chief officer was 35 years old and had been at sea for 12 years, primarily in the cruise industry, before joining Condor Marine Services in April 2012. He held an STCW II/2 master's (unlimited) CoC and a special pilotage licence for St Peter Port. He had been the chief officer of *Commodore Clipper* since November 2013.

1.7 CONDOR MARINE SERVICES LIMITED

The company was originally founded in 1964 and had ties with the Commodore Shipping Group. In 2003 the two companies merged and operated solely under the Condor name. The company operated a fleet of high speed and conventional[9] roll-on and roll-off passenger and freight ferry services on regular routes between UK, Guernsey, Jersey and France.

1.8 SAFETY MANAGEMENT SYSTEM

Condor Marine Services' Document of Compliance, confirming that the company's SMS met the requirements of the ISM Code, was issued by DNV on behalf of the Flag State on 28 May 2013 and was valid until 6 May 2018.

The company provided a generic SMS for use by all its vessels. The SMS was divided into three volumes:

- Group management manual
- Group route operational manual
- Group shipboard manual

There was also a dedicated operational procedures manual for *Commodore Clipper*.

The group management manual set out the company's policy for safety, quality management and environmental protection. It also contained detailed guidance on pilotage including the conduct of passage planning and navigation.

The group route operational manual included operational limitations and detailed guidance on company approved routes. Each of the company's routes had been certified as safe for navigation by its vessels in all states of tide. However, the routes did not contain authorised cross track distances (XTD). The operational limitations for conventional ferries included the requirement for a minimum under keel clearance (UKC) of 1m. This manual also contained guidance for the use of ECDIS.

The group shipboard manual focused on crew management, training and onboard services, including terms of reference for all staff.

Commodore Clipper's operational procedures manual provided guidance on the company's operational and engineering processes. It included the pre-arrival and departure checklists **(Annex A)** that listed a requirement for arrival and departure

[9] *Commodore Clipper* and *Commodore Goodwill* were the company's 'conventional' ferries.

briefs. It was a requirement of the grounding-raking checklist **(Annex B)** to immediately inform the coastguard, the company and passengers following such incidents.

1.8.1 Master's standing orders

The SMS was required to be supplemented by a set of master's standing orders, which had been issued dated 22 January 2007; key extracts included:

- *'The vessel's position is to be continuously monitored and plotted on the chart.*
- *Radar parallel indexing is a simple and highly effective method of monitoring the vessel's track close to land. It should always be used approaching the Big or Little Russel.*
- *The tides in the area are very strong. It is not uncommon to have to allow 20 degrees set.*
- *The whole point of increasing the bridge team in pilotage waters is so that each member monitors the others actions.'*

Given that these orders were issued prior to the ECDIS installation, no guidance on the use of this equipment was included.

1.8.2 Crew training and drills

The SMS list of emergency drills required to be conducted is at **Annex C**. This list did not specifically include a requirement for grounding or flooding training, but a damage control exercise was required every 3 months and its checklist[10] **(Annex D)** included damaged stability management, void space access and use of submersible pumps.

Commodore Clipper's log of crew training and drills undertaken between 21 April 2014 and the accident **(Annex E)** shows that, on 9 June 2014, a fire exercise was *'combined with instructions for damage control'*. Other than this, the crew training conducted in this period prior to the accident was dominated by simulated fires and abandon ship drills.

1.9 NAVIGATION THROUGH THE LITTLE RUSSEL

The Little Russel is a northern approach channel to St Peter Port between the islands of Guernsey and Herm. The primary method of navigating through the Little Russel was visual; the key reference for the passage west of Roustel was the leading marks bearing 220° when in transit **(Figure 13)**. The Roustel is a rocky shoal that dries at low water and is marked by a beacon **(Figure 14)**. There are also numerous navigational marks and transits that provide further visual references to monitor the passage through. For vessels approaching St Peter Port from the north, use of the Little Russel is 4 nautical miles (nm) shorter than using the deeper and wider approach via the Big Russel passing east of Herm **(Figure 15)**.

[10] Although titled for *Commodore Goodwill*, this list was assumed to apply to both Condor's conventional ferries.

Reproduced from Admiralty Chart BA 0808-0 by permission of the Controller of HMSO and the UK Hydrographic Office.

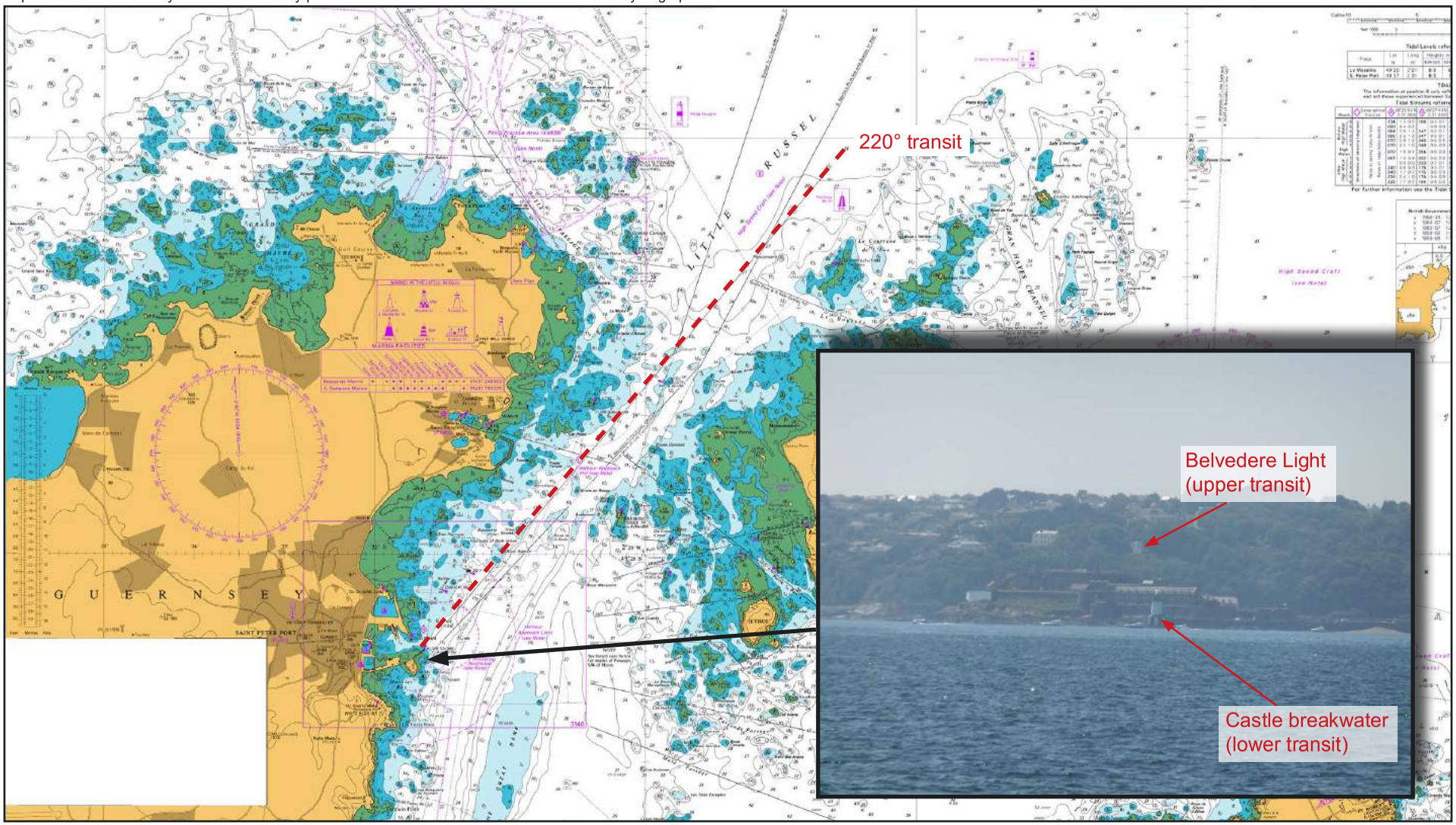


Figure 13: The 220° leading transit passing west of Roustel

Image courtesy of Captain Andy Lowe

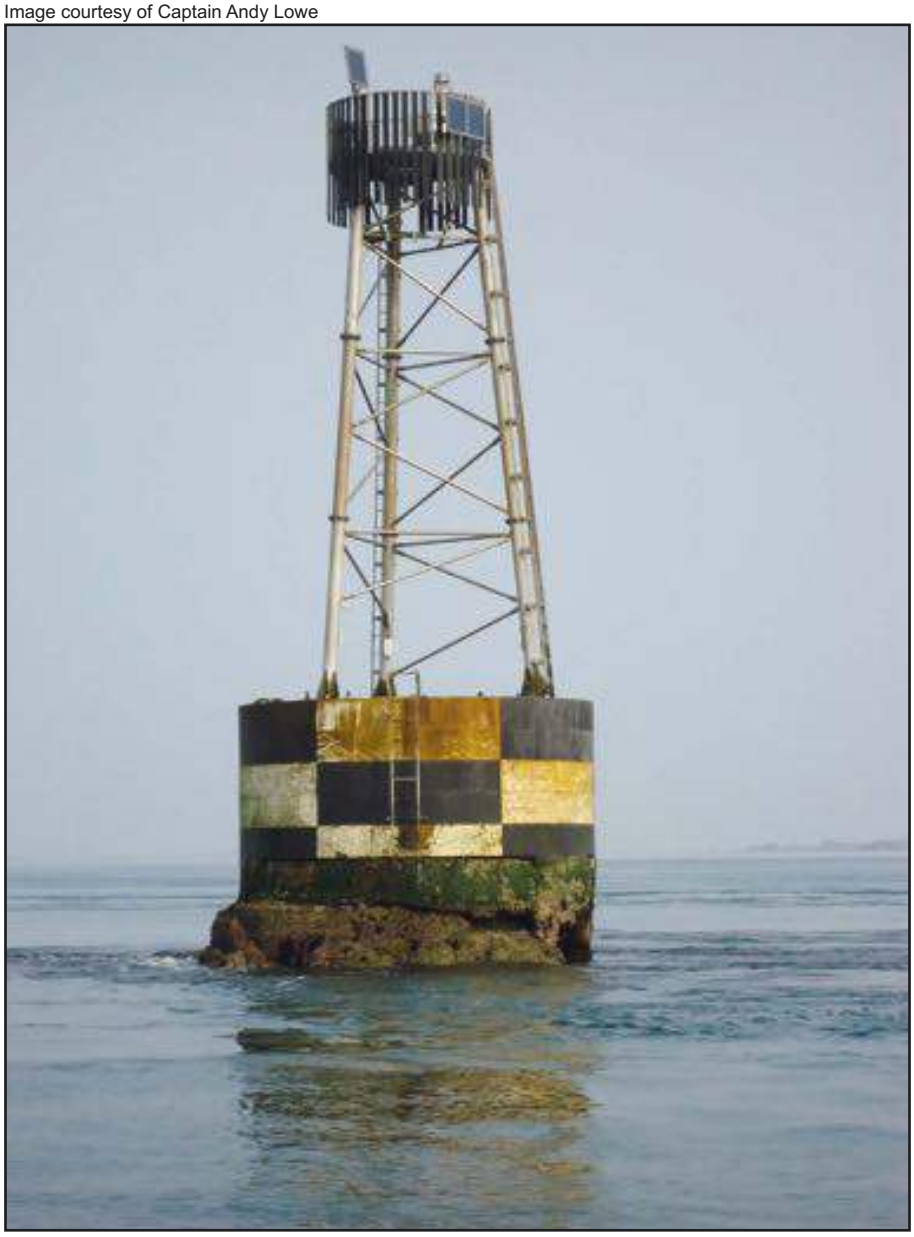


Figure 14: Roustel beacon pictured at low water

For vessels planning a passage through the Little Russel, Admiralty Sailing Directions (Channel Pilot) (NP27) contains detailed guidance on safe navigation, including the 220° leading marks. It also contains specific cautions on the rocky shoals with depths less than 10m that present a very significant hazard to navigation in this channel.

The syllabus for St Peter Port special pilotage licence training contained a route recommended by local pilots **(Figure 16)** that advised use of the 220° transit when passing west of both Roustel and Grune au Rouge, before turning south to pass west of Boue de la Rade.

The company approved route through the Little Russel **(Figure 16)** mirrored the Admiralty and Guernsey pilots' advice, passing west of Roustel and Grune au Rouge on the 220º transit. Thereafter, the company route turned to a southerly heading but passed east of Boue de la Rade.

Reproduced from Admiralty Chart BA 0808-0 by permission of the Controller of HMSO and the UK Hydrographic Office.

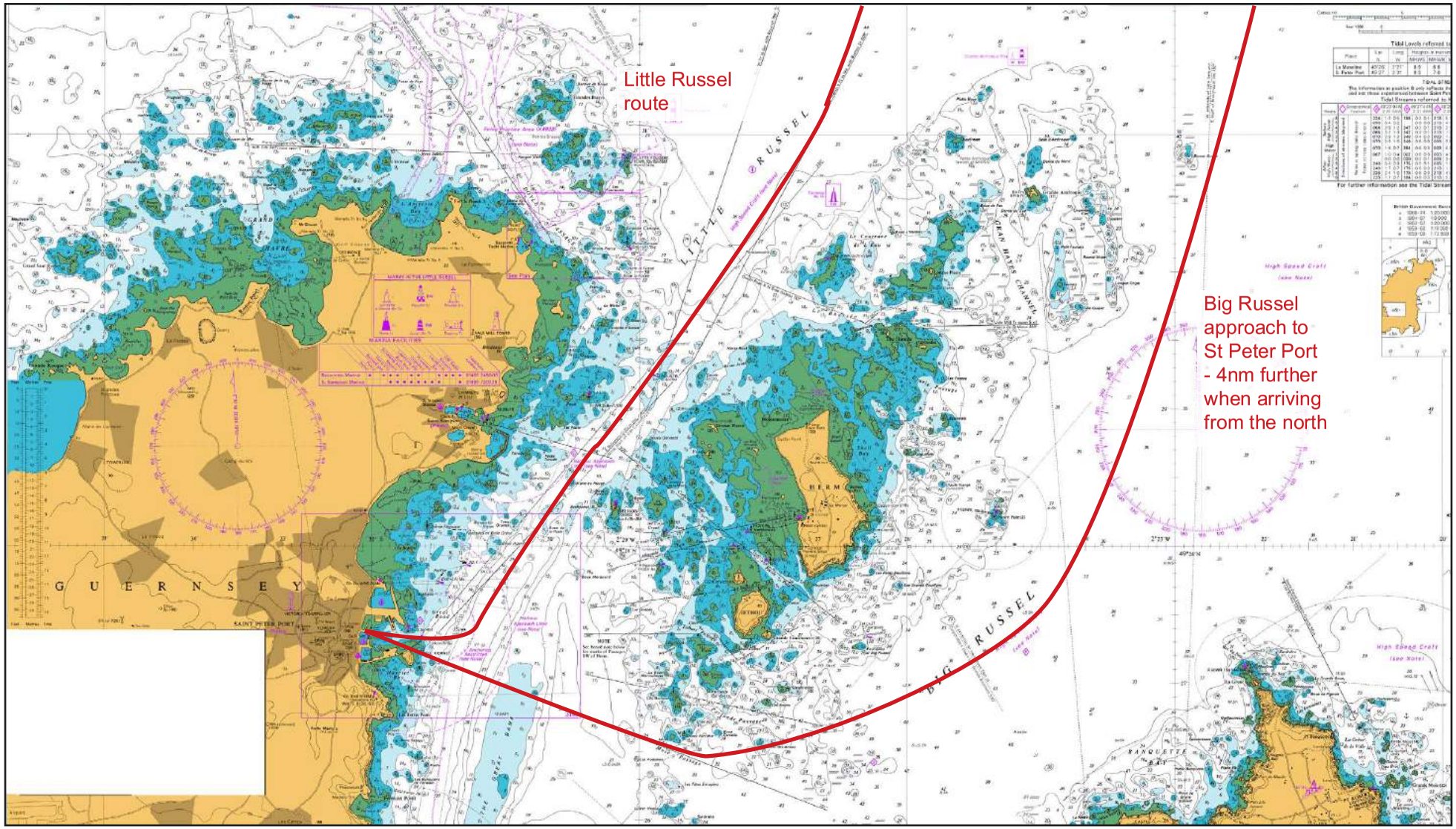


Figure 15: Comparison of Big and Little Russel routes into St Peter Port approaching from the north

Reproduced from Admiralty Chart BA 0808-0 by permission of the Controller of HMSO and the UK Hydrographic Office.

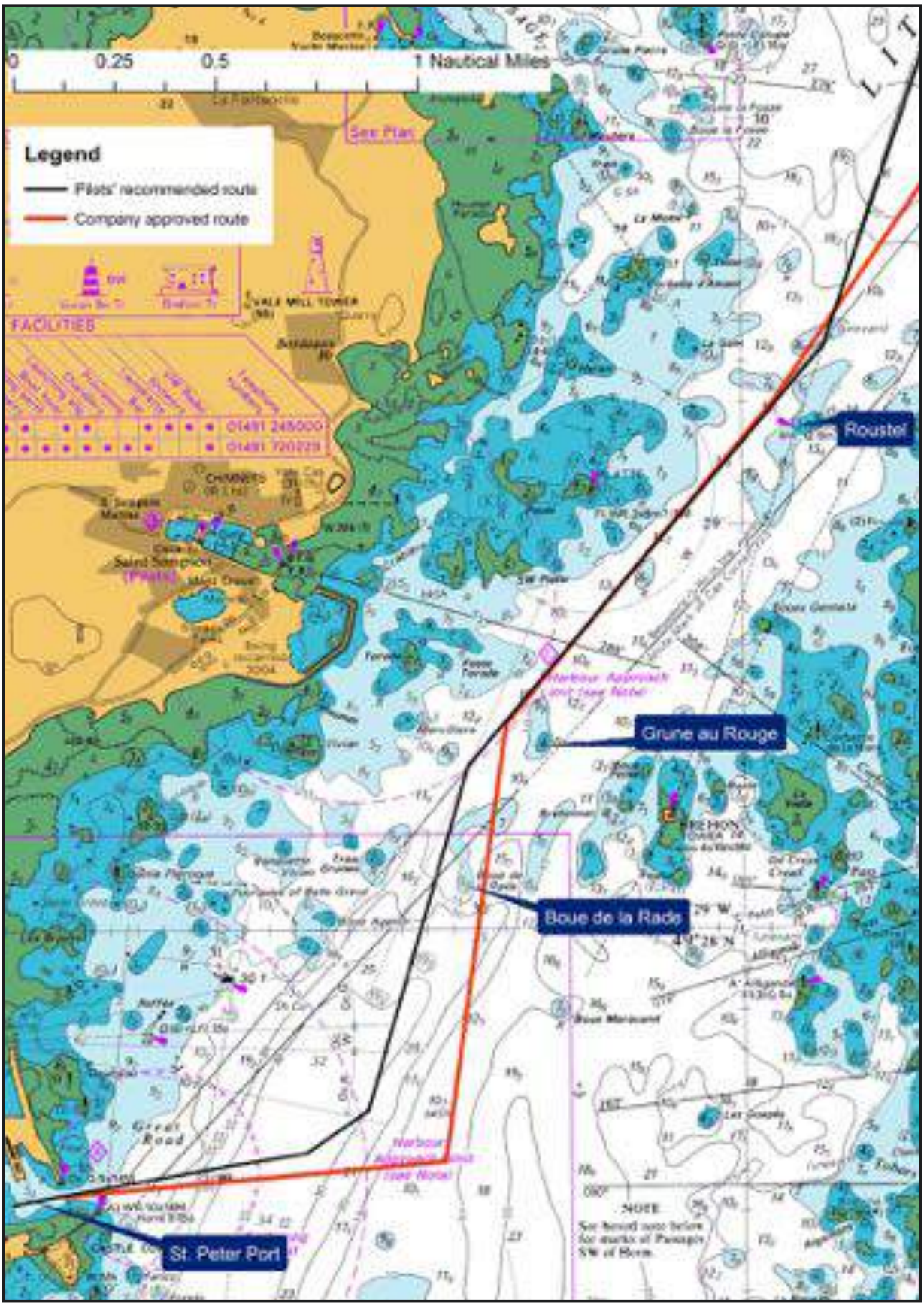


Figure 16: Pilots' recommended route and company approved route through the Little Russel

In the course of this investigation, the MAIB obtained 12 months of available[11] automatic identification system (AIS) data for *Commodore Clipper*'s southbound transits of the Little Russel prior to the grounding. This data **(Figure 17)** showed that the vessel routinely deviated from the company route by passing east of Grune au Rouge.

1.10 PASSAGE PLANNING

1.10.1 International requirement

The International Maritime Organization's (IMO) Resolution A.893(21) *Guidelines for Voyage Planning* requires masters to plan every voyage, identifying a route that takes into account all navigational hazards and ensures sufficient sea room for the safe passage of the vessel. The IMO guidelines explains that:

> *'The development of a plan for voyage or passage, as well as the close and continuous monitoring of the vessel's progress and position during the execution of such a plan, are of essential importance for safety of life at sea, safety and efficiency of navigation and protection of the marine environment.'*

The guidance sub-divides passage planning into four key stages: appraisal, planning, execution and monitoring. The initial voyage planning **appraisal** stage involves the gathering of all information relevant to the intended voyage. The next stage requires the detailed **planning** of the whole voyage from berth-to-berth. The third and fourth stages are the effective **execution** of the plan and **monitoring** the progress of the vessel during the implementation of the plan.

1.10.2 Company guidance

Condor Marine Services' group management manual stated:

> *'3.2.16.7. The passage plan must take into account all the pertinent information relating to the voyage, in particular:*
>
> - *The draught of the vessel*
> - *Depth of water and range of tide*
> - *Tidal flow and rate, currents and swell*
>
> *All tracks laid down shall be well clear of hazards to navigation giving adequate under keel clearance at all times.*
>
> *Masters have full discretionary powers to delay entry or leaving port if by reason of adverse weather or other conditions they consider it unsafe.*
>
> *In general, when either entering or leaving port where the charted depth is a critical factor it is best to wait until near the time of High Water, to provide a reasonable margin of water under keel.'*

[11] This data set is not a complete history of all the vessel's tracks but is sufficiently well populated to provide an overview of routes used.

Reproduced from Admiralty Chart BA 0808-0 by permission of the Controller of HMSO and the UK Hydrographic Office.

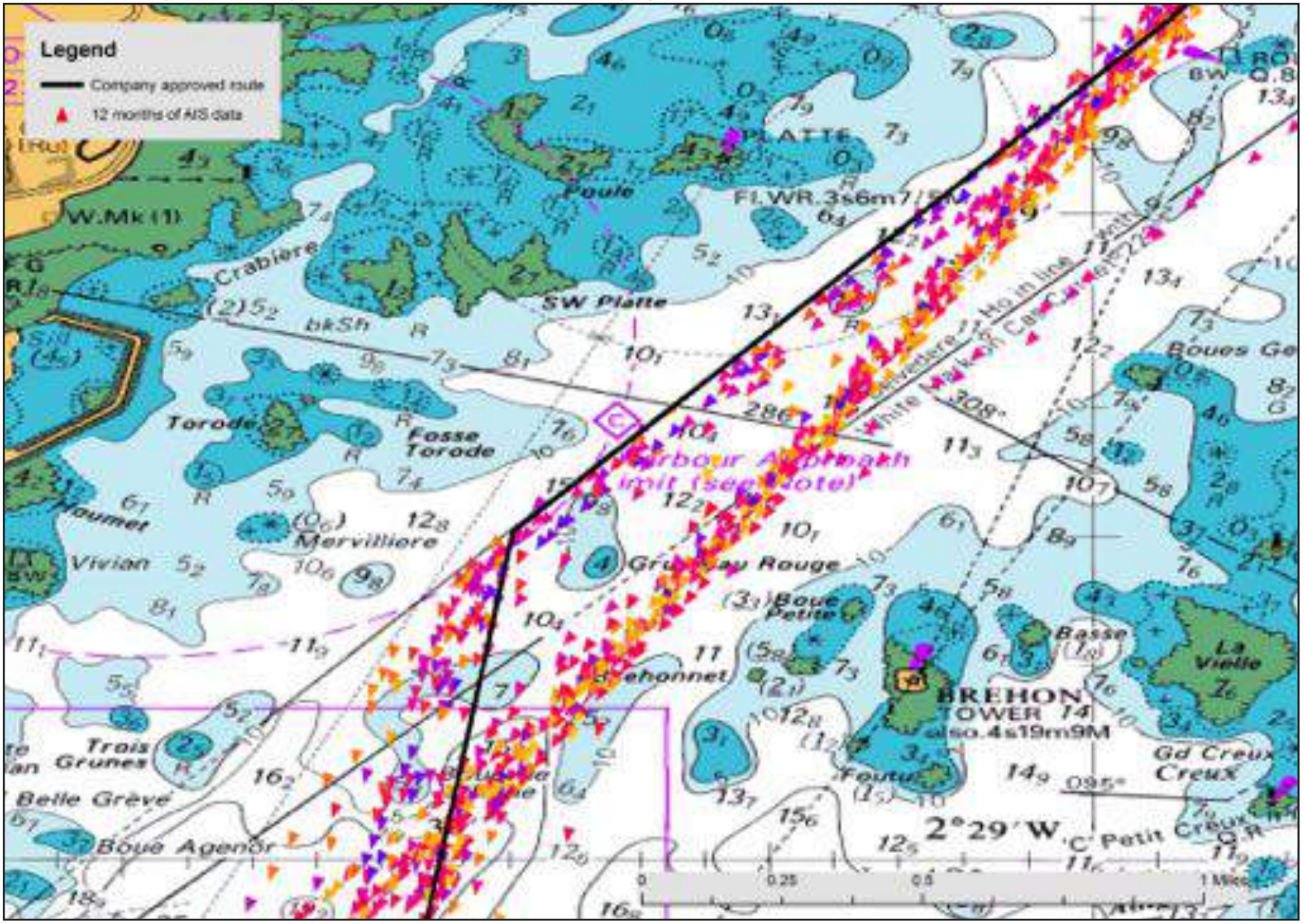


Figure 17: Twelve months AIS history of *Commodore Clipper*'s southbound passages via the Little Russel

For conventional ferries inbound to St Peter Port, the group route operations manual stated:

> *'11.8.4.2. The usual approach to Saint Peter Port is via the Little Russell. Guernsey pilots have made a recommendation that the Big Russell and a Southerly approach to St. Peter Port should be used in reduced visibility. It should be stressed however that use of the Little Russell in poor visibility is not prohibited, all hazards should be taken into account, including speed of transit, before using this approach channel'* [sic].
>
> *'14.7.3. The Little Russel Passage is not used in fog due to problems with the identification of small craft; passage is via the Big Russell'* [sic].

1.10.3 Onboard preparations

Prior to each voyage, the master chose the route to be followed, which was then selected from pre-loaded route data in the ECDIS and radar systems. The OOW was also required to update tidal data on a state-board by the chart table. No other specific passage planning actions were taken; ECDIS safety depth, safety contour and XTD settings were not adjusted to reflect the safe water, based on height of tide, available for the passage.

1.10.4 Passage execution in pilotage waters

In pilotage waters, the master, chief officer and a helmsman were required on the bridge. In addition, for inbound passages, after handing the con to the master, the OOW would routinely remain on the bridge until required to close up at a mooring station thus providing additional manpower in the approach to harbour. Having taken the con, the master would pass verbal instructions to the helmsman for required courses to steer, but operated the propulsion power levers himself. The master did not routinely vocalise his intentions or plans to the rest of the bridge team.

1.11 INTERACTION

1.11.1 Effects

Interaction between a moving vessel and the seabed takes a number of forms including squat and shallow water effect. Squat is the decrease in under keel clearance that results from the increased velocity of water flowing under a vessel's hull and, therefore, the consequent reduction in pressure underneath. Shallow water effect can cause loss of speed, vibration and sluggish handling when a vessel is in waters shallower than the onset depth[12]. Shallow water effects increase as depth reduces and becomes significant at 25-30% of the onset depth. In this case, for *Commodore Clipper* with a displacement of 7975 tonnes and a speed of 18kts, the onset depth would be 61m and the effects significant in approximately 18m or less sea depth. Interactions vary with the square of the vessel's speed through the water, therefore reducing speed is the most effective method of limiting shallow water effect.

[12] Onset depth = speed x 0.17 x cube root of displacement in tonnes

1.11.2 Topography

The seabed in the approaches to Portsmouth and St Peter Port have different topographical features. The eastern approach to the Solent consists of gently shelving mud and sandbanks; whereas the Little Russel is mainly granite with steep rocky shoals. Thus, the onset of shallow water effect in the Solent approach is gradual and easily detected by the bridge team. Conversely, the onset of interaction effects in the Little Russel will not be gradual and, therefore, much more difficult to recognise or respond to.

1.11.3 Company guidance

The group management manual discussed hydrodynamic interaction and excessive speed, and stated:

> *'3.2.14.1. The Master and Chief Officer are reminded of the hydrodynamic interaction forces between vessels and banks of channels, and 'squat' over the ground. These forces can almost be eliminated by proceeding at slow speed. No consideration of prior knowledge or experience of the pilotage waters, schedule, practice or prior instruction can justify a speed likely to cause a casualty.'*

The ECDIS section of the group route operations manual offered guidance on the calculation of safe depth taking squat into account, and the wheelhouse poster **(Figure 18)** contained estimated squat data for planning. The information on the poster showed that in approximately 10m of water and at a speed of 12kts, a 'draught increase'[13] of 1.18m should be applied.

After the grounding, the company commissioned an independent consultant to assess the effects of squat in the Little Russel; this calculation showed an estimated value for squat at the time of grounding of 1.46m.

1.12 ECDIS

1.12.1 Equipment, training and performance standards

Commodore Clipper's Transas Navi-sailor 4000 ECDIS had been approved by the Flag State for use as the primary means of navigation on board since 14 August 2013. All of the deck officers had completed the necessary generic training and type-specific familiarisation. This training had been provided by ECDIS Limited in Fareham, UK and fulfilled the requirements of the IMO Model Course 1.27 syllabus, thus meeting the requirements of the STCW Code.

The performance standards for ECDIS are detailed in IMO Resolution MSC 232(82): *Adoption of the Revised Performance Standard for Electronic Chart Display and Information Systems*, dated 5 December 2006. Appendix 5 to this Resolution mandates an alarm whenever a vessel crosses the safety contour or deviates from the selected route. An alarm is defined as '*an alarm or alarm system which announces by audible means, or audible and visual means, a condition requiring attention*.'

[13] Squat does not result in an increase in the vessel's draught; however, it is most easily considered in this way for the purpose of calculating under keel clearances.

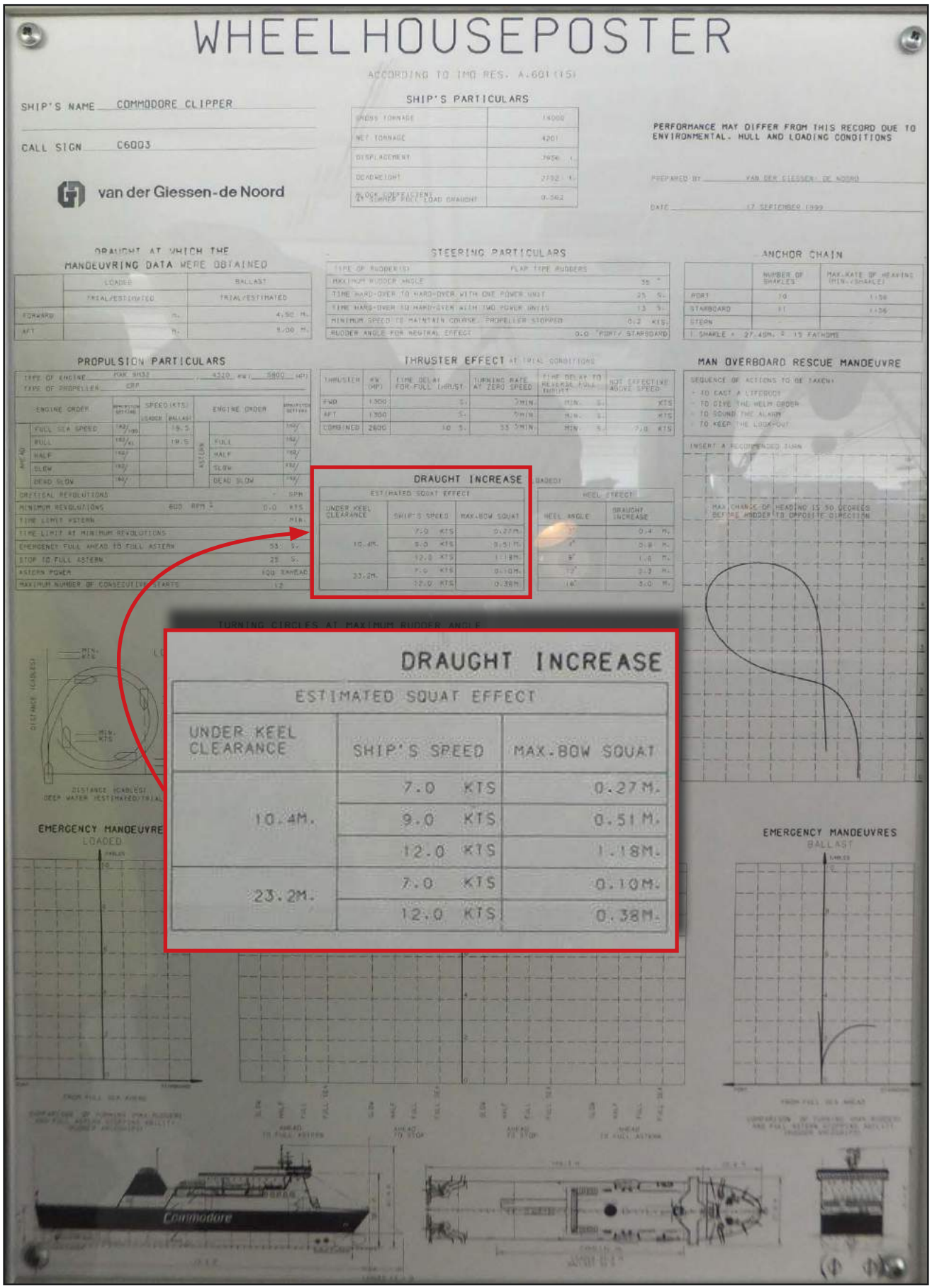


Figure 18: Wheelhouse poster showing estimated squat data for planning

1.12.2 Safety depth and safety contour

Warning of the risk of grounding is achieved using the safety depth and safety contour functions. The group route operations manual gave the following calculation for safety depth:

'Safety depth = draught + squat + minimum UKC – height of tide'

At the time of the accident, the safety depth was set at 7m.

The safety contour is intended to show the operator a clear distinction between safe and unsafe water. If there is not an ENC contour corresponding to the chosen safety contour value, ECDIS will automatically default to the next deeper contour. However, should the operator wish to use a safety contour that does not correlate with an available ENC contour, ECDIS has the capability for a limiting danger line (LDL) to be drawn manually at whatever safety contour value is required. At the time of the accident, the safety contour was set to 5m.

1.12.3 Deviation from planned route

Warning of deviation from the planned route is achieved by use of the XTD setting, which is an operator defined safety corridor either side of the planned route. If the vessel crosses outside the XTD, the system will alarm until the vessel is back inside the safety corridor. Particularly in pilotage waters, the XTD should be calculated for each leg of a passage and take into account the expected width of safe water available. For the leg of the passage plan at the time of grounding, the XTD settings were:

- XTD (port): 0.025nm (50 yards[14])
- XTD (starboard): 0.06nm (120 yards)

The XTD alarm on board *Commodore Clipper* was active from 1504 when the vessel crossed outside the safety corridor until the time of the grounding.

1.12.4 Safety frame

The safety frame feature is a look-ahead zone providing navigational safety by forewarning of a risk of grounding ahead. An anti-grounding alarm is generated when the safety frame crosses the safety contour or passes over the safety depth. The size of the safety frame ahead of the vessel's position is measured in time[15] and the width either side is defined as a distance. The available settings were:

- Ahead: 0 – 15 minutes
- Port/starboard: 0.1nm - 4nm

The group route operational manual stated:

[14] 1 yard = 0.9144m

[15] By measuring ahead in time, the distance at which a warning occurs is a function of the vessel's speed

'16.5.8.1. Turning the Safety Frame off means that the system will only alarm when the ship symbol encounters them [safety depth or safety contour]*, which in most cases will be too late.'*

On *Commodore Clipper* the safety frame feature was switched off at the time of the accident.

1.12.5 Alarm management

After ECDIS was approved for use as the primary means of navigation, its alarms activated frequently during *Commodore Clipper*'s passages. Along with the bridge teams from other vessels in the company's fleet, the crew on the bridge of *Commodore Clipper* found the constant ECDIS audible alarms a significant distraction. As a result of concerns raised by the masters of its vessels, the company allowed the audible alarms to be disabled across its fleet. Nevertheless, the visual alarms remained active and could still be observed on the ECDIS display. The company did not notify the Flag State of its decision to allow the ECDIS audible alarm to be disabled.

1.13 INSPECTIONS AND AUDITS

Between March 2013 and the accident, *Commodore Clipper* was inspected seven times in accordance with the ISM Code and the Paris Memorandum of Understanding, and no navigational non-conformities were raised. The inspections consisted of two internal ISM audits by the company, a renewal ISM audit by DNV, an annual inspection by the Flag State and three Port State Control (PSC) inspections.

The most recent external inspection prior to the accident was the renewal ISM audit conducted by a DNV surveyor on 3 June 2014. The inspection report stated that the vessel's *'bridge processes, including navigation, watchkeeping, voyage planning, equipment maintenance, and testing, communications, library and publications, etc'* had been reviewed and found to be satisfactory. The inspection did not identify that the ECDIS audible alarm had been disabled.

1.13.1 Internal audits

The report of the company's internal audit conducted on 5 - 6 May 2014 noted a *'very high level of knowledge of vessel procedures was found as was a commitment to safe operations'* and *'an inspection of operational areas of the vessel was carried out as was an informal Bridge Team Management Assessment and the standard achieved was observed to be high.'*

Condor Marine Services also had a system of conducting regular navigation and bridge team management (BTM) assessments. The assessment programme was delivered by the company's marine manager and included an annual check voyage with each vessel to assess standards and provide a training opportunity for bridge teams. The output from these assessments was a BTM evaluation checklist with comments where necessary. The marine manager also conducted random navigational data downloads from ECDIS and voyage data recorders (VDR), which were then analysed ashore and feedback provided to the bridge team concerned.

1.14 HYDROGRAPHY

1.14.1 International obligations

The International Convention for the Safety of Life at Sea (SOLAS), Chapter V, Regulation 9 requires IMO member states to provide nautical and hydrographic services that are suitable for safe navigation. Provision of such services is an obligation for the UK, its overseas territories and crown dependencies. The States of Guernsey is a self-governing crown dependency of the UK.

Responsibility for prioritising and managing civil hydrographic surveying in UK waters is held by the Maritime and Coastguard Agency (MCA) and for the Channel Islands is delegated to its local governments. Responsibility for analysis of survey data and the preparation of charts and corrections is held by the UKHO.

1.14.2 Survey data quality

Admiralty paper charts contain a source data diagram that is a scaled replica of the area covered showing the quality of the survey source. This information should be taken into consideration during the passage planning process. For ENCs, a similar system is used to categorise the accuracy of the hydrographic data. Referred to as the category of zone of confidence (CATZOC), it gives an accuracy for both positional and depth data on the ENC. The CATZOC table from the Mariners' Handbook is at **Annex F**.

The survey data for the Little Russel was based on 1960s single-beam echo soundings. Data from the ENC in use at the time showed that the position of the grounding was in an area defined as CATZOC 'B', which means that, for depths down to 10m, an error of plus or minus (+/-) 1.2m should be applied[16].

Guernsey Harbours recognised its obligation to maintain accurate hydrographic data in its territorial waters, and in March 2014 it commissioned a commercial multi-beam echo sounder survey of St Peter Port's harbour approaches. The results of this survey were completed and passed to Guernsey Harbours by the survey company at the end of June 2014; the data was then forwarded to the UKHO for analysis. After the accident, scrutiny of this new data showed the rocky shoal in the grounding position had a surveyed depth of 4.6m below chart datum **(Figure 19)**.

1.15 THE STATES OF GUERNSEY HARBOUR AUTHORITY

1.15.1 Guernsey Harbours

The States of Guernsey's Public Services Department (PSD) was responsible for the maritime environment. As a sub-department of the PSD, Guernsey Harbours undertook specific mandated functions as the island's harbour authority. These functions included: operation and management of the island's harbours, moorings, vessel registry, provision of pilotage, coastguard functions, aids to navigation and facilities maintenance.

[16] A positional error of ±50m would also apply and the absence of full seafloor coverage by the survey meant that, although not expected, uncharted features may exist.

Figure 19: Extract of data from multi-beam survey conducted in March 2014 showing 4.6m sounding in grounding position (orientated north up)

Guernsey Harbours was led by a harbour director who was responsible directly to the PSD Board, and a harbourmaster who delivered the operational outputs. Although the harbourmaster had a team of assistant harbourmasters, harbour managers and operators, there was no individual member of staff assigned direct responsibility for safety management.

In 2013, Guernsey Harbours managed over 3,600 commercial shipping movements entering or departing either St Peter Port or Saint Sampson; the majority of these were ferries. Each year, St Peter Port also hosts approximately 85 cruise ship visits, landing over 100,000 visitors to the island by small boats. Cruise ships anchor outside the harbour with pilotage assistance. The island's fishing fleet consists of 165 vessels (2013 data) and Guernsey Harbours also manages significant levels of leisure vessel activity, especially in the summer months.

1.15.2 The Port Marine Safety Code and Guernsey safety management

The UK Port Marine Safety Code (PMSC) established the principle of a national standard for every aspect of marine operations in ports and pilotage areas across the UK. Although it is a voluntary code, it has been adopted by most harbour authorities that have statutory powers and duties. It applies the processes of risk assessment and safety management systems in order to ensure operations are conducted safely by trained and competent staff.

The PMSC offered guidance on the establishment of accountability for safety through the appointment of a duty holder[17] and a designated person. The duty holder is directly accountable for the safety of marine operations in its waters and approaches. The designated person provides independent assurance about the operation of the harbour authority's safety management system and has direct access to the harbour board.

In order to comply with the PMSC, the duty holder, on behalf of the harbour authority, must:

*'1. **Review and be aware** of their existing powers based on local and national legislation;*

*2. **Comply** with the duties and powers under existing legislation, as appropriate;*

*3. **Ensure all risks are formally assessed** and as low as reasonably practicable in accordance with good practice;*

*4. **Operate an effective marine safety management system** which has been developed after consultation and uses formal risk assessment;*

*5. **Use competent people** (i.e. trained, qualified and experienced) in positions of responsibility for safety of navigation;*

*6. **Monitor, review and audit** the marine SMS on a regular basis – an independent designated person has a key role in providing assurance for the duty holder;*

[17] Duty holder – for most harbour authorities this means members of the harbour board, both individually and collectively.

7. ***Publish a safety plan*** *showing how the standard in the Code will be met and a report assessing the performance against the plan;*

8. ***Comply with directions*** *from the General Lighthouse Authorities and supply information & returns as required.'*

In 2001, Guernsey Harbours commissioned an external review of its operations. The output of this work was a Marine Operations Plan for the ports of Guernsey, dated 17 April 2001. Although Guernsey Harbours were not required to apply the UK PMSC, its Marine Operations Plan was compliant with the 2001 edition of the Code. Subsequently, this plan was not updated or amended and was not in use as a safety management system for operations at the time of the grounding.

The PMSC also provided guidance for the development of a port passage plan, regarded as essential for the safe conduct of navigation and environmental protection. Guernsey Harbours did not have a port passage plan for St Peter Port.

Guernsey Harbours maintained a risk register that was managed by a risk working group; however, this process primarily considered strategic and commercial risks. **Annex G** is an extract of the risk register regarding the safe navigation at sea. There was no evidence of risk assessments for the conduct of navigation or pilotage, including supporting capabilities such as underway boat transfers.

1.15.3 Harbour control

Under the direction of the harbourmaster, Guernsey Harbours maintained a continuous watchkeeping organisation that fulfilled two functions: harbour control and the Guernsey Maritime Rescue Co-ordination Centre (MRCC). Watchkeepers kept watch in a harbour control operations room at the end of the St Peter Port breakwater; situational awareness was provided by a commercial radar, AIS data and very high frequency (VHF) radio including digital selective calling (DSC).

The watchkeepers were trained locally and were responsible for maintaining a log of events, keeping a radar lookout and approving shipping movements in the harbour. In the event of a search and rescue, the Guernsey MRCC would co-ordinate operations with the UK, Jersey and French MRCCs in Falmouth, St Helier and Jobourg respectively.

1.15.4 Vessel traffic services

SOLAS Regulation 12 Chapter V (Safety of Navigation) required contracting governments to arrange for the establishment of vessel traffic services (VTS) where the volume of traffic or the degree of risk justified such a service. The regulation also required contracting governments planning and implementing such services to follow IMO guidance[18]. The MCA's Marine Guidance Note (MGN) 401 (M + F)[19] provided the UK interpretation of VTS and offered guidance to assist statutory harbour authorities in the implementation or review of a VTS service.

[18] IMO Resolution A.857(20) Guidelines for Vessel Traffic Services

[19] MGN 401 (M+F) – *Navigation: Vessel Traffic Services (VTS) and Local Port Services (LPS) in the United Kingdom*

The purpose of a VTS is to enhance safety of navigation and protection of the marine environment. A VTS should comprise at least an Information Service, and may also include others such as a Navigational Assistance Service or a Traffic Organisation Service, or both. An Information Service does not involve the direction of shipping movements but provides essential and timely information which may include other vessel movements, weather forecasts, notices to mariners and status of aids to navigation. The prerequisites of a VTS include: the provision of equipment appropriate for the type of service provided, and suitably qualified staff trained to IALA[20] V-103 standard. The St Peter Port harbour control watchkeepers were not V103 qualified and Guernsey Harbours was not providing a VTS.

1.15.5 Pilotage

The primary legislation for pilotage in and around St Peter Port was the States of Guernsey Pilotage Ordnance Act, 1967, as amended. It defined the Statutory Pilotage Area **(Figure 20)**, established the powers of the Pilotage Board and also set out the requirement for the granting and renewal of general and special pilotage licences. Holders of special pilotage licences were empowered to conduct pilotage of their vessels within the statutory area without a Guernsey pilot embarked.

Gaining a special pilotage licence required candidates to complete a dedicated period of self-study and practical training. The syllabus included details of the navigational hazards in the pilotage area as well as a minimum of 10 supervised entries and exits from the ports defined in the licence. Candidates were also required to be fully familiar with Guernsey pilotage and harbour laws. On completion of the training, the candidate was required to pass a practical examination.

Special pilotage licence holders were then required to complete a minimum of 20 entries and exits from designated ports every 12 months in order for their licence to be revalidated. There was no continuous professional development programme or further requirement for the periodic re-assessment of special pilotage licence holders.

1.16 SIMILAR AND PREVIOUS ACCIDENTS

1.16.1 Condor Marine Services

This is the third casualty since 2010 involving vessels managed by Condor Marine Services that has resulted in a published report.

On 16 June 2010, *Commodore Clipper* suffered a major fire on its main deck while on passage from Jersey to Portsmouth. Although the crew contained the fire, they were unable to extinguish it; damage was extensive and the fire-fighting effort also affected the vessel's stability. The accident was investigated by the MAIB and the report[21] was published in November 2011.

On 28 March 2011, the high speed craft *Condor Vitesse* collided with the French fishing vessel *Les Marquises*. *Les Marquises* was cut in two by the collision and one of the three crew was lost. The accident was investigated by both the Bahamas

[20] IALA – The International Association of Marine Aids to Navigation and Lighthouse Authorities

[21] MAIB Report No 24/2011 – https://www.gov.uk/maib-reports/fire-started-by-unaccompanied-refrigerated-trailer-unit-on-main-vehicle-deck-of-ro-ro-passenger-ferry-commodore-clipper-in-the-english-channel-on--route-to-portsmouth-england

Figure 20: Guernsey Ordnance Act statutory pilotage area

Maritime Authority (BMA)[22] and the French Bureau of Marine Accident Investigation (BEAMer)[23]. Poor visibility and a lack of attention on the bridge of *Condor Vitesse* as well as *Les Marquises*' lack of a continuous radar lookout were identified as causal factors of the accident. BEAMer made a recommendation to *Condor Vitesse*'s owners to ensure ISM Code and company procedures were implemented on board. The BMA report concluded that the speed of *Condor Vitesse* was probably too fast for the conditions, and the bridge team's level of alertness appeared to have lapsed once the vessel had left the restrictions of the St Malo channel.

[22] The Commonwealth of the Bahamas report into the collision between the high speed ferry *Condor Vitesse* and the fishing vessel *Les Marquises* on 28 March 2011. http://www.bahamasmaritime.com/downloads/Casualty%20Reports%202001%20onwards/CONDOR%20VITESSE%20-%20March%202011.pdf

[23] The report of the safety investigation into the collision between the high speed craft *Condor Vitesse* and the potter *Les Marquises* on 28 March 2011 http://www.bea-mer.developpement-durable.gouv.fr/IMG/pdf/RET_CONDOR_VITESSE_-_LES_MARQUISES_04-2011_Site.pdf.

1.16.2 *Queen Elizabeth 2*

On 7 August 1992, *Queen Elizabeth 2* grounded whilst on passage to New York; the weather was fine and the vessel was under pilotage. The MAIB report[24] concluded that the immediate causes of the grounding were that the depth of water was less than shown on the chart, the height of tide had been over-estimated and the effect of squat was substantially greater than had been allowed for. Contributing factors included high speed and a failure to heed guidance on the planning and conduct of passages.

1.16.3 ***Octopus* and *Harald*** – MAIB Report 18/2007

On 8 September 2006, the jack-up barge *Octopus*, which was under tow by the tug *Harald*, grounded to the west of Green Holm Island in the Orkneys. The grounding occurred on an uncharted 7.1m patch in an area where the closest sounding indicated a depth of 26m. The area had last been surveyed in the 1840s. The MAIB report included a recommendation for relevant industry bodies to emphasise to shipmasters and navigating officers the need to carefully consider the chart source data and, in the case of electronic charts, the CATZOC when passage planning.

1.16.4 ***Ovit*** – MAIB Report 24/2014

On 18 September 2013, the Malta registered chemical tanker *Ovit* ran aground on the Varne Bank in the Dover Strait. The MAIB investigation report established that the passage plan was unsafe as it passed directly over the sandbank. In addition, the vessel's ECDIS, which was the primary means of navigation, gave no warning of the grounding. This was because the ECDIS was not being used effectively; safety settings were inappropriate and the audible alarm was switched off. Recommendations were made to the MCA, the Flag State, the International Chamber of Shipping and the Oil Companies International Marine Forum aimed at improving the standard of navigational inspections of vessels using ECDIS.

[24] MAIB report of the investigation into the grounding of passenger vessel *Queen Elizabeth 2* on 7 August 1992. https://www.gov.uk/maib-reports/grounding-of-passenger-cruise-ship-queen-elizabeth-2-on-uncharted-rocks-south-of-cuttyhunk-island-usa

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

Commodore Clipper suffered significant raking damage after grounding on a charted, rocky shoal in the Little Russel. The bridge team had good positional awareness but were not concerned as they were unaware of the limits of safe water available. Their lack of risk appreciation occurred because insufficient passage planning had taken place prior to the voyage; in particular, the extremely low tide and effect of squat were not properly assessed. The company approved route was not followed and, recognising that the vessel was to port of the leading transit line, the master made a succession of course alterations to regain track; however, this action was ineffective due to the strength of the prevailing tidal stream that was setting the vessel off course.

2.3 PASSAGE PLANNING

Prior to sailing, the master selected the company 'Route 06' for the voyage between Portsmouth and St Peter Port but no detailed planning was undertaken. Passage planning factors not properly taken into account by the bridge team of *Commodore Clipper* were the height of tide, squat and accuracy of survey data.

For mariners planning passages through unfamiliar waters, consideration of the height of tide, interaction and the calculation of UKC and LDLs are no more than the application of basic navigation principles. However, where the passage is through familiar waters navigated daily all year round for many years by special pilotage licence holders, such planning action may not appear necessary. As the vessel approached the Roustel, both the master and the chief officer recognised that it was off track to port; indeed the chief officer stepped out of his chair to check the position visually from the bridge centreline just before the grounding. However, without knowledge of the available width of safe water, neither of them appreciated that the vessel was beyond the limit of navigational safety.

Irrespective of a vessel's size, its operational function or, in some cases, the repetitive nature of its journeys, it is imperative that every voyage is properly planned taking into account all relevant factors necessary to ensure that hazards are avoided. Complacency can be defined as 'repeated exposure to risk without consequence', and the evidence in this case clearly indicates that the repetitive nature of the task was a causal factor.

2.4 HEIGHT OF TIDE

The mean spring range of 7.9m in St Peter Port is significant and requires awareness of its applicability to each passage; specifically, how the height of tide affects the width of safe water available. The grounding occurred 6 minutes after

low water on a 115% spring tide, causing an unusually low value of just 0.9m height of tide. Although the bridge team were aware of the time and height of low water, no action was taken to assess its significance.

Figure 21 is a comparison of the ECDIS display showing safety contours set at 2m and 10m; a difference of 8m, which is effectively the mean spring range. These two images offer a visual comparison of the difference and significance that 8m height of tide makes to the width of navigable water in the Little Russel channel. For *Commodore Clipper*, the importance of this planning consideration is reinforced by the fact that several of the shoals in the Little Russel are hazardous at low water but perfectly safe to pass over at high water. Any of the OOW, chief officer or the master could have made an assessment of the effect on navigational safety resulting from such a low tide.

2.5 INTERACTION

Although the bridge team were aware of the effects of interaction and had routinely experienced it during their approaches to Portsmouth, squat was not considered by the crew when approaching St Peter Port. A post-grounding assessment indicated that the vessel was squatting by 1.46m, and data available on the bridge prior to the accident suggested that at least 1.18m of squat should be applied.

Interaction between a moving vessel and the seabed is a dynamic feature and effects of topography can be difficult to assess. Nevertheless, it is ever-present in shallow water and the speed of the vessel is the most significant factor in managing the effects.

When approaching Portsmouth, vibration experienced from shallow water effect acted as a cue to slow down; however, the rocky shoals in the approaches to St Peter Port meant the onset of squat was faster and not apparent to the crew in the same way as when approaching Portsmouth. This induced a situation where masters and watchkeepers of *Commodore Clipper* took account of, and responded to, shallow water effect when approaching Portsmouth, but did not consider it when approaching St Peter Port.

2.6 ACCURACY OF HYDROGRAPHIC SURVEY DATA

The vessel grounded on a rocky shoal charted at 5.2m. This depth was based on 1960's data, and the information on the ENC defined it as CATZOC B, which meant an error of +/- 1.2m should have been applied. While the March 2014 survey established a depth of 4.6m in the area of the grounding, this was within the tolerance denoted by the CATZOC.

Modern, colour UKHO paper charts or ENCs can give a misleading impression of accuracy. In ENCs, the CATZOC information can either be displayed in a symbolic form or found in the system's menu pages. The key point is that masters and navigating officers must take this information into account when passage planning.

Had the bridge team produced a berth to berth voyage plan, taking the chart accuracy into consideration, a worst case depth of 4.0m (5.2m – 1.2m) for the rocky shoals adjacent to Roustel and Boue de la Rade would have been applied. Had this been the case, the area where the vessel grounded and the Boue de la Rade would have been identified as unsafe, and avoided.

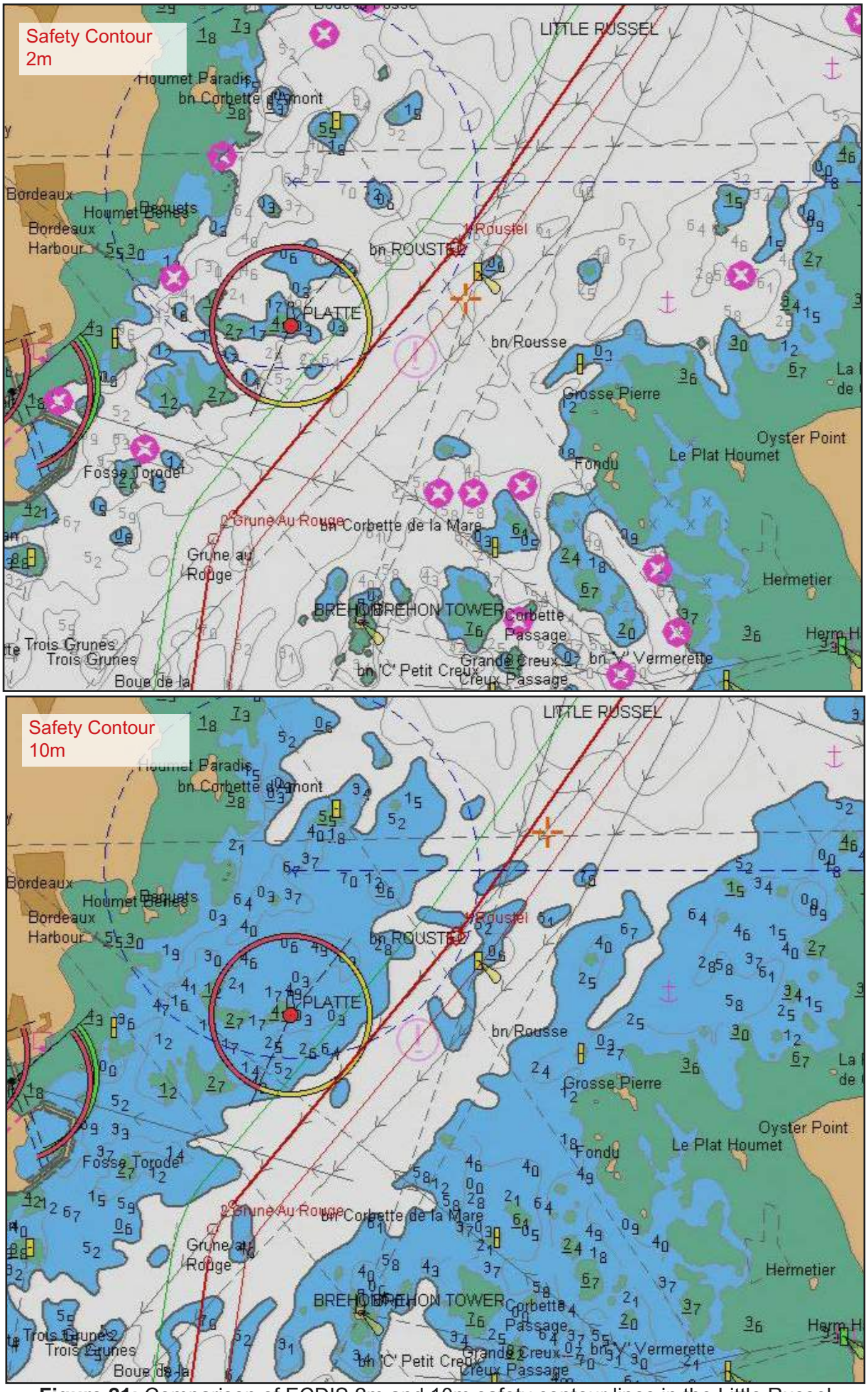


Figure 21: Comparison of ECDIS 2m and 10m safety contour lines in the Little Russel

2.7 CALCULATING THE SAFETY DEPTH

The master was aware of the charted 5.2m shoal patch and the company's requirement for a minimum UKC of 1.0m. He was also aware of the height of tide of approximately 1.0m. Thus his planning appreciation of the navigational situation was:

- Draught + minimum UKC = 6.0m
- Charted depth + height of tide = 6.2m

Having made this mental appraisal, the master assessed that the vessel could pass safely over the 5.2m shoal and thus no danger was associated with it, both before and after the grounding. However, had squat been taken into account, calculation of a safety depth would have been:

- Draught + minimum UKC + allowance for squat – height of tide
- 5.0m + 1.0m + 1.2m[25] – 0.9m = 6.3m

Thus, the vessel should not have passed over any charted depth of 6.3m or less. Furthermore, if the +/- 1.2m source data accuracy of the chart is added to this equation then, for assurance of maintaining the minimum UKC, the vessel should not have passed over any charted depth of less than 7.5m in the Little Russel. **Figure 22** is an illustration of the assessed values for the moment of grounding.

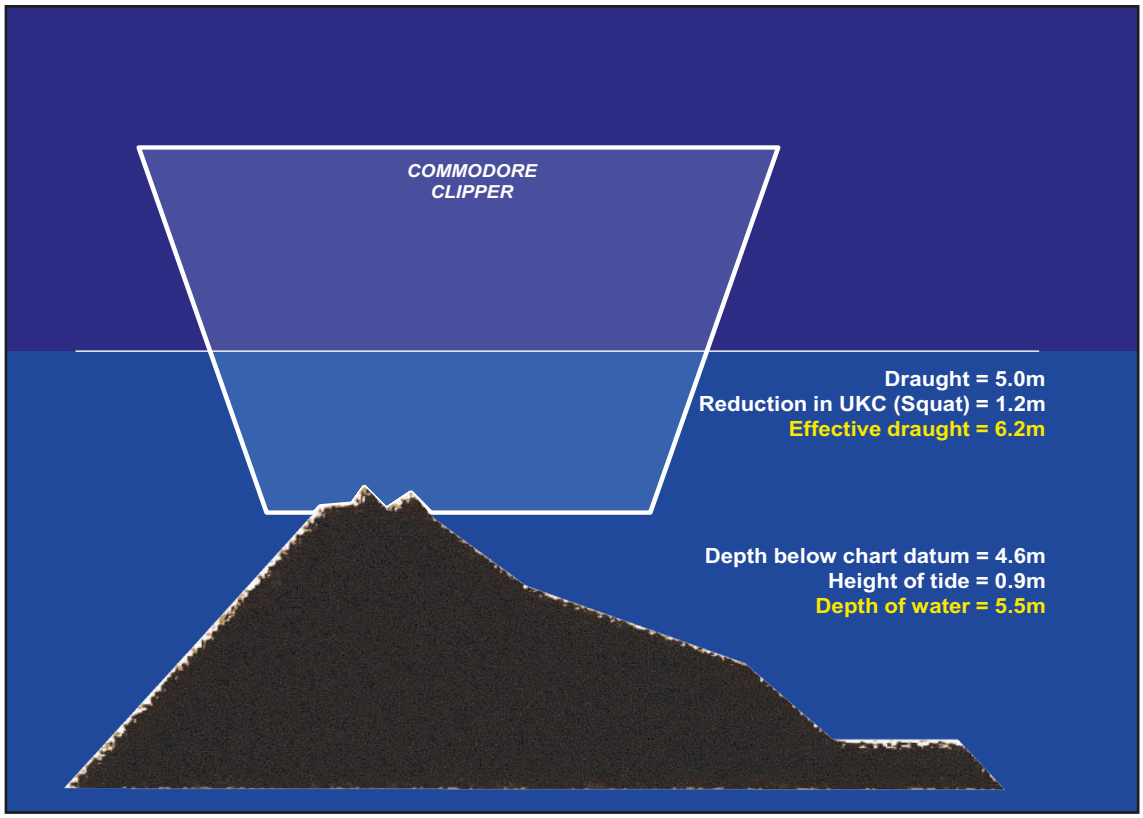


Figure 22: Assessment of actual values of draught and depth during grounding

[25] Value used is taken from data available on board at the time, rounded to nearest 10cm.

Had an accurate assessment of the safety depth been made prior to the voyage, alternative plans, such as approaching St Peter Port through the Big Russel or adjusting the time of arrival to coincide with a greater height of tide, would have been considered. Even a simple calculation, taking squat into account, might have led to such a decision.

2.8 PASSAGE EXECUTION AND MONITORING

2.8.1 Route

Admiralty sailing directions, Guernsey pilots' and the company's approved route through the Little Russel all converge on a track which passes west of Roustel and Grune au Rouge on the 220º transit. Thereafter, the recommended tracks diverge with the company approved route passing east of Boue de la Rade, but the Guernsey pilots' route passing west of it. Having selected the company's generic route for the Portsmouth to St Peter Port crossing, which had been authorised by the company for all states of tide, the master did not follow it through the Little Russel.

Figure 23 shows the company approved route and the actual route taken by the vessel. In the approach to the grounding, *Commodore Clipper* was always to the east of the approved track. The vessel then passed under 100 yards to the east of Grune au Rouge **(Figure 24)** and over the eastern side of the Boue de la Rade shoal **(Figure 25)**.

The absence of leading transit marks when passing Grune au Rouge and Boue de la Rade meant that it would not be possible visually to assess the vessel's position (or the drift) to the accuracy required given the very close proximity of danger. Therefore, the Guernsey pilots' recommended route passing west of Grune au Rouge and Boue de la Rade utilising the 220° transit would be safer.

In addition, given that the Boue de la Rade is charted at the same depth as the grounding position (5.2m), and subject to the same survey accuracy of +/- 1.2m, then passing over this shoal created a similar navigational hazard to the grounding. This event reinforces the analysis that the crew were unaware of the limits of safe water in the Little Russel.

Reproduced from Admiralty Chart BA 0808-0 by permission of the Controller of HMSO and the UK Hydrographic Office.

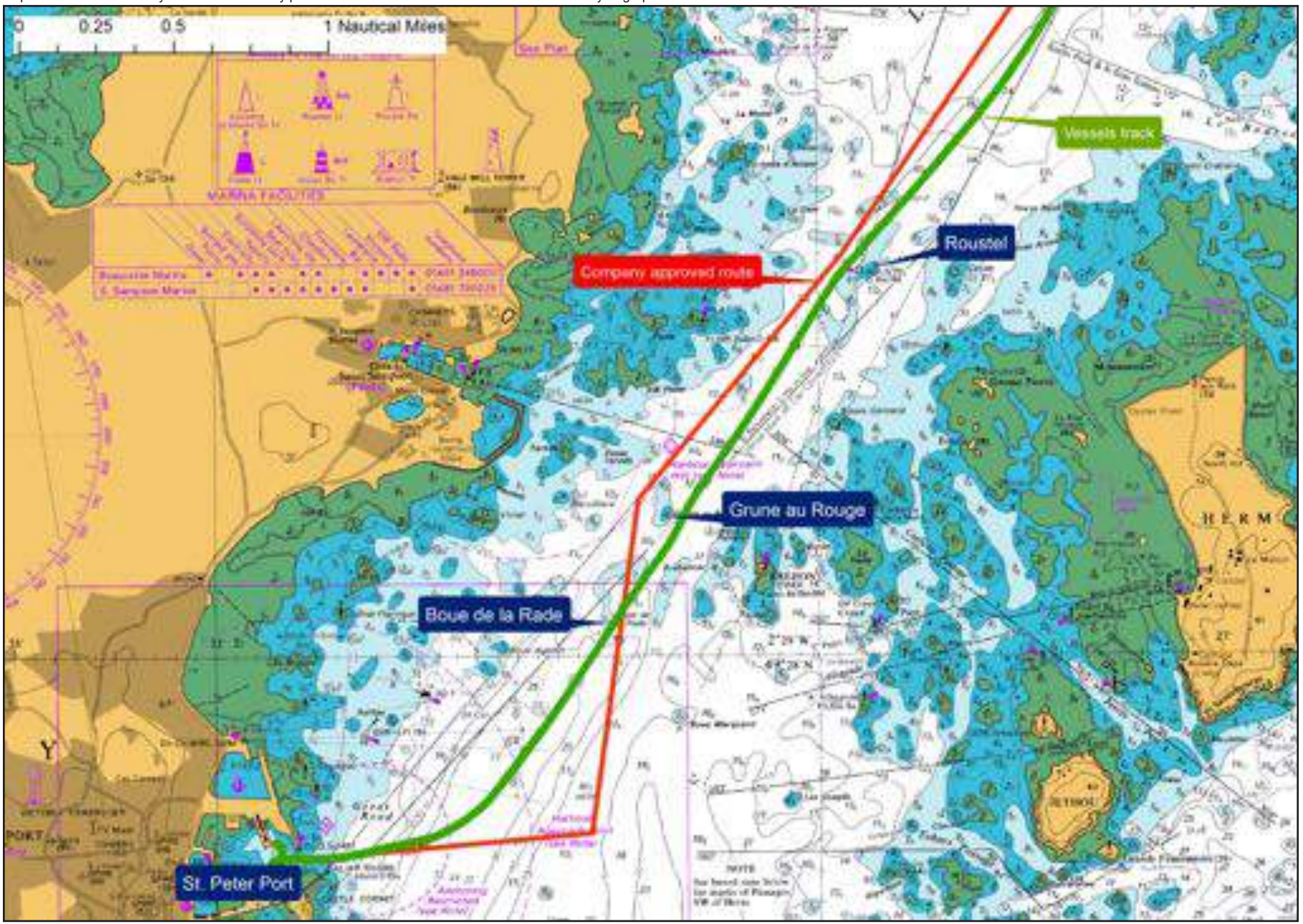


Figure 23: Comparison of company approved route and *Commodore Clipper*'s actual track

Reproduced from Admiralty Chart BA 0808-0 by permission of the Controller of HMSO and the UK Hydrographic Office.

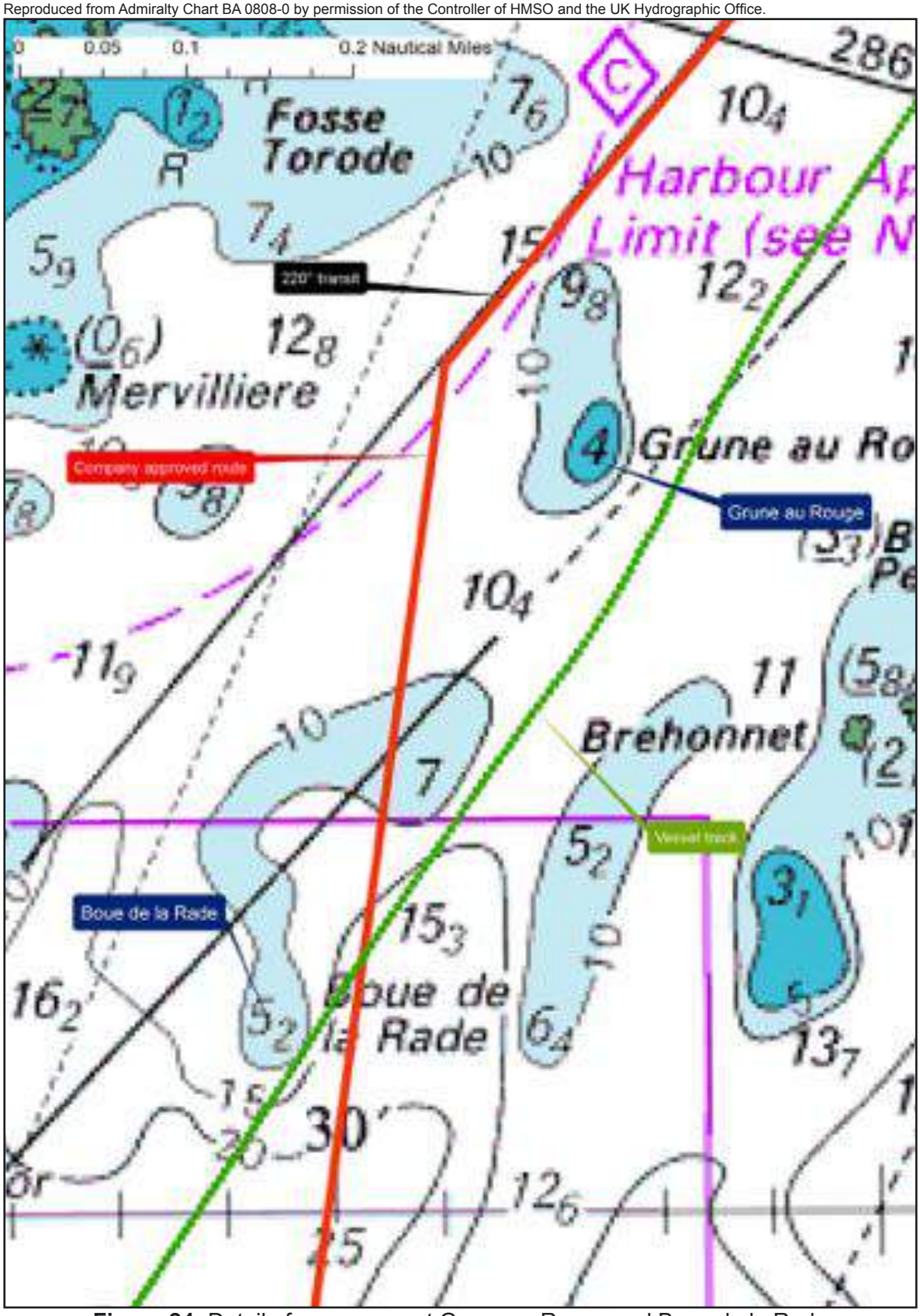


Figure 24: Detail of passage past Grune au Rouge and Boue de la Rade

Figure 25: Details of ECDIS display as vessel crossed Boue de la Rade shoal

2.8.2 Countering the tidal stream

As *Commodore Clipper* made its approach to the grounding position, the south-south-easterly tidal stream was setting the vessel off course to port. In the 2 minutes prior to the grounding, and appreciating the set, the master made a series of heading alterations intended to offset the effects of the stream and regain track. However, comparison of *Commodore Clipper*'s heading and the course over the ground **(Table 1)** shows that after the alterations to 222º and 224º, the vessel was still opening away from the leading transit. It was not until 226º was being steered that the course over the ground was 222º and thus the vessel was finally regaining the transit. However, this heading was insufficient to avoid danger; a larger and earlier alteration of course would have been necessary to get *Commodore Clipper* back into safe water.

Time	Helmsman reported steady on heading	True heading	Course over the ground
1513:40	222	221.8	218.0
1514:06	224	224.2	220.0
1514:36	226	225.8	**222.0**

Table 1: Comparison of heading being steered and course over the ground immediately prior to grounding

2.8.3 Monitoring

Positional awareness in the Little Russel was primarily achieved visually using the 220º transit; however, the margins of safety were extremely limited. At the point of grounding, the vessel was 100 yards to port of the intended track where only about 50 yards of safe water existed. Such distances require highly accurate levels of situational awareness to remain on track; there is also effectively no sea-room to allow for other vessels. Nevertheless, had the master followed, with precision, the company route through the Little Russel, *Commodore Clipper* would not have grounded.

Teamwork on a bridge is vital, especially in pilotage waters where maintaining continuous, high levels of situational awareness is required and frequent decisions relating to navigational safety are being made. Key to this is a common understanding of the plan. Pre-departure and pre-arrival briefings, both of which were required by the vessel's SMS, provide one method of delivering this. This was particularly important on board *Commodore Clipper* as evidence from its AIS history **(Figure 17)** indicated that its masters routinely deviated from the recommended route.

Had the master briefed the bridge team on his intentions prior to *Commodore Clipper* entering the Little Russel, he would have improved the capability of the chief officer and OOW to monitor his subsequent actions. Absence of this insight hampered the chief officer and OOW's ability to assist the master by monitoring his actions and providing timely inputs to the command decision making process.

2.8.4 Use of electronic navigational aids

Although the primary means of maintaining track in the Little Russel was visual, electronic navigation aids can provide vital additional data, aiding the bridge team. The master's radar and ECDIS displays at the time of grounding **(Figures 26** and **27)** both showed the company approved route and the vessel's position relative to track. The radar display showed a digital readout of the distance off track of 0.05nm (100 yards). However, given the setting on a 3nm range scale, it would be difficult to use this information for navigational safety. The ECDIS display showed the vessel's course over the ground, which took tidal stream into account and therefore provided an immediate assessment of drift.

Although good visual situational awareness was available to both the chief officer and the master from their seated positions **(Figure 2)**, the layout of the bridge console prevented the chief officer having ready access to the ECDIS. This restricted his ability to gain situational awareness from the system and, in turn, adversely affected the level of support he could give to the master.

The echo sounder's safety alarm depth was set to 0m so the alarm feature was not effective. However, the system was switched on and the display was visual to all on the bridge. Use of an echo sounder as a safety barrier during pilotage can be effective but relies on two conditions: the expectation of danger, and seabed contours that would show reducing soundings in sufficient time to react. In this case, neither of these conditions were present; the bridge team were unaware of the approaching hazard and the steep sided nature of the rocky pinnacles in the area would not have provided sufficient forewarning that the vessel was about to run aground.

2.9 EXTENT OF THE DAMAGE

The grounding caused significant hull damage along two thirds the length of the vessel. The hull was holed in several places and internal structural damage was caused by the upwards forces acting on the transverse frames. Seawater flooded into two void spaces but was contained by the vessel's double-bottom construction. The ballast tanks that were holed were already full of water and therefore there was no adverse effect on the vessel's stability. However, this was an extremely fortunate outcome because if the vessel had been damaged in more vulnerable areas such as stabilisers, steering or propellers, the situation could have posed a serious hazard to the vessel, its crew, passengers and the environment.

2.10 EMERGENCY RESPONSE AND DAMAGE ASSESSMENT

2.10.1 Denial

The severity of the noise and vibration during the grounding alarmed many of the crew. The fact that the master immediately reduced power and directed both of the other officers on the bridge to look astern is evidence that he knew something significant had happened. However, the master was convinced that there had been sufficient water where the vessel had passed and concluded that the vibration had probably been caused by a string of fishing pots becoming snagged around the propellers.

Even the chief engineer, who described to the master the severity of the shudder experienced in the engine control room, could not influence the master's view that the vessel had not grounded. After their phone conversation, the chief engineer trusted the master's judgment and advice, and took no further immediate action. Additionally, soon after passing Roustel, the vessel was in the final approaches to St Peter Port and the bridge team's focus was on safely negotiating the harbour entrance; this deflected their attention from analysing the event further.

The master's firm conviction was underpinned by the absence of alarms and the normal functioning of the vessel's steering and propulsion systems. However, there was no evidence of fishing pots being snagged; nothing had been seen astern and the shafts were not fouled. This should have led to consideration being given to alternative possibilities for the cause of the vibration, particularly raking over the ground given the vessel was in shallow water.

2.10.2 Appropriate response

In the event of such a loud and shuddering vibration, it is vital that action is taken immediately to identify any damage that might have been suffered. The grounding and raking checklists **(Annex B)** included requirements to search for and assess damage as well as taking tank soundings. Notwithstanding the command priority to enter harbour safely, action should have been taken by the crew to check for damage. Had such an effort commenced immediately after the event, it is likely that the water ingress would have been identified earlier. This would then have triggered a more prompt assessment of the situation, including a stability assessment, and any damage control action necessary. Had the damage to the hull been more severe, such delays could have led to the loss of the vessel or the loss of life.

2.11 USE OF ECDIS

2.11.1 Audible alarms

ECDIS audible alarms on board *Commodore Clipper* and the rest of the Condor vessels had been disabled. However, the audible alarm is a mandated feature of an ECDIS; therefore, disabling it meant that the system was not compliant with IMO performance standards.

After the installation of ECDIS in Condor's vessels, the audible alarm was reported as sounding frequently, causing a distraction on the bridge particularly in pilotage waters. As a result, the company took the decision to disable the ECDIS audible alarms based on its assessment that this would improve safety by reducing this persistent distraction. However, the audible alarm was permanently disabled, so could not have audibly alerted watchkeepers under any circumstances.

Persistent ECDIS audible alarms are recognised as a significant distraction to bridge teams and there are evidently situations, such as operating in pilotage waters with enhanced bridge teams at high readiness, where silencing the audible alarm would be helpful. Furthermore, the disabling of ECDIS audible alarms is increasingly apparent in MAIB investigations[26]. However, accidents investigated by MAIB where bridge alarms were silenced have, unlike this accident, occurred outside pilotage waters and often with a lone watchkeeper. In such circumstances, audible alarms

[26] MAIB Report 24/2014 (grounding of *Ovit*) and MAIB Report 02/2012 (grounding of *CSL Thames*) both identified and assessed the consequences of the ECDIS audible alarm being disabled.

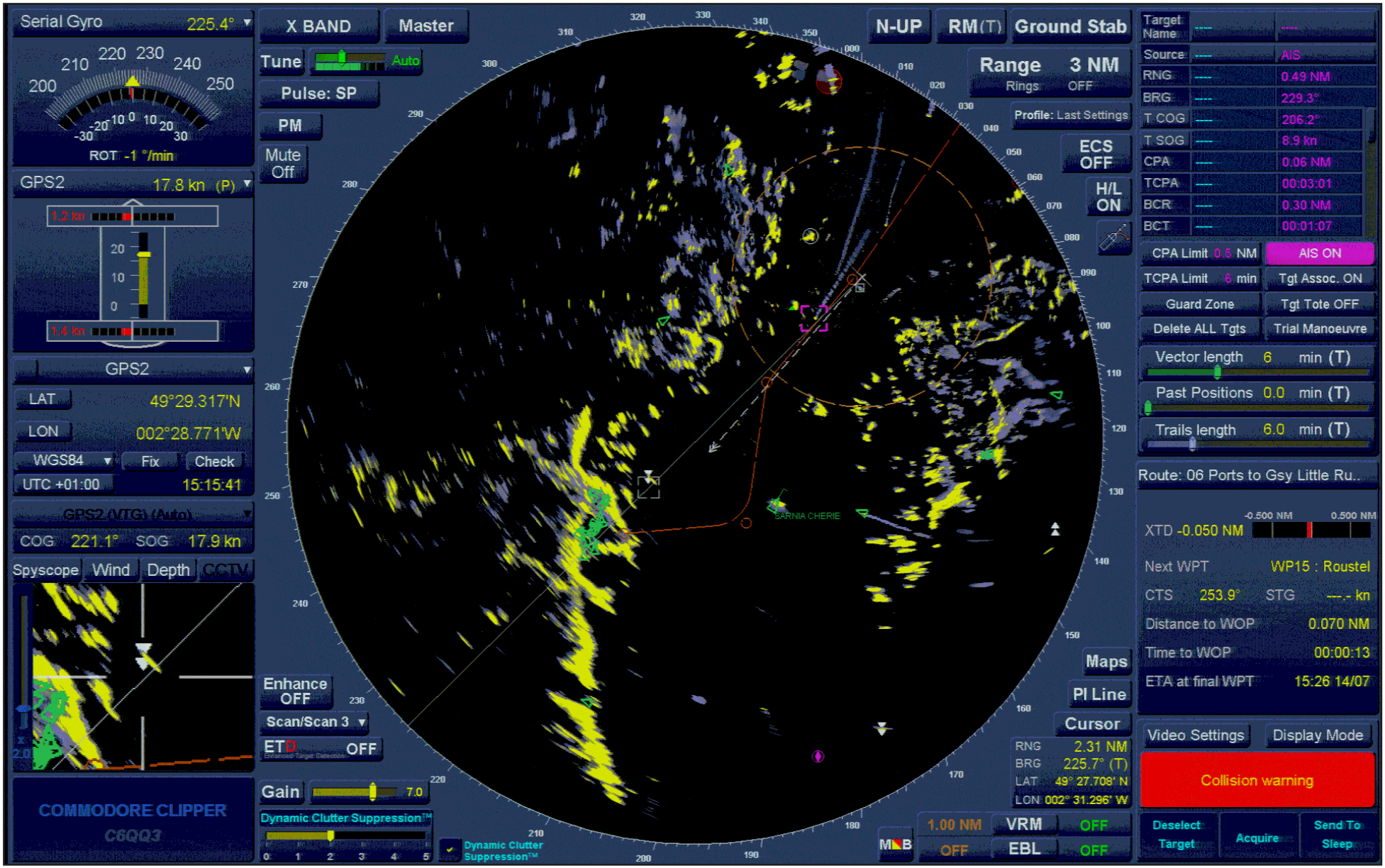


Figure 26: Master's radar display when grounding

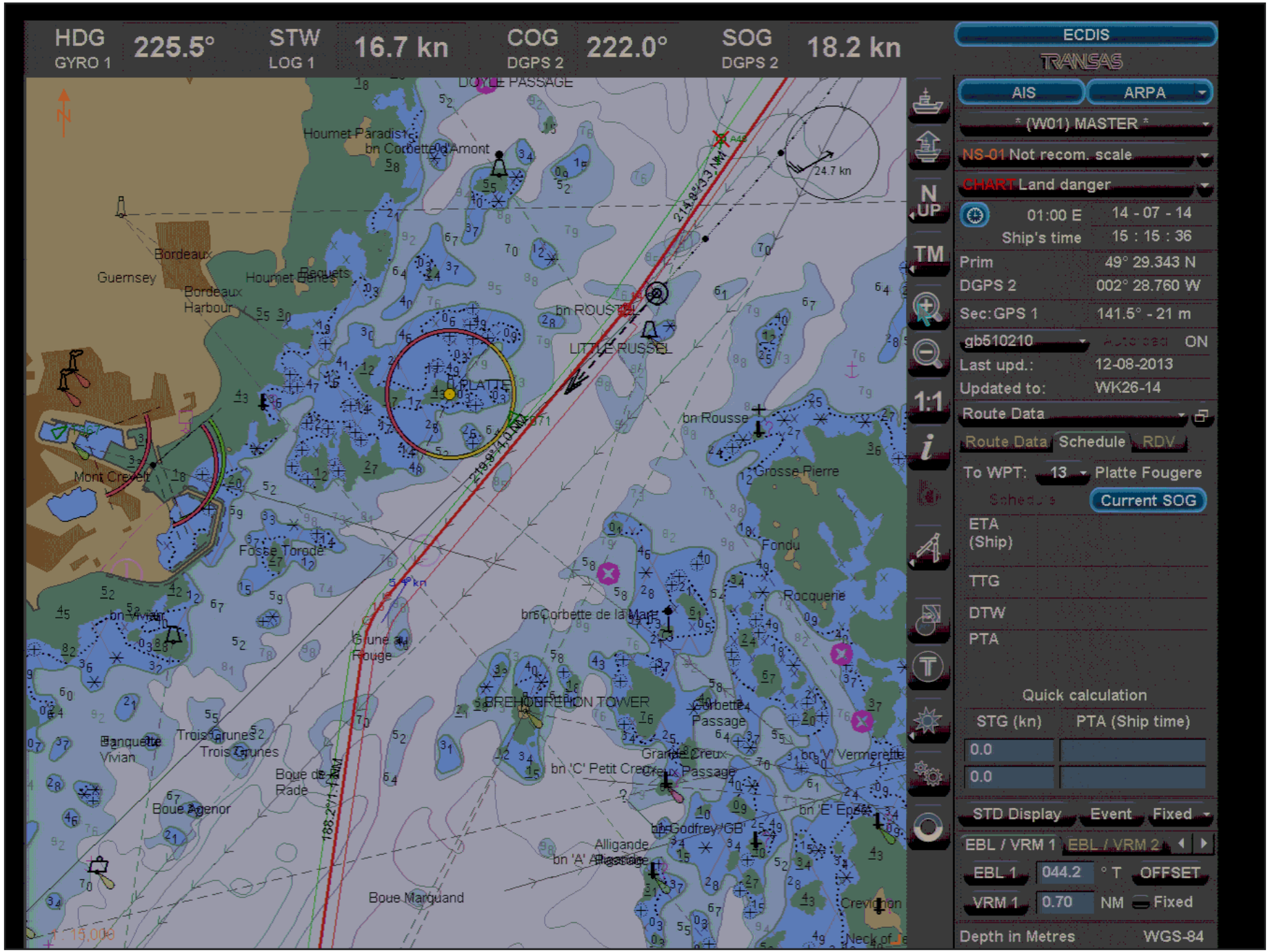


Figure 27: Master's ECDIS display when grounding

are critical and will alert fatigued or distracted watchkeepers to danger. Thus, improving the management of ECDIS alarms needs to be addressed through future developments of the system, delivering an alarm capability that only activates when there is a genuine danger and gives the operator sufficient time to react.

2.11.2 Safety planning

The master had selected company 'Route 06' for *Commodore Clipper*'s voyage to St Peter Port, but neither the track nor the ECDIS safety features were checked as safe. While the exact track itself was inherently safe, the ECDIS safety contour, safety depth and XTD should have been adjusted for each passage taking the local conditions into account.

The ECDIS safety depth setting of 7m was appropriate for the voyage, but the safety contour value of 5m was not. The safety contour could have been set at a minimum value of 6.3m (see Section 2.7) and the ECDIS would have defaulted to the next deeper ENC contour of 10m. However, a 10m safety contour would have given the impression that the Little Russel was impassable. It would have been possible to draw an LDL in ECDIS at 6.3m, which would have given the most accurate electronic picture of the safe water available. An illustration of such a manually constructed ECDIS LDL is at **Figure 28**. Although this facility was available and the crew had been trained in its use, it was not practiced on board. Whilst this method could have provided a more realistic ECDIS picture of the available safe water, it is a method that carries significant risk as the LDL value is unique to a specific height of tide value and would need to be adjusted if the planned time of the passage changed. Nevertheless, on board *Commodore Clipper* the safety depth and safety contour settings were never routinely adjusted for the local conditions.

2.11.3 Cross track distance errors

Although the company's approved route did not specify XTD values for use in ECDIS, the settings at the time of the accident were appropriate. **Figure 29** is a detail of the ECDIS picture in the vicinity of the grounding position where it is evident that, had the vessel remained within the XTD, the grounding would have been avoided. The XTD error alarm (visual on the display, but not audible) was active in the final approach to the grounding, but the bridge team did not respond. Had the bridge team appreciated the significance of crossing outside the XTD then this alarm could have acted as a trigger to indicate that the vessel was heading into danger.

2.11.4 Safety frame

The ECDIS safety frame is a feature that offers forewarning of danger, primarily intended to prevent grounding, but this feature was switched off. However, the minimum width setting for the safety frame was 0.1nm (200 yards); this meant that the safety frame feature would have raised an alarm when the vessel was on track and in safe water as well as when it was unsafe (off-track). **Figure 30** shows a reconstructed ECDIS display with the vessel on the 220º transit approaching Roustel and the safety frame active - a 6.3m LDL is also drawn around the grounding position. It can be seen from this image that the safety frame would have activated an alarm with the vessel on the 220º transit. Thus, the safety frame feature would have been unable to discriminate between safety and danger when passing Roustel.

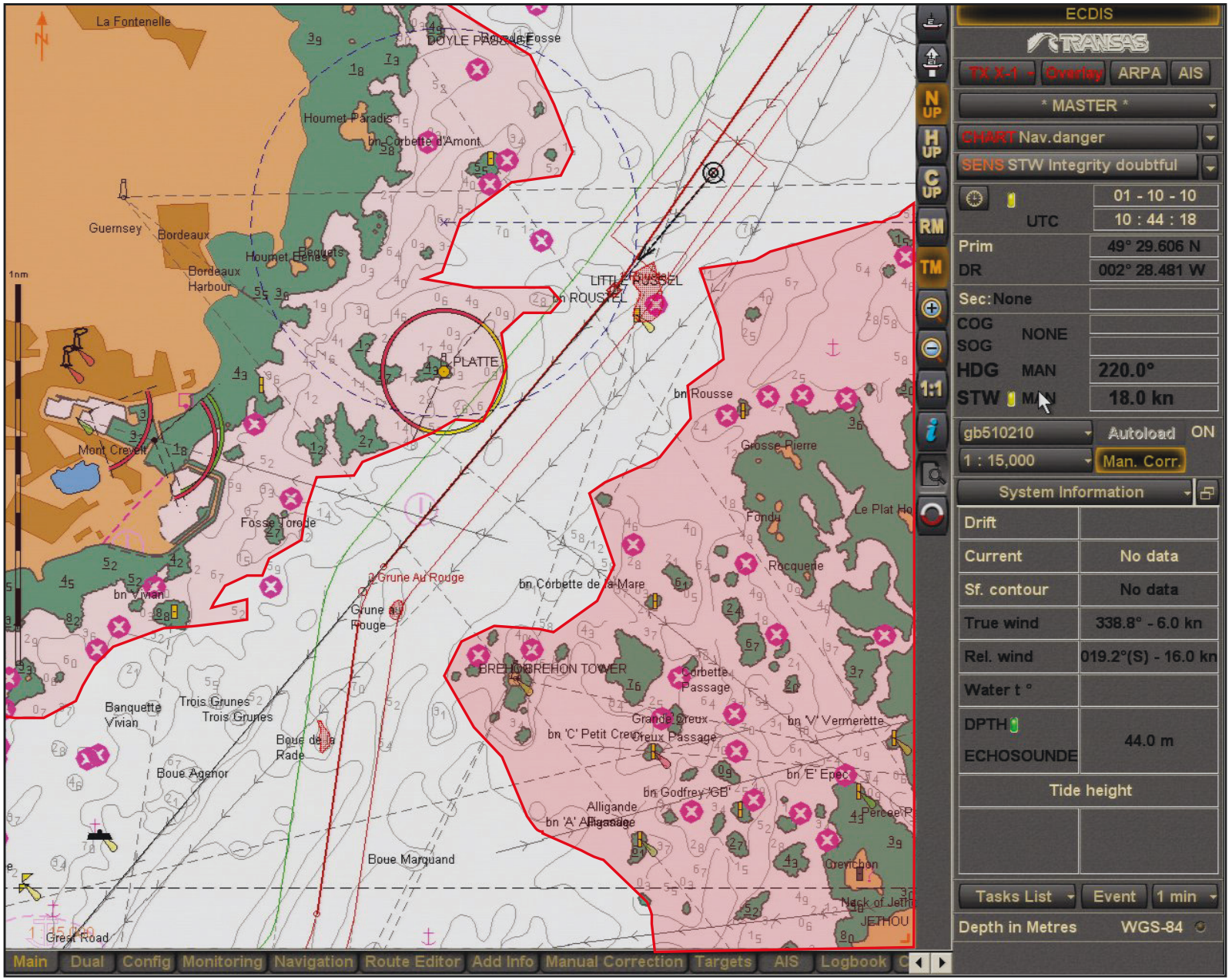


Figure 28: Reconstructed ECDIS display showing manually constructed LDL at 6.3m

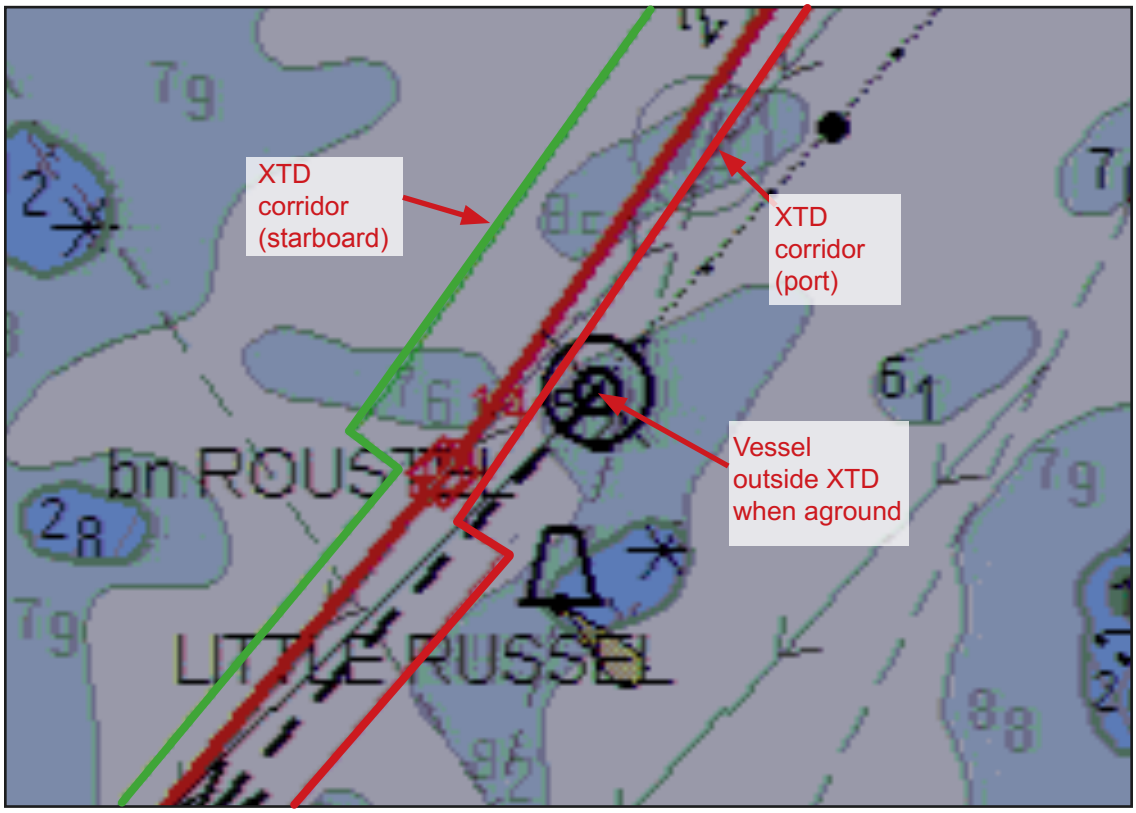


Figure 29: Detail of ECDIS display when grounding showing cross track distances

Figure 30: Reconstructed ECDIS display showing safety frame crossing 6.3m LDL

2.12 SAFETY MANAGEMENT

2.12.1 Onboard guidance

Although spread across all four manuals, *Commodore Clipper*'s SMS contained extensive guidance on navigational safety, bridge procedures and passage planning. Also embedded within the various manuals was some guidance on controlling interaction effects and the application of squat values to ECDIS formulas. There was, however, some contradictory advice in the SMS such as whether or not the Little Russel could be used by conventional ferries in poor visibility.

As a supplement to the SMS, the master's standing orders should provide further guidance on the conduct of navigation and safe operation of the vessel. The orders on board *Commodore Clipper* did offer some advice but it was evidently not followed; for example, parallel indexing was not applied and the effects of the tidal stream were underestimated. In addition, the orders had not been updated following the introduction of ECDIS, which was unhelpful as this document could have been used to establish advice or best practice in the use of this primary navigational aid.

2.12.2 Audits and inspections

The degree of navigational risk routinely being taken on board *Commodore Clipper* and highlighted in this investigation had not been identified as a concern by any of the recent internal or external audits or inspections of the vessel. Additionally, Condor Marine Services did not consult the Flag State before deactivating the ECDIS audible alarms on its vessels and none of the four inspections of *Commodore Clipper* undertaken after ECDIS had become the primary means of navigation identified the audible alarm non-conformity.

Audits and inspections are recognised as a sampling process, and it is not possible to check every facet of a vessel's navigational safety and compliance. Nevertheless, *Commodore Clipper*'s ECDIS alarm deactivation was a non-conformity that ought to have been detected by audits and inspections. However, many of the auditors and inspectors used by Flag States or their recognised organisations, may have limited experience with ECDIS. It is also more challenging for them to scrutinise the performance of a bridge team using ECDIS compared to one that uses paper charts.

The MAIB report into the grounding of *Ovit*[27] has already addressed this issue through a safety recommendation intended to improve understanding of ECDIS knowledge and enhance questions used by auditors and inspectors.

2.12.3 Training and readiness

It is evident from *Commodore Clipper*'s internal training records that the response to grounding was not routinely rehearsed. Despite the requirement for damage control training, onboard drills were dominated by fire exercises and crew musters. Fire may be a significant risk, but so too is the possibility of grounding when operating close to the coast as frequently as *Commodore Clipper* was required to. Thus, if grounding or damage control had been strong themes in the programme of internal training, then tasking the crew to search for damage would potentially have been more instinctive.

[27] MAIB Report 24/2014

2.13 GUERNSEY HARBOURS

2.13.1 Notification and emergency response

Guernsey Harbours' staff were unaware of the incident until a call made by the company to the harbourmaster over 2 hours after the grounding. Even then, the severity of the matter was not fully understood and the harbourmaster was initially only informed that the vessel had touched the bottom. Given this brief and the evidence from his visit on board, which established that the situation was stable and there were no casualties, it is understandable that no emergency response reactions were taken by the harbourmaster or his team.

Nevertheless, had the harbour authority been informed of the grounding at the time of the accident, there would have been an opportunity to consider the full range of potential emergency responses and, where necessary, prepare for a contingency response such as pollution containment or casualty management that may have been required.

2.13.2 Risk assessments and safety plans

It was apparent in the course of this investigation that some operational aspects of Guernsey Harbours' work had not been subject to a formal risk assessment or were not undertaken in accordance with an endorsed safety plan. In particular, the conduct of pilotage and boat transfers had not been risk assessed and the safety plan prepared in 2001 had not been updated. The risk assessment that did exist for navigation **(Annex G)** was strategic in nature and therefore did not seek to mitigate operational risks.

The UK PMSC offers guidance on the development of risk-based safety management of pilotage and harbour services. Developing a safety management system employing such principles would highlight where risk was present and the actions necessary to mitigate. In particular, the development of a port passage plan would serve as a guide for pilots, vessels and shore authorities to safely manage the conduct of navigation in the statutory pilotage area.

2.13.3 Special pilotage licences

The special pilotage licence training process was comprehensive, thorough and provided candidates with the knowledge and competence necessary to pilot their vessels in the waters approaching St Peter Port. The training documentation also provided a useful guide to the pilotage area after the training was complete. However, once a candidate was qualified, the only further requirement was evidence of 20 entries and exits from St Peter Port in order for the licence to be revalidated annually. Over time, it is inevitable that changes in best practice will be made and new surveys will highlight changes to the local environment. As a result, there is a strong case for delivery of a continuous professional development programme for special pilotage licence holders; this could take the form of 'check rides' by Guernsey pilots or written/classroom updates for licence holders.

2.13.4 Harbour control

The operations room watchkeepers in St Peter Port were fulfilling the roles of both an MRCC and harbour control with radar, visual, AIS and VHF/DSC equipment for situational awareness. However, important information such as tidal and weather data was not routinely transmitted to approaching vessels. Given the critical importance of the height of tide, it is reasonable to conclude that, had *Commodore Clipper* been reminded of the extremely low water before entering the Little Russel, this information might have been considered more carefully on board. Although only strictly applicable to UK ports, upgrading the arrangements in St Peter Port to meet the requirements of an information level VTS would deliver an improved service.

2.13.5 Hydrographic data

SOLAS requires that governments make every effort to ensure that hydrographic surveying is carried out, adequate to the requirements of safe navigation. Given the nature of shipping traffic in St Peter Port, particularly cruise ships and ferries, it is important for Guernsey Harbours to sustain a programme of prioritised survey effort to meet users' requirements.

At the time of the grounding, data from the survey conducted in March 2014, which showed a depth of 4.6m in the grounding location, was still being processed by UKHO[28]. If this data met the criteria for CATZOC A1, then the depth accuracy to be applied would be +/- 0.6m and, therefore, navigators should have expected a 'worst case' depth of 4.0m below chart datum. However, the source data of the ENC in use by *Commodore Clipper* at the time of the grounding was based on 1960s surveys, and the feature that was struck fell within the source data accuracy, and this also gave a worst case minimum depth of 4.0m.

Therefore, in both cases of the 1960s data (charted depth 5.2m) and the March 2014 information (surveyed depth 4.6m), applying the source data accuracy to the position of the grounding gave the same worst case minimum depth value of 4.0m. This is the figure that should have been used for passage planning.

[28] The March 2014 survey data had only been held by the UKHO for 2 weeks prior to the grounding; this was less than the minimum time, agreed between all concerned parties, that the UKHO needs to assess such complex data, and prepare and quality assure any navigational corrections that may be required.

SECTION 3 - CONCLUSIONS

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

1. *Commodore Clipper* grounded on a charted, rocky shoal in the Little Russel because insufficient passage planning had been undertaken. In particular, the extremely low tide and the effect of squat had not been properly taken into account. [2.3, 2.4, 2.5]

2. Had all the factors affecting under keel clearance been accurately assessed, it would have been apparent that it was potentially unsafe to pass over any charted depth less than 7.5m in the Little Russel. [2.6, 2.7]

3. The absence of sufficient passage planning meant that the bridge team was unaware of the limits of safe water so approached danger without appreciating the hazard. Furthermore, a safer course of action was available - use of the wider Big Russel channel. [2.3, 2.7]

4. Course alterations intended to regain track were insufficient given the strength of the tidal stream setting *Commodore Clipper* off course. [2.8.2]

5. The highly repetitive nature of *Commodore Clipper*'s schedule induced a degree of planning complacency. [2.3]

6. Although the primary method of navigating in the Little Russel was visual, ECDIS was not utilised effectively as a navigation aid. In particular, the safety contour value was inappropriate, the cross track error alarm was ignored and the audible alarm was disabled. [2.11]

7. The layout of the central bridge console prevented the chief officer from utilising the ECDIS display to support the master during pilotage. [2.8.4]

8. The significant navigational risk routinely being taken by the crew of *Commodore Clipper* and the ECDIS non-conformity went undetected by audits and inspections. [2.12.2]

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

1. After the accident, *Commodore Clipper* passed within 100 yards of the Grune au Rouge rock and over the Boue de la Rade shoal; both events created an unnecessarily high risk of further groundings. These events reinforced the analysis that the bridge team was not distinguishing between safe and unsafe water. [2.8.1]

2. The grounding caused significant damage, including flooding; however, it was extremely fortunate that this was contained within double-bottom void spaces. [2.9]

3. Despite a noisy, shuddering vibration, the crew did not immediately search for damage or follow the grounding-raking checklist. [2.10.1]

4. The possibility that the vessel had grounded was denied; this was reinforced by the absence of alarms, the steering and propulsion responding normally, and the master's conviction that there had been sufficient depth of water where the vessel had passed. [2.10.1]

5. No contingency planning or emergency response measures were activated by Guernsey Harbours' staff as they were unaware of the grounding until over 2 hours after the incident. [2.13.1]

6. As the responsible authority, Guernsey Harbours did not have an effective risk assessment or safety management plan for the conduct of navigation in the statutory pilotage area. [2.13.2]

7. Special pilotage licence holders were thoroughly trained; however, there was no provision for continuous professional development after their initial qualification. [2.13.3]

8. Guernsey harbour control was not routinely transmitting important navigational safety information to approaching vessels. [2.13.4]

9. The grounding position was charted at 5.2m; however, it was subsequently established as being 4.6m below chart datum. Nevertheless, the difference between the charted and actual depths in the grounding position was within the source data accuracy for the quality of the survey of the area. [2.13.5]

SECTION 4 – ACTIONS TAKEN

Condor Marine Services Limited has:

- Conducted an investigation into the grounding, identified the causal factors and circulated its report to other command teams.
- Imposed a minimum 4.0m height of tide restriction for conventional vessels using the Little Russel.
- Undertaken a study of the interaction characteristics of all its vessels, leading to publication of advice to masters on the calculation and application of squat.
- Fitted an ECDIS repeater display at the chief officer's position on board *Commodore Clipper.*
- Included a plan to install bilge alarms into *Commodore Clipper*'s double-bottom void spaces during the next refit period.
- Provided additional bridge team management training for all command teams, using a refreshed training syllabus taking into account the lessons identified in the accident, in particular the utility of ECDIS.
- Updated the safety management system to include:
  - Additional guidance on application of survey data accuracy
  - Additional advice for all company approved routes to include options for secondary routes and to ensure that these plans provide appropriate margin for error
  - A revision of random voyage data recorder review processes.

Guernsey Harbours has:

- Committed to delivering a safety management system for pilotage and navigation operations, adopting the principles of the UK Port Marine Safety Code where applicable.
- Secured additional resources for the provision of an assistant harbourmaster with specific responsibility for implementation of the Port Marine Safety Code.
- Enhanced knowledge of port management by the harbourmaster attending UK MCA approved training in National Occupational Standards and the Port Marine Safety Code.
- Established a routine for St Peter Port harbour control watchkeepers to transmit tidal and weather information by VHF radio to inbound vessels prior to entering the pilotage area.
- Procured and installed a new remote tide gauge system.

SECTION 5 - RECOMMENDATIONS

Condor Marine Services Limited is recommended to:

2015/144 Continue to improve the standard of passage planning by its bridge teams through implementing measures to ensure that:

- Proper account is taken of all factors affecting draught and available depth of water; in particular, an assessment of how such factors affect the width of safe water available.

- Use of ECDIS safety features is improved, including adjustment of the safety contour relevant to the local conditions and observation of all alarms.

The Government of Guernsey is recommended to:

2015/145 Improve the standard of vessel traffic services within the Guernsey Ordnance statutory pilotage area by implementation of an information level service to shipping as guided by the applicable elements of the Maritime and Coastguard Agency's Marine Guidance Note 401.

2015/146 Implement measures designed to provide assurance that, post-qualification, its Special Pilotage Licence holders continue to demonstrate the required level of proficiency when conducting acts of pilotage.

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

Marine Accident Report

INVESTORS IN PEOPLE

ACCIDENT REPORT

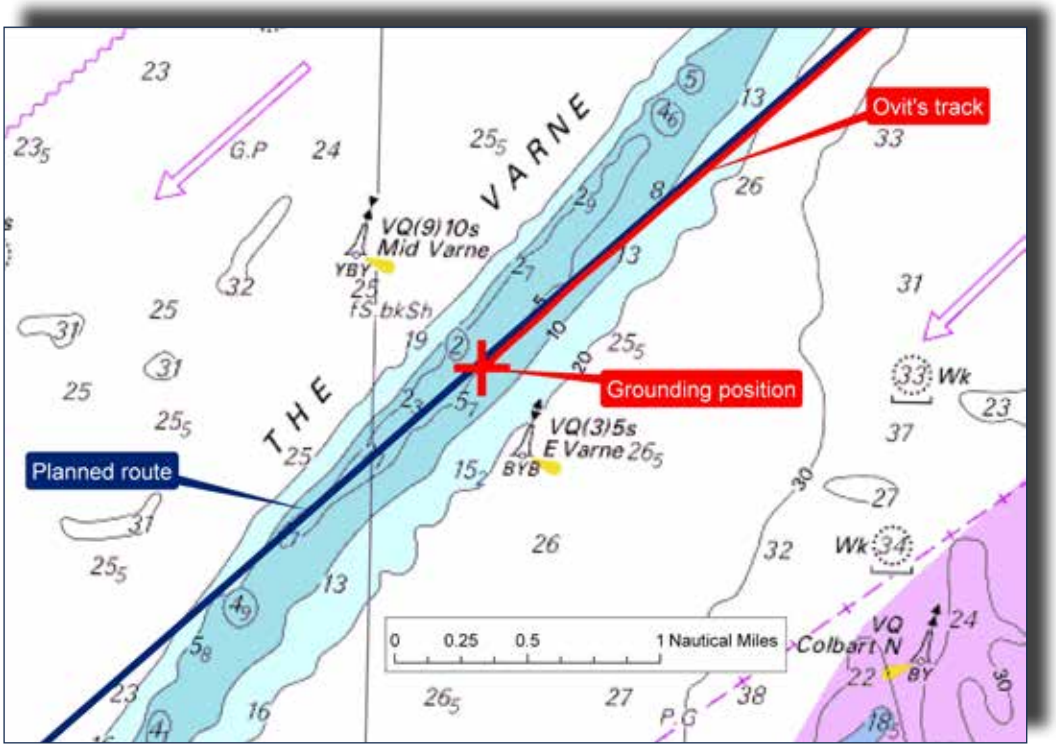
Report on the investigation of

the grounding of

Ovit

in the Dover Strait

on 18 September 2013



MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

LESS SERIOUS MARINE CASUALTY REPORT NO 24/2014 SEPTEMBER 2014

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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Annex H - Dover Coastguard Watch Staffing Planning and Risk Evaluation

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ABS	American Bureau of Shipping
AIS	Automatic Identification System
ARPA	Automatic Radar Plotting Aid
BNWAS	Bridge Navigation Watch Alarm System
BRM	Bridge resource management
BV	Bureau Veritas
CNIS	Channel Navigation Information Service
CoC	Certificate of Competency
COG	Course over the ground
DNV	Det Norske Veritas
DP	Designated Person
DSC	Digital Selective Calling
ECDIS	Electronic Chart Display and Information System
ENC	Electronic navigational chart
GPS	Global Positioning System
ICS	International Chamber of Shipping
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISM Code	International Safety Management Code
kts	measurement of speed: 1 knot = 1 nautical mile per hour
m	metre
Maris	Marine Information Systems AS
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MSN	Merchant Shipping Notice

nm	nautical miles
OCIMF	Oil Companies' International Marine Forum
OOW	Officer of the watch
PSC	Port State Control
SAR	Search and Rescue
SENC	System electronic navigational chart
SIRE	Ship Inspection Report Programme
SMC	Safety Management Certificate
SMS	Safety Management System
SOLAS	International Convention for the Safety of Life at Sea 1974, as amended
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended (STCW Convention)
TSS	Traffic Separation Scheme
UMS	Unmanned Machinery Space
UTC	Universal Co-ordinated Time
VDR	Voyage data recorder
VHF	Very High Frequency (radio)
VTS	Vessel Traffic Service
XTD	Cross Track Distance

Times: All times used in this report are UTC

CHIEF INSPECTOR'S FOREWORD

This is the third grounding investigated by the MAIB where watchkeepers' failure to use an electronic chart display and information system (ECDIS) properly has been identified as one of the causal factors. As this report is published, there are over 30 manufacturers of ECDIS equipment, each with their own designs of user interface, and little evidence that a common approach is developing. Generic ECDIS training is mandated by the International Maritime Organization (IMO), but it is left to Flag States and owners to decide whether or not type-specific training is necessary and, if so, how it should be delivered. As experience of ECDIS systems improves, evidence indicates that many owners are concluding that type-specific training is essential, though some are resorting to computer-based training once the watchkeeper is on board. In this accident, however, despite dedicated training ashore on the system they were to use, the operators' knowledge of the ECDIS and ability to navigate their vessel safely using the system were wholly inadequate.

Unfortunately, the current generation of ECDIS systems, though certified as complying with regulatory requirements, can be operated at a very low level of functionality and with key safety features disabled or circumvented. Training and company culture may mitigate these shortcomings to some extent, but can only go so far. While systems allow individuals to operate them in a sub-standard manner, there are those who will do so: such is human nature. For all shipping companies navigation is a safety-critical function and failure to navigate effectively can and does result every year in pollution, loss of vessels, and loss of life. It is to be hoped, therefore, that the next generation of ECDIS will embody features making them less vulnerable to the vagaries of human performance to achieve a better level of assurance that safe navigation is being consistently achieved.

Steve Clinch
Chief Inspector of Marine Accidents

SYNOPSIS

At 0434 on 18 September 2013, the Malta registered chemical tanker, *Ovit*, ran aground on the Varne Bank in the Dover Strait while on passage from Rotterdam, Netherlands, to Brindisi, Italy. The vessel, which was carrying a cargo of vegetable oil, remained aground for just under 3 hours; there were no injuries and damage to the vessel was superficial. There was no pollution. *Ovit* refloated on the rising tide and subsequently berthed in Dover.

Ovit's primary means of navigation was an electronic chart display and information system (ECDIS). The officer of the watch was following a route shown on the ECDIS display; the route passed directly over the Varne Bank.

The investigation established that:

- The passage was planned by an inexperienced and unsupervised junior officer. The plan was not checked by the master before departure or by the officer of the watch at the start of his watch.

- The ship's position was monitored solely against the intended track shown on the ECDIS. Navigational marks on the Varne bank were seen but not acted upon.

- The scale of the chart shown on the ECDIS was inappropriate. The operator-defined settings applied to the system were unsuitable and the system's audible alarm did not work.

- The officer of the watch's situational awareness was so poor that it took him 19 minutes to realise that *Ovit* had grounded.

- Although training in the use of the ECDIS fitted to the vessel had been provided, the master and deck officers were unable to use the system effectively.

- A Channel Navigation Information Service (CNIS) procedure, which should have alerted *Ovit*'s officer of the watch as the tanker approached the Varne Bank, was not followed because the procedure had not been formalised and an unqualified and unsupervised CNIS operator was distracted.

Recommendations have been made to the Maritime and Coastguard Agency, Transport Malta, The International Chamber of Shipping, the Oil Companies International Marine Forum and Ayder Tankers Ltd aimed at improving the standard of navigational inspections of vessels using ECDIS as the primary means of navigation. A further recommendation to the Maritime and Coastguard Agency is intended to ensure that the Channel Navigation Information Service is manned appropriately. A recommendation has also been made to Marine Information Systems AS intended to improve the functionality of its ECDIS 900.

SECTION 1 - FACTUAL INFORMATION

1.1 PARTICULARS OF *OVIT* AND ACCIDENT

SHIP PARTICULARS	
Vessel's name	*Ovit*
Flag	Malta
Classification society	American Bureau of Shipping
IMO number	9466611
Type	Oil/chemical tanker
Year of build	2011
Registered owner	Ovit Shipping Limited
Manager(s)	Ayder Tankers Limited
Construction	Steel
Length overall	117m
Gross tonnage	6,444
Minimum safe manning	14
Authorised cargo	Oil/chemicals
VOYAGE PARTICULARS	
Port of departure	Rotterdam, Netherlands
Port of arrival	Brindisi, Italy
Cargo information	9,500 tonnes of vegetable oil
MARINE CASUALTY INFORMATION	
Date and time	0434 UTC on 18 September 2013
Type of marine casualty or incident	Less Serious Marine Casualty
Location of incident	Varne Bank, Dover Strait
Injuries/fatalities	None
Damage/environmental impact	Hull coating loss. No pollution
Ship operation	In passage
Voyage segment	Mid-water
External environment	Wind: South-west force 3-4. Sea state: moderate. Visibility: good
Persons on board	14

Ovit

1.2 NARRATIVE

1.2.1 The grounding

During the early morning of 18 September 2013, the Malta registered tanker *Ovit* was transiting the Dover Strait. The vessel was on passage from Rotterdam, Netherlands, to Brindisi, Italy carrying a cargo of vegetable oil. The intended route through the Dover Strait **(Figures 1** and **2)** was prepared using the ship's electronic chart display and information system (ECDIS).

At 0230[1], the chief officer arrived on the bridge and took over from the second officer as the officer of the watch (OOW). He was joined by the deck cadet who was the assigned lookout. *Ovit* was following an autopilot controlled heading of 206° at a speed of between 12 and 13 knots (kts). The OOW selected the scale on the ECDIS display that closely aligned with the 12 nautical miles (nm) range scale set on the adjacent radar display. He then sat in the port bridge chair where he had a direct view of both displays **(Figure 3)**. At about 0300, the heading on the autopilot was adjusted to 225°.

As *Ovit* approached the Varne Bank, the deck cadet, who was standing on the starboard side of the bridge and using binoculars, became aware of flashing white lights ahead. He did not identify the lights or report the sighting to the OOW.

At approximately 0417, *Ovit* passed close by the Varne Light Float. From 0432 the ship's speed slowly reduced until the vessel stopped when it grounded on the Varne Bank at 0434 **(Figure 4)**.

1.2.2 Shore monitoring

At 0411, *Ovit*'s radar vector[2] crossed into the Channel Navigation Information Service's (CNIS) Varne Bank alerting zone. This activated an audible alarm in the operations room at Dover Coastguard. The ship's symbol on the CNIS display also changed from black to red and started to flash **(Figure 5)**. The CNIS operator '*authorised*' *Ovit*'s approach to the Varne Bank using a drop down menu on the CNIS display. This action silenced the audible alarm, and the ship's symbol stopped flashing and its colour changed to black. The operator then returned to a very high frequency (VHF) radio exchange with another vessel inside the CNIS area.

1.2.3 Post grounding

The OOW did not appreciate that *Ovit* had grounded. At 0437, an engineering alarm sounded and the OOW placed both azipod control levers to zero. He then telephoned the master in his cabin to inform him of the alarm. He also telephoned the second engineer and instructed him to check the engines.

At 0443, the second engineer telephoned the bridge and informed the OOW that 45° of ahead pitch was available on the starboard azipod. Accordingly, the OOW moved the starboard azipod control lever to 45° pitch ahead. The ship remained stationary, which led the OOW to assume that there was still a problem with the ship's engines.

[1] This was 0430 ship's time (UTC+2 hours).

[2] A computer projection ahead of the ship, the length of which is a function of the ship's speed.

Reproduced from Admiralty Chart BA 0002-0 and 2182A-0 by permission of the Controller of HMSO

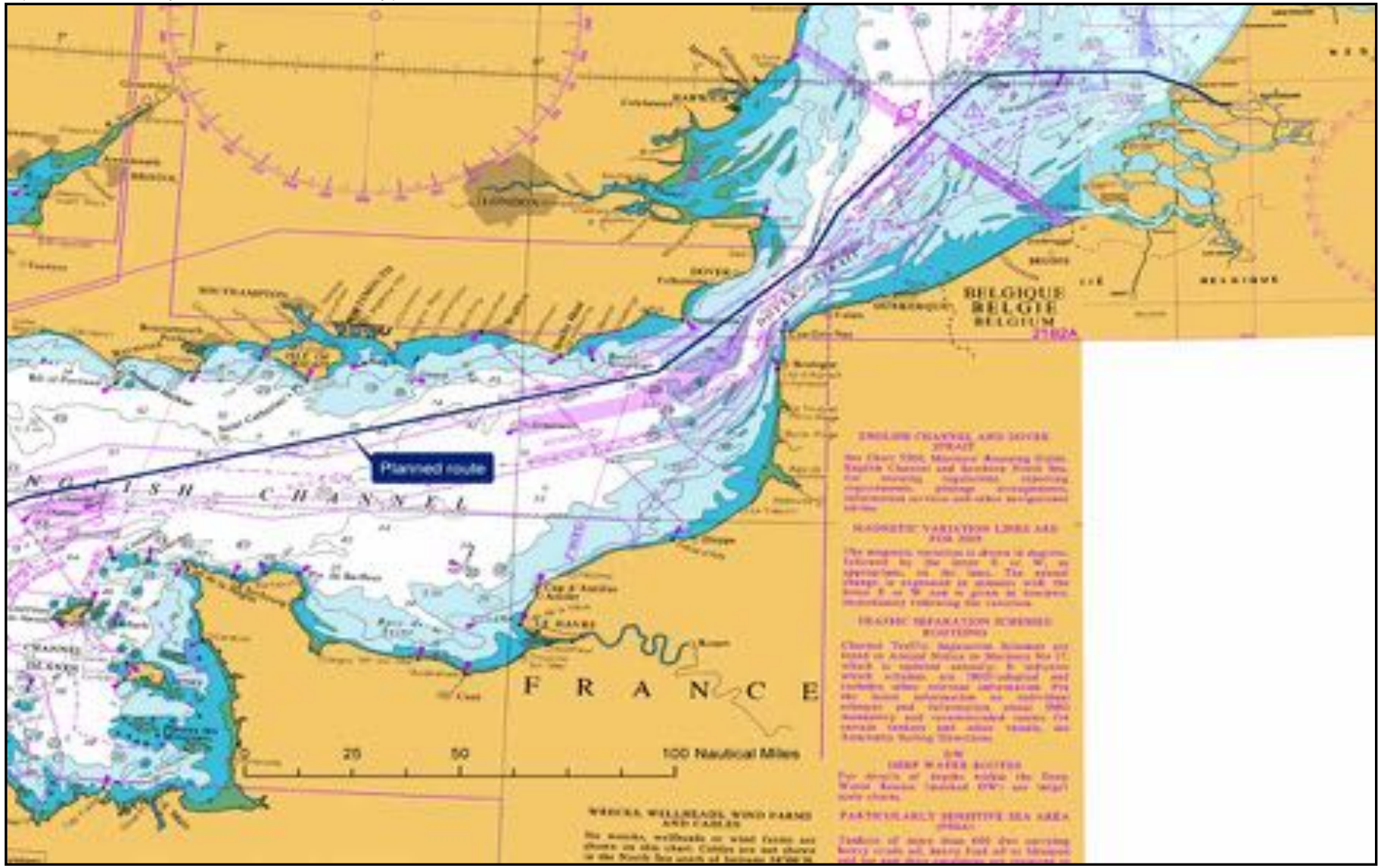

Figure 1: *Ovit*'s passage plan through the Dover Strait

Reproduced from Admiralty Chart BA 2675-0 by permission of the Controller of HMSO

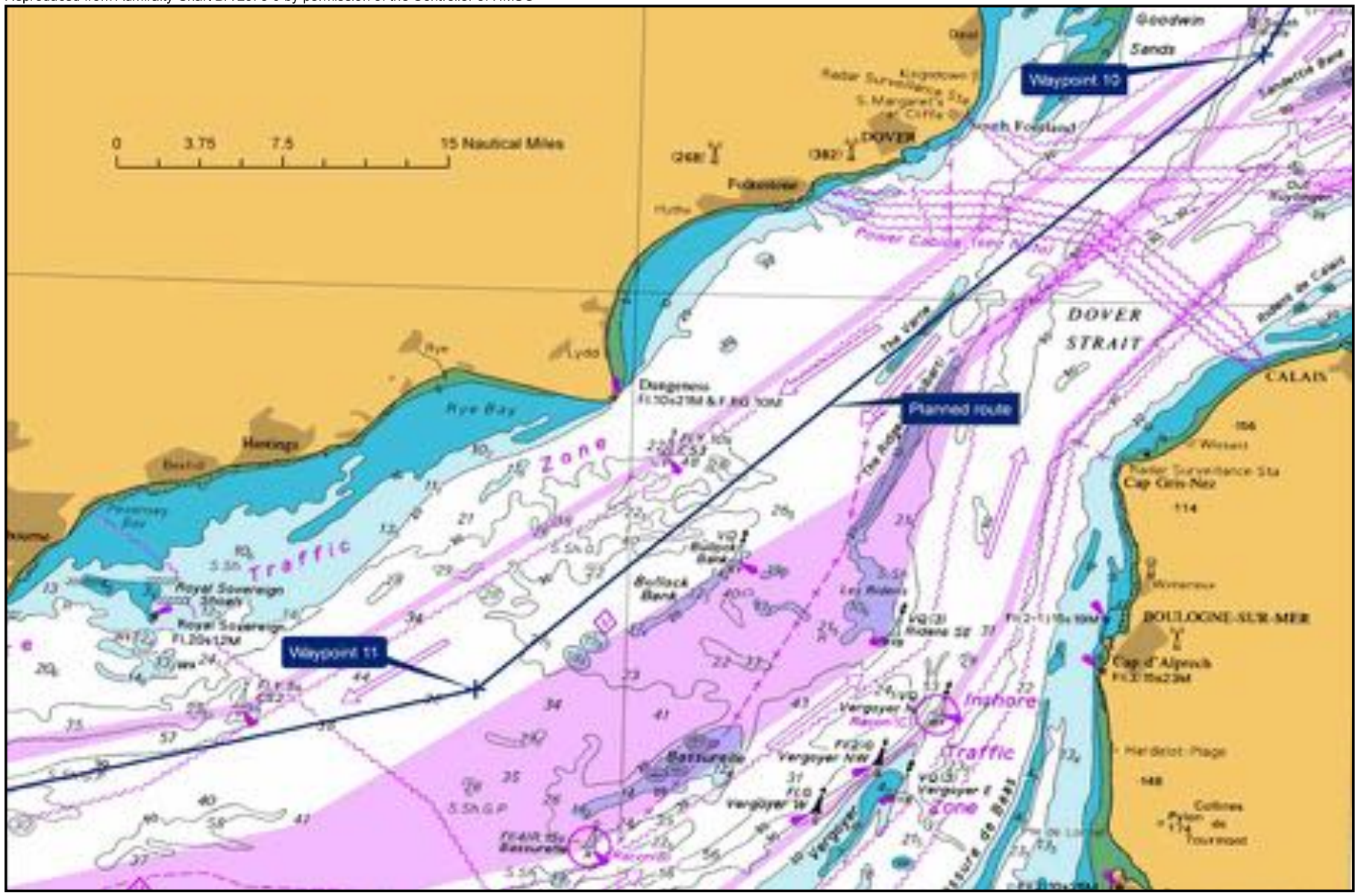

Figure 2: Detail of Dover Strait passage plan

Figure 3: OOW view of bridge displays from the port bridge chair

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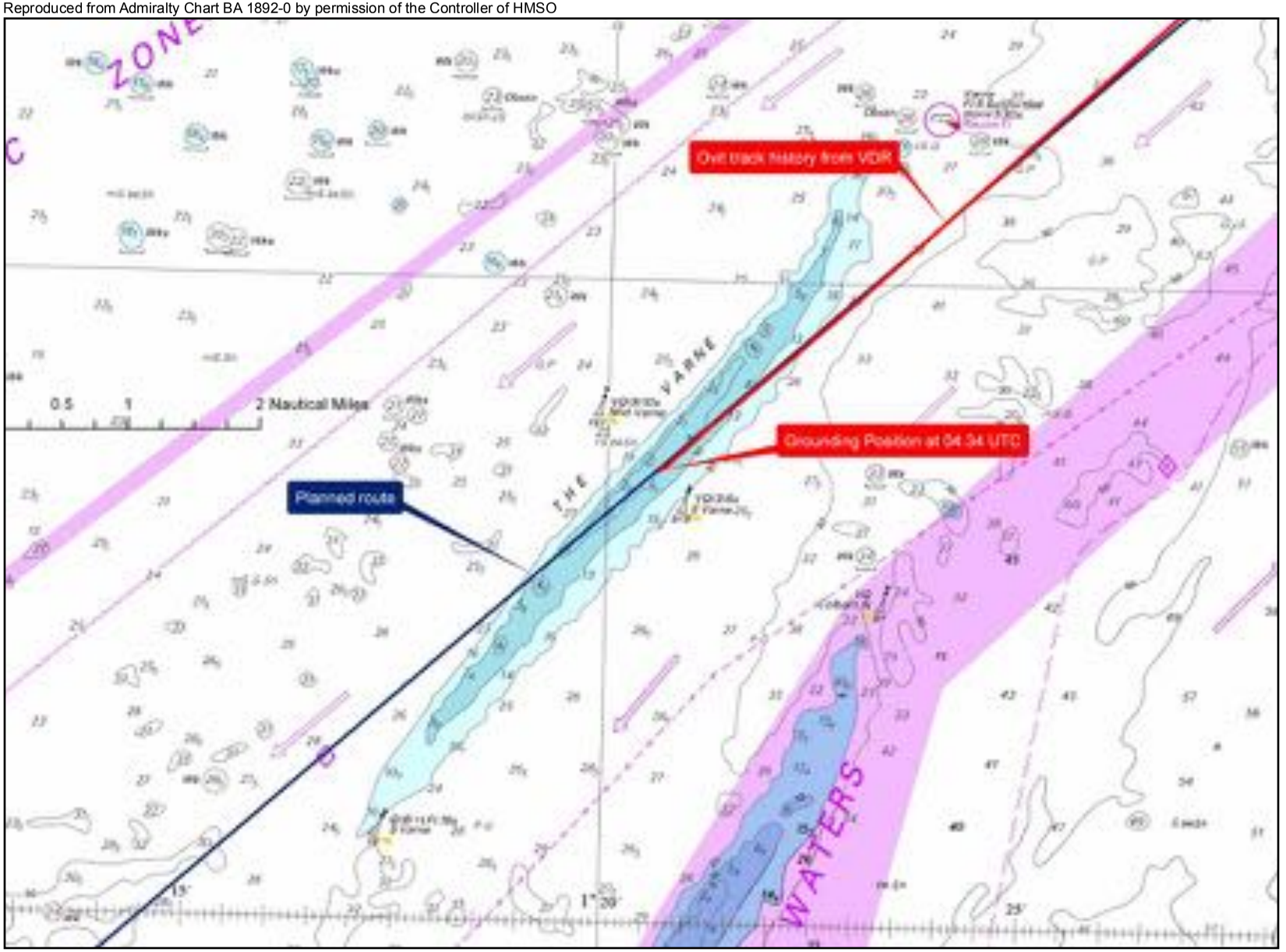


Figure 4: *Ovit*'s grounding position

Figure 5: CNIS display as *Ovit* entered the Varne Bank alerting zone

Between 0449 and 0452, a series of VHF radio exchanges took place between the OOW and the CNIS operator. A transcript of these exchanges is shown at **Table 1:**

Time	Station	VHF transmission
04:49:15	CNIS	*"Ovit, Ovit, this is Dover Coastguard, channel 11, over"*
04:49:20	*Ovit*	*"Yes, this is Ovit, go ahead please"*
04:49:22	CNIS	*"Ovit, this is Dover Coastguard, according to our radar, sir, you may be on the Varne Bank, is everything OK on board sir?"*
04:49:30	*Ovit*	*"Yes, we have an engine breakdown problem, but I think in 5 minutes it will be OK"*
04:49:38	CNIS	*"Roger sir, that is understood, what is your current depth of water, over?"*
04:49:48	*Ovit*	*"Dover Coastguard, this is Ovit, could you please repeat"*
04:49:50	CNIS	*"Roger sir, what is your depth of water? How much water is currently underneath your vessel, over?"*
04:50:05	*Ovit*	*"My present draught is 7.9m, 7.9m, over"*
04:50:10	CNIS	*"Negative sir, what is the under keel clearance, over?"*
04:50:32	*Ovit*	After a pause *"It's approximately 10m, the under keel clearance"*
04:50:58	CNIS	*"Roger sir, this is Dover Coastguard, what is the nature of your engine difficulty over?"*
04:51:13	Ovit	*"My engine is azimuth pitch propellers"*
04:51:17	CNIS	*"Say again sir, over"*
04:51:21	*Ovit*	*"My engine is azimuth pitch propeller engine"*
04:51:58	CNIS	*"Roger sir, how long do you believe it will take to effect repairs, over?"*
04:52:04	*Ovit*	*"I think in 10 minutes, the problem will be solved"*
04:52:16	CNIS	*"Roger sir, if you could call us back in 10 minutes or once you have effected repairs, over"*
04:52:20	*Ovit*	*"OK, I understand"*

Table 1: Transcript of VHF radio exchanges between 0449 and 0452

At approximately 0453, the OOW zoomed in on the ECDIS display and noticed that *Ovit* was in an area of shallow water and he realised the vessel was aground. The OOW placed the starboard lever back to zero pitch and called the master, who came to the bridge. Between 0506 and 0509, there was a further exchange between CNIS and *Ovit*'s OOW **(Table 2)**.

05:06:28	CNIS	*"Ovit, Dover Coastguard"*
05:06:30	*Ovit*	*"Yes, go ahead please"*
05:06:35	CNIS	*"Ovit, Dover Coastguard, may I have a situation report on the repairs, over?"*
05:06:42	*Ovit*	*"Now the engineers are working and I think in 5, 10 minutes it will be OK"*
05:07:02	CNIS	*"Ovit, this is Dover Coastguard, please can you confirm sir; are you aground? Have you touched the bottom, over"*
05:07:36	*Ovit*	*"Dover Coastguard, this is motor tanker Ovit, now the speed over the ground is zero and, yes, there is a possibility of a grounding and now we are checking ballast tanks but it seems like there are no leakage to the ballast tanks"*
05:08:00	CNIS	*"Roger sir, say again regarding the ballast tanks over"*
05:08:08	*Ovit*	*"Now we are checking the ballast tanks manually, we are checking the soundings but there is no water inlet to the ballast tanks"*
05:08:20	CNIS	*"Roger sir, is there any damage to the vessel, over?*
05:08:26	*Ovit*	*"For now, there is no damage, for now there is no damage but we are keep checking"*
05:08:40	CNIS	*"Roger, and the state of the crew, is everyone okay, there are no injuries, over?"*
	Ovit	*"Negative, negative, no injuries, everybody is OK"*
05:08:50	CNIS	*"Roger sir, and what are your intentions?"*
05:09:14	*Ovit*	*"Now I think it is low water time and we will wait for the water level to get high, to the high water time, I think it's close to the noon time and when it's high water time, we will try to move the vessel"*

Table 2: Transcript of VHF radio exchanges between 0506 and 0509

During this period, the general alarm was not sounded and the crew were not mustered. As soon as it had been established that the ship had grounded, ballast tanks were checked for internal leaks and a visual search was made around the ship for pollution.

A photograph taken of the ECDIS display at 0602 is at **Figure 6**. Between 0716 and 0722, *Ovit* refloated on the rising tide. The vessel subsequently berthed alongside in Dover, UK, to enable the hull to be inspected by divers.

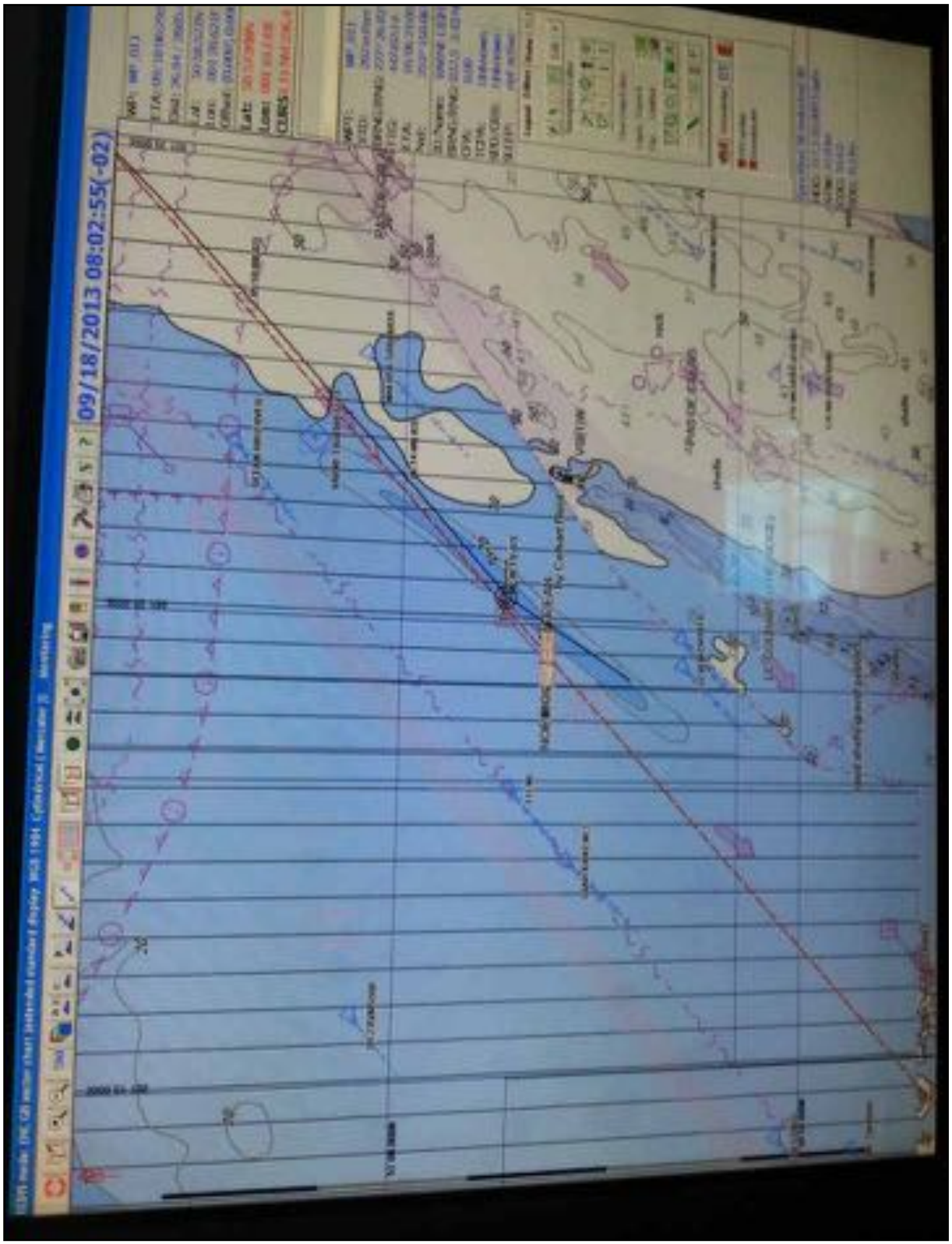


Figure 6: *Ovit*'s ECDIS display when the ship was aground

1.3 VESSEL EXAMINATION

While *Ovit* was berthed alongside in Dover:

- A dive survey established that damage to the vessel was limited to significant hull coating loss, particularly on the plating below the bilge keel on the starboard side.

- MAIB inspectors examined the ECDIS. Among their findings, which are included in **paragraph 1.8**, was that the system's audible alarm was not functioning.

- A port state control (PSC) inspection was undertaken by a surveyor from the Maritime and Coastguard Agency (MCA). *Ovit* was detained subject to an assessment of seaworthiness and rectification of the defective ECDIS audible alarm.

- A service engineer repaired the ECDIS after seeking advice from the equipment manufacturer's customer support team.

1.4 ENVIRONMENTAL DATA

Wind:	South-westerly, force 3 - 4
Sea state:	moderate
Visibility:	good
Morning civil twilight:	0502
Sunrise (Dover):	0535
Predicted low water:	0507 (1.1m)
Predicted high water:	1001 (6.7m)
Height of tide (0434 - grounding):	1.4m, falling
Height of tide (0716 - refloat):	4.2m, rising

1.5 CREW

1.5.1 General

All of *Ovit*'s 14-man crew were Turkish nationals. The crew's morale was reported as low. Several of the crew had expected to leave the vessel during recent port visits, including Hamburg, Germany, on 14 September 2013, but the crew changes had been cancelled. A planned delivery of cigarettes in Hamburg also did not arrive.

1.5.2 Deck officers

All the deck officers' International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended (STCW) certificates had been endorsed by the Malta Transport Authority.

The master was 35 years old and had been on board for 3 months. He had been at sea for 15 years and had held an STCW II/2 certificate of competency (CoC) for 8 years. *Ovit* was his first ship on which ECDIS was the primary means of navigation. In March 2013, he had completed a bridge resource management (BRM) training course.

The chief officer was 27 years old and had been on board for 2 months; it was his first contract as a chief officer. He had 5 years' seagoing experience and held an STCW II/2 CoC.

The second officer was 27 years old and had been on board just over 6 months. He had been expecting to leave the ship in Hamburg and was disappointed and demotivated by having to extend his time on board. The second officer had 4 years' seagoing experience and held an STCW II/1 CoC.

The third officer had been on board for 5 months and it was his first contract since being awarded an STCW II/1 CoC. His previous seagoing experience was as a deck rating for 4 years followed by 7 months as a deck cadet on board a general cargo ship. The third officer was expecting to be promoted to second officer when the second officer left the ship.

The deck cadet had been on board for 6 months and held an STCW II/4 CoC, which qualified him to stand a watch as a bridge lookout. He routinely accompanied the chief officer during his bridge watches at sea.

1.5.3 Watchkeeping routine

At sea, the deck officers kept bridge watches as follows:

- second officer: 0000 - 0400 and 1200 - 1600
- chief officer/deck cadet: 0400 - 0800 and 1600 - 2000
- third officer: 0800 - 1200 and 2000 - 0000

During cargo operations in harbour, the chief officer worked the hours necessary to supervise loading or discharge and the second officer and third officer alternated in 6 hour watches as the duty deck officer.

1.5.4 ECDIS training

All of *Ovit*'s deck officers had attended a generic ECDIS course and a type-specific ECDIS training course which focused on the Marine Information System AB Type 900 ECDIS (Maris 900) fitted on board *Ovit*. The type-specific training was delivered by STT Marine Electronics in Istanbul, which was endorsed by Marine Information Systems AS (Maris) as an authorised training provider for its systems.

Attendees at the Maris 900 training courses were a mix of senior and junior officers with varying degrees of experience at sea and with ECDIS. *Ovit*'s master was uncomfortable completing the course with junior officers. In particular, he found it embarrassing to ask questions.

1.6 NAVIGATION

1.6.1 Responsibility

The second officer was the ship's navigator. However, the master instructed the third officer to plan the passage from Rotterdam to Brindisi because it was assumed he would be taking over the second officer's responsibilities when the second officer left the vessel. In effect, the master instructed the third officer to assume the duties of navigator while the second officer was still on board. However, there was no handover in this respect between the second and third officers and the master had not submitted his intended re-designation of duties to the ship's manager for approval.

1.6.2 Passage planning

The passage plan for the voyage between Rotterdam and Brindisi was prepared by the third officer on 15 September 2013, while the vessel was at anchor off Rotterdam. He was not given any guidance by the master on how it should be prepared and no reference was made to previous, similar passages.

When the passage plan was completed, it was checked by the third officer by scrolling ahead and zooming in on each of the route's legs in order to identify the navigational dangers. The third officer's work was not supervised by the second officer. Prior to departure, the intended route was not checked by the master and there was no pre-departure brief among the deck officers.

The passage plan checklist, which was included in *Ovit*'s safety management system (SMS) and was completed by the third officer, is at **Annex A**. Against the line *'Are there any routing hazards?'* the *'no'* box had been ticked. In addition, for the question, '*Have the team members been made aware of any defective equipment?*' the response was '*yes*'. A voyage planning checklist for use in ECDIS fitted ships, which was also included in the vessel's SMS but had not been completed, is at **Annex B**.

1.7 MARIS 900 ECDIS

1.7.1 Approval and installation

The Maris 900 ECDIS was certified by Det Norske Veritas (DNV) to be compliant with the necessary regulations from the International Maritime Organization's (IMO) Convention for the Safety of Life at Sea (SOLAS) in November 2009 **(Annex C)**. For its certification, the system was tested using the International Electrotechnical Commission (IEC) standard 61174 (2008).

The Maris Type 900 fitted on board *Ovit* was supplied and installed by STT Marine Electronics in Istanbul. The installation certificate **(Annex D)** dated 1 April 2011 stated that '*all configuration have been done* [sic]. *System is tested in sea trial and seen OK* [sic].'

The system comprised a planning terminal on the starboard side of the bridge by the chart table **(Figure 7)** and a monitoring terminal on the port side bridge console **(Figure 8)**. Both computers were connected in a local area network and each system was supported by an independent, uninterrupted power supply.

Figure 7: ECDIS planning terminal

Figure 8: ECDIS monitoring terminal

The ship's gyro data, global positioning system (GPS), log speed, echo sounder, wind information and automatic identification system (AIS) were all connected to the ECDIS.

Ovit's Cargo Ship Safety Equipment Certificate, issued by the American Bureau of Shipping (ABS), confirmed that '*the ship complied with the requirements of the Convention as regards ship borne navigational equipment…and nautical publications.'* This certificate was valid until 3 May 2016.

1.7.2 Electronic navigational charts

The Maris 900 uses electronic navigational charts (ENC). An ENC is a '*vector chart, issued by or on behalf of a Governmental body that complies with the IHO*[3] *ENC product specification that is part of the chart data transfer standard known as S57*[4]*'.* ENC data is divided into 'cells' that contain hydrographic data intended for use between defined maximum and minimum scales. The first digit of the cell's number indicates the intended use and appropriate range scale as shown in **Table 3**.

Navigational purpose	Name	Scale Range
1	Overview	< 1:1499 999
2	General	1:350 000 – 1:1499 999
3	Coastal	1:90 000 – 1:349 999
4	Approach	1:22 000 – 1:89 999
5	Harbour	1:4 000 – 1:21 999
6	Berthing	> 1:4 000

Table 3: ENC cell range scales

1.7.3 Contours and depths

The following contour depths (in metres) could be set on the Maris 900 ECDIS:

- Deep contour
- Safety contour
- Shallow contour
- Safety depth

These values were selected on the S57 settings page **(Figure 9)**. The deep and shallow contour values only control colour shading. The safety contour and safety depth settings require values which are appropriate to the local navigational conditions and take into account; the ship's draught, the effect of squat and, where necessary, height of tide[5].

[3] International Hydrographic Organization

[4] An openly available data format defined in IHO Document S-66 Edition 1 '*Facts about Electronic Charts and Carriage Requirements*'

[5] The safety contour is a critical feature intended to show the operator a difference between safe and potentially unsafe water; crossing the safety contour is a mandatory ECDIS alarm. When a safety contour depth is set, if the selected contour is not available, the system defaults to the next deepest contour available. (For example, if the safety contour was set to 15m but the ENC contours available were only every 10m, then the display would show the safety contour at 20m.) The safety depth value is intended to assist the operator by highlighting spot depths less than the chosen setting by the use of a bold font.

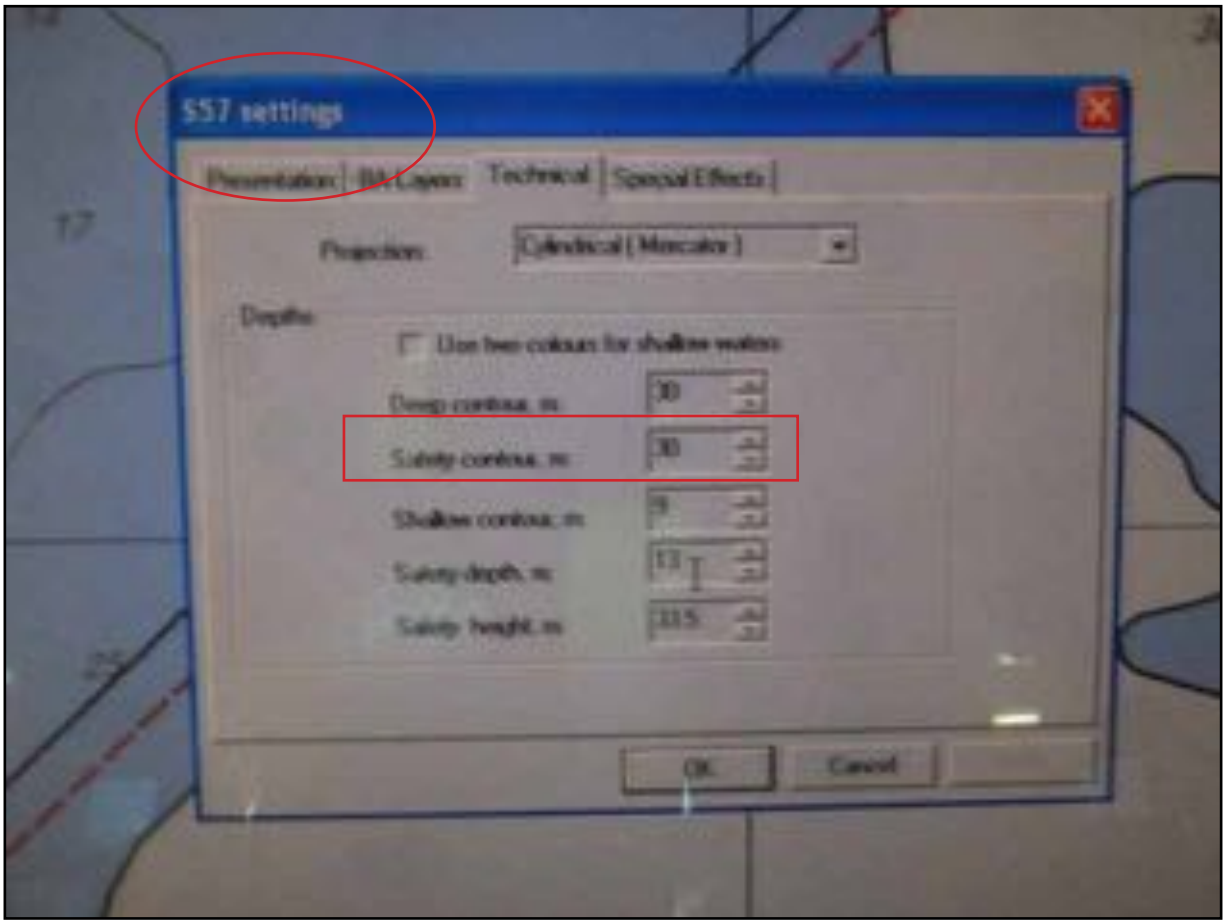


Figure 9: Maris 900 ECDIS 'S57' input page

1.7.4 Guard zone

The Maris 900 ECDIS uses a guard zone ahead of the ship to provide advance warning of dangers. The extent of the guard zone is defined by setting a time and an angle across the bow **(Figure 10)**[6]. The operator is also able to select whether the dangers identified in the guard zone are highlighted on the display. However, even if the operator selects for the dangers not to be highlighted, an audible alarm should still sound when a danger is identified inside the guard zone.

1.7.5 Depth alarms

The Maris 900 incorporates two depth alarms:

- The safety contour alarm activates if the guard zone crosses the selected safety contour. This is a mandatory alarm required by the IMO performance standards. The Maris 900 factory default setting value for the safety contour was 30m.

- The grounding alarm activates when the depth at the ship's position is less than the selected safety depth.

[6] The setting of an angle across a ship's bow generates a cone, the extent of which is determined by speed and the time set. For example, with an angle of 50° and a time of 5 minutes set, the guard zone of a ship at 12kts would extend 25° either side of the bow out to a range of 1nm.

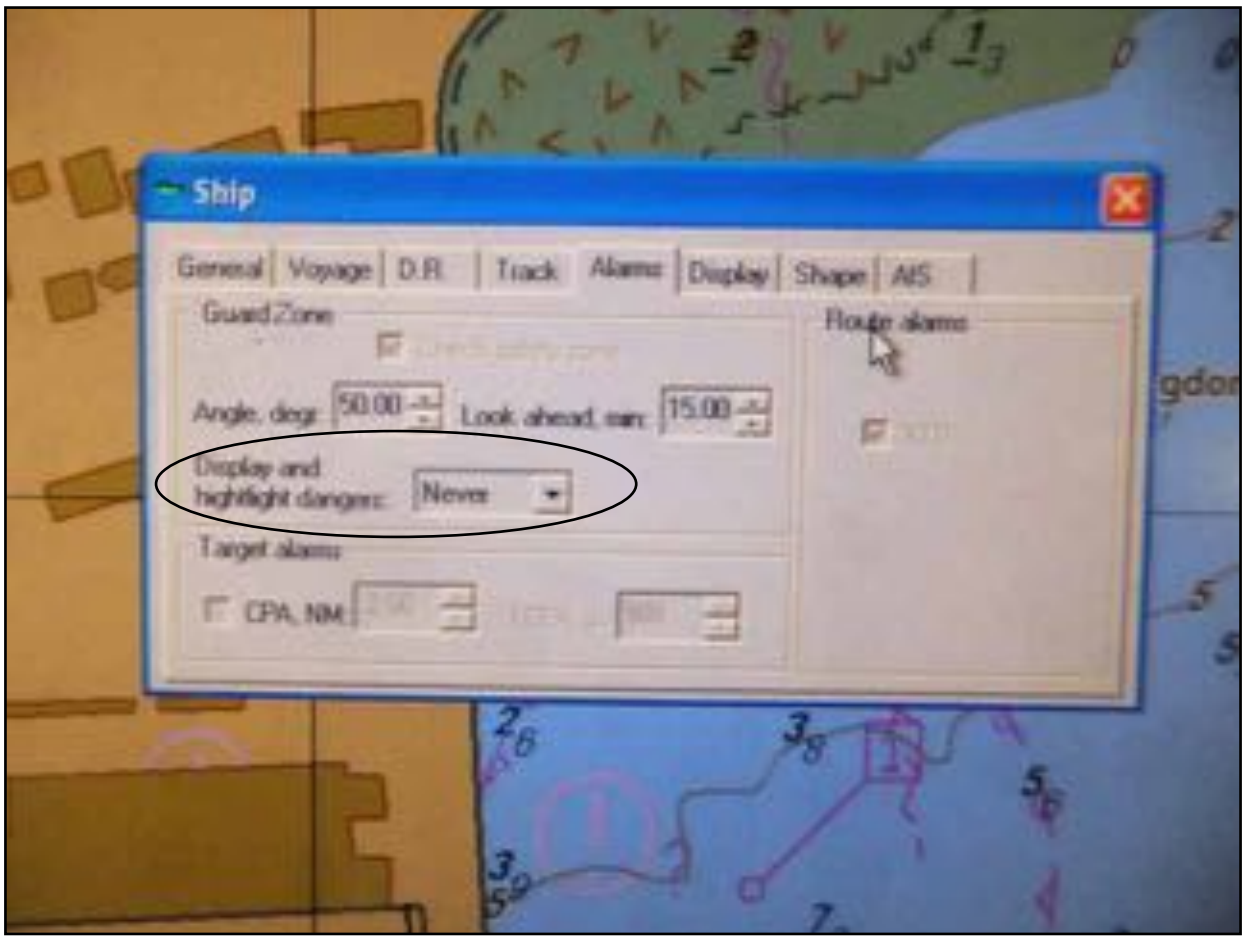


Figure 10: Maris 900 ECDIS guard-zone settings page

1.7.6 Alarm management

When a safety parameter is exceeded, the Maris 900 system activates an audible alarm. It also provides the reason for the alarm in the alarm panel on the display. Once the operator acknowledges the alarm, the audio signal is cancelled. However, the user guide states:

> *'The same alarm will not be triggered again but the message will remain displayed for as long as the relevant limitation is exceeded or until the function is purposely switched off. For example after acknowledgement, the message '**XTD out limits**' will remain displayed for as long as the XTD[7] exceeds the XTD limit value defined in the system or until the route is deactivated.'*

1.7.7 Route checking

When a passage plan has been completed and is activated for use, the Maris 900 ECDIS automatically defaults to the 'check-route' function. This feature checks the intended route for navigational hazards within a user-defined distance both sides of the track. When a vessel is underway, deviation from a pre-determined route (by exceeding the XTD value) is a mandatory ECDIS alarm.

[7] Cross Track Distance

1.7.8 Over-zoom notification

Referred to as the 'jail bars', the Maris 900 ECDIS system contained an over-zoom notification to alert an operator to the fact that important navigational detail may be missing from the display because of the scale in use. The jail bars can be seen at **Figure 6**. In addition, the Maris 900 ECDIS system had an 'auto-load' feature which, if selected, loaded the most appropriate scale ENC available.

1.7.9 Logbook and track recording

The Maris 900 user guide states that:

'*During the process of its operation, ECDIS automatically maintains two different electronic logbooks:*

- *Voyage record*
- *Twenty four hours logbook*

The voyage record stores every two hours the position, course and speed of the ship for half a year. The twenty-four hour logbook records both the navigational events and system events.'

The Maris 900 system also had a user-controlled track recording function which, if enabled, would display and record the ship's position at pre-defined intervals.

1.8 ECDIS USE ON BOARD *OVIT*

1.8.1 Examination

Following the grounding, MAIB examined and analysed *Ovit*'s ECDIS. The findings included:

- The audible alarm was not functioning. The audio output communications port had not been configured[8]. Therefore, when an alarm activated, no signal was sent to the integral speaker in the ECDIS display.
- The route in use was named '*Rotterdam-Vasto'* and had been selected for navigation on 16 September 2013. It had 47 waypoints and totalled 2749.84nm.
- The ENC cell in use was GB202675. ENC cell GB401892 was available. The ENC auto-load feature was switched off.
- The depth settings **(Figure 9)** were:
  - Deep contour: 30m
  - Safety contour: 30m
  - Shallow contour: 9m
  - Safety depth: 13m.

[8] Analysis of the ECDIS hard drive shows that other computer configuration settings were correctly set up at the point of installation.

- The cross track distance (XTD) was set to 0.00nm. The safety guard zone was set to 50° and 15 minutes. The 'display and highlight dangers' sub menu was selected to 'never' **(Figure 10)**.

- With the *Rotterdam - Vasto* route selected, the 'check-route' page highlighted a significant list of potential hazards including the risk of grounding on the Varne Bank **(Figure 11)**. The page was shown to *Ovit*'s deck officers who interpreted the 'no alarms' notation on the lower half of the page to mean that there were no hazards along the route.

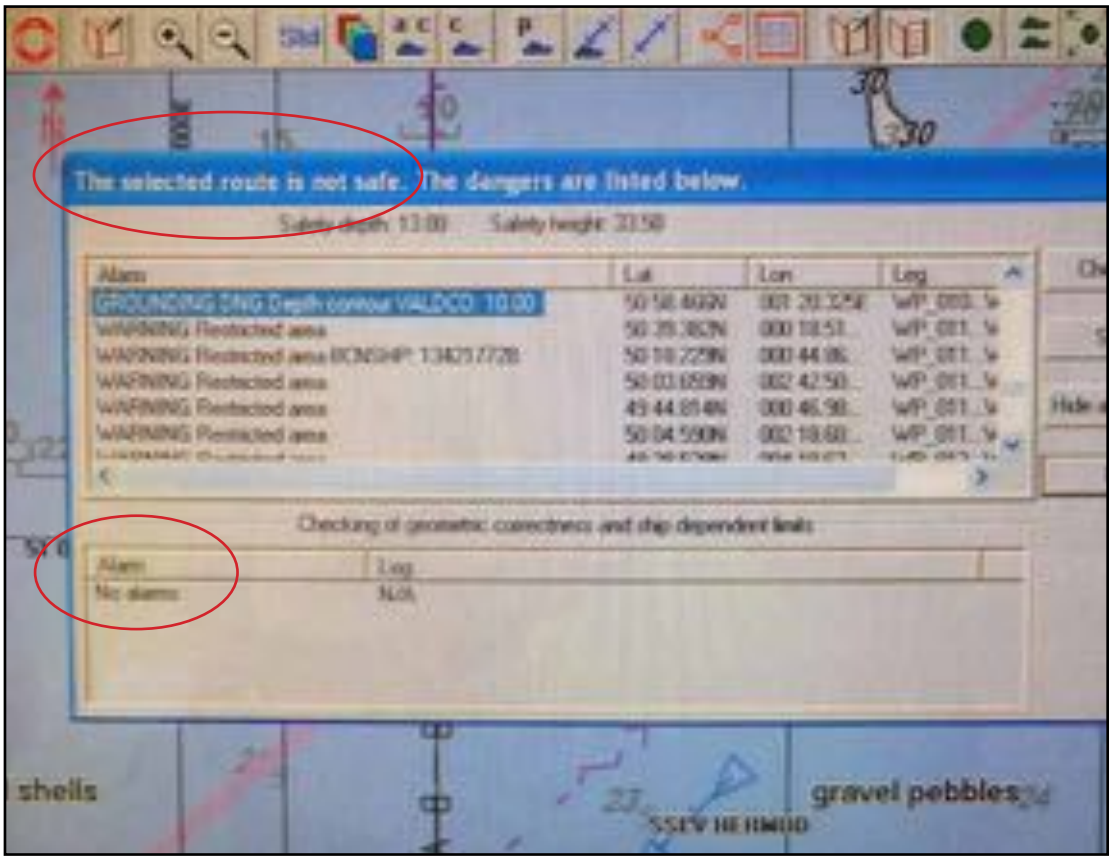


Figure 11: Maris 900 ECDIS check-route page

- Logbook recording was switched off. However, *Ovit*'s position at 0412 on 18 September 2013 was recovered. Neither MAIB nor Maris technical staff were able to recover historical track data between 16 and 29 September 2013. Data had been recorded outside of these dates.

- System alarms were recorded in the chart system log, which showed numerous XTD out of limits alarms.

1.8.2 Display in use

Figure 6 is a photograph of the ECDIS display on board *Ovit*, which was taken when the vessel was aground. Information shown includes:

- The over-zoom notification had activated (jail bars).
- The next waypoint was 'WP_11' which confirmed the route in use.
- The XTD in the grounding position was 202 metres (m) to port of the intended track.
- The 30m contour was highlighted as the safety contour.
- Two alarms were active:
    - 'XTD out limits'
    - 'Grounding alert'.

1.9 RECONSTRUCTION

1.9.1 Set up and limitations

With the assistance of Warsash Maritime Academy, *Ovit*'s grounding was reconstructed in a bridge simulator to gain an appreciation of the various factors potentially influencing the OOW's situational awareness. The inputs for the reconstruction included waypoints from *Ovit*'s passage plan, environmental data corresponding to that at the time of the accident, *Ovit*'s characteristics and positional data from the vessel's voyage data recorder (VDR).

Two independent ECDIS (not Maris) were used during the reconstruction. One system was set up to replicate the settings used in *Ovit* during the grounding, the other system was configured to show the optimum display available. The reconstruction considered both the planning and the monitoring aspects of the grounding.

1.9.2 Findings

Observations made during the reconstruction included:

- *Ovit* crossed the 30m safety contour at 0251 **(Figure 12)** and 0417.
- *Ovit* passed over a charted depth of 13m at 0427 which initiated the 'grounding alarm'.
- The Varne Light Float was sighted at a range of just over 10nm.
- The lights on the cardinal buoys marking the east and west sides of the Varne Bank were sighted at 5nm.

Figure 12: Reconstruction showing *Ovit*'s earlier 30m contour crossing

- There was a considerable difference between the ECDIS display with a safety contour set at 20m, and the display with the safety contour set at 30m **(Figure 13)**.

1.10 VESSEL OPERATION AND MANAGEMENT

1.10.1 General

Ovit was a 6,444 gross tonnage (gt) liquid chemical carrier built in Istanbul in 2011. The vessel was primarily engaged on European and Mediterranean routes and had transited the Dover Strait on 3 occasions in the 3 months before the grounding.

The vessel was owned by Ovit Shipping Ltd, registered in Malta and was one of nine chemical carriers operated by Ayder Tankers Ltd. The company, which was established in 2006, managed every aspect of its fleet from its head office in Tuzla, Istanbul. Its Document of Compliance (DoC) had been issued by Bureau Veritas (BV) and was valid until 25 September 2016. *Ovit*'s Safety Management Certificate (SMC) was also issued by BV and was valid until 14 February 2017.

1.10.2 Navigation equipment

In addition to the Maris 900, *Ovit*'s navigational equipment included:

- Sperry Marine Vision Master 3cm (X Band) radar
- Sperry Marine Vision Master 10cm (S Band) radar
- Sperry Marine R4 GPS navigation receiver
- Rutter NW04 VDR
- Martek Marine 'Nav-guard' Bridge Navigational Watch Alarm System (BNWAS)
- Sperry Marine Nav-pilot 4000 autopilot
- Sperry Marine ES5100 echo sounder.

At the time of the grounding, the BNWAS was switched off and no alarm depth had been set on the echo sounder.

1.10.3 Recruitment policy

Ayder Tankers Ltd recruited its crews through its manning office; manning agencies were not used. Job applications were scrutinised and then potential recruits were interviewed before a contract was signed. Newly employed senior officers spent a minimum of 2 days at the company's offices, to be briefed on the SMS and their responsibility for its implementation on board. *Ovit*'s master had attended the ship manager's office before joining the ship.

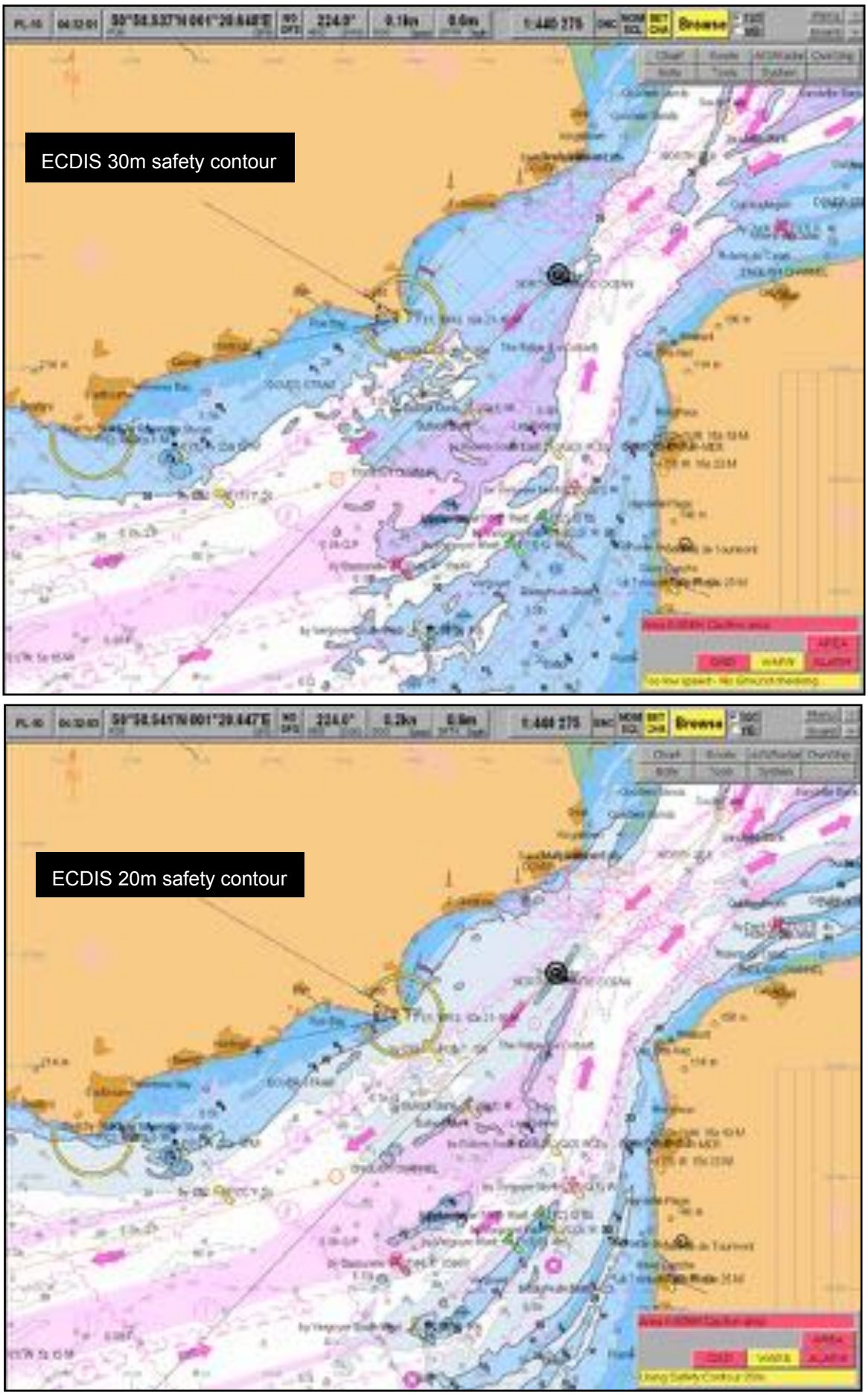


Figure 13: ECDIS display comparison of 30m and 20m safety contours

1.10.4 Safety management system

The implementation of the Safety Management Systems (SMS) on board Ayder Tankers' vessels was the responsibility of the Designated Person (DP), who was an experienced master and well established within the organisation. The company regularly issued circulars with updated safety information and the DPA conducted frequent visits to ships. The SMS contained detailed guidance and procedures for the safe operation of the ship. In particular:

Master's responsibility

The SMS set out the responsibilities of masters, which included:

'1.1.1 Master's responsibility:

- *Ensuring that all bridge personnel are fully familiar with the location and operation of all bridge controls and equipment*
- *Ensuring that the bridge is properly manned for the prevailing conditions*
- *Ensuring that a berth-to-berth passage plan is prepared and that safe distance from nearest grounding line are maintained'*

Passage planning

The SMS stated that the second officer was designated as the navigating officer and responsible for preparing a berth-to-berth passage plan and presenting it to the master. Key points included:

'3.2 Principles of passage planning:

The passage plan is to be in three sections:

- *Berth to commencement of sea passage (outward pilotage)*
- *Sea passage*
- *End of passage to berth (inward pilotage)*

3.2.1 The passage plan preparation checklist must be used. An overall assessment of the intended passage must be made by the master, in consultation with the navigating officer and the other deck officers. This will be when all relevant information has been gathered. This appraisal will provide the master and his bridge team with a clear and precise indication of all areas of danger, and identify the areas in which it will be possible to navigate safely taking into account the calculated draught of the ship and planned under keel clearance.'

Use of ECDIS

The SMS provided detailed instructions to ships on which ECDIS was the primary means of navigation. Specifically:

'7.12.13 safety checks:

- *The master and officers should ensure that ECDIS both visual and audible alarms are KEPT ON in the ECDIS.* [sic]

- *After completion planned passage plan, planned passage should be checked with entered parameters in ECDIS. This is called by safety checks. When safety checks carried out, ECDIS will warn you, if there are some unsafe situation* [sic].

SMS Section 7.12.14 provided guidance on the calculation of safety settings including the XTD **(Annex E)**.

Watch conditions

The SMS also included definitions for three watch conditions **(Annex F)** which were based on proximity of danger:

- Condition A: little traffic and good visibility

- Condition B: heavy traffic, poor visibility, entering / leaving port or crossing / entering separation zone

- Condition C: heavy traffic, dense fog.

1.10.5 Master's orders

Ovit's master had issued a personal set of bridge standing orders to accompany the company's SMS bridge manual. On 17 September 2013, he had also issued handwritten sea orders which were for '*From Rotterdam to Brindisi.'* However, neither the master's bridge nor sea orders included guidance on ECDIS safety settings.

1.10.6 Defect reporting

Ayder Tankers Ltd had a well-established procedure for its crews to record and report defects on board. However, no records were found indicating that the absence of an audible alarm in the ECDIS on board *Ovit* had been reported.

1.10.7 Navigation risk assessment

A risk assessment for navigation **(Annex G)** was held on board, which included the following identified hazards:

- *'High draft/less under keel clearance (UKC)* [sic]

- *Uncorrect position fixing* [sic]

- *Faulty passage plan'*

The mitigation for '*Faulty passage plan'* was *'Navigational Checklists / Bridge Procedures Guide'.*

1.11 AUDITS, INSPECTIONS AND SURVEYS

1.11.1 Navigation audits and survey

Ayder Tankers Ltd conducted an internal audit on board *Ovit* on 27 August 2012. The audit report stated that passage planning was '*okay'* and that the officers were familiar with ECDIS and its functions. A Flag State inspection in Malta on 1 November 2012 identified that the ship's deck officers were '*not in possession of type-specific ECDIS certificates.'* An annual safety equipment survey conducted by ABS on 16 July 2013 did not identify any problems with the vessel's navigation equipment.

1.11.2 Ship Inspection Report Programme

The Ship Inspection Report Programme (SIRE) is a significant industry initiative introduced by the Oil Companies' International Marine Forum (OCIMF) to enable risk-based analyses using data from vessel inspections.

A SIRE inspection was conducted on board *Ovit* on 8 September 2013. The navigation section of the inspection report contained two observations:

- *'Admiralty Pilot North Sea (East)(NP55) was out of date*
- *Port side gyro repeater was not operational'*

The report also commented that the passage plan was well prepared, ECDIS training certificates were held and detailed ECDIS procedures were included in the company bridge manual.

1.12 ECDIS CARRIAGE REQUIREMENTS

1.12.1 International

SOLAS Chapter V, Regulation 19 states:

'2.1.4. All ships…shall have nautical charts and publications to plan and display the ship's route for the intended voyage and to plot and monitor positions throughout the voyage. An electronic chart display and information system (ECDIS) is also accepted as meeting the chart carriage requirements of this subparagraph. Ships to which paragraph 2.10 applies shall comply with the carriage requirements for ECDIS detailed therein;

2.1.5 back-up arrangements to meet the functional requirements of subparagraph .4, if this function is partly or fully fulfilled by electronic means

2.10 Ships engaged on international voyages shall be fitted with an Electronic Chart Display and Information System (ECDIS) as follows:

.1 passenger ships of 500 gross tonnage and upwards constructed on or after 1 July 2012;

.2 tankers of 3,000 gross tonnage and upwards constructed on or after 1 July 2012;

.3 cargo ships, other than tankers, of 10,000 gross tonnage and upwards constructed on or after 1 July 2013;

.4 cargo ships, other than tankers, of 3,000 gross tonnage and upwards but less than 10,000 gross tonnage constructed on or after 1 July 2014;

.5 passenger ships of 500 gross tonnage and upwards constructed before 1 July 2012, not later than the first survey on or after 1 July 2014;*

.6 tankers of 3,000 gross tonnage and upwards constructed before 1 July 2012, not later than the first survey on or after 1 July 2015;*

.7 cargo ships, other than tankers, of 50,000 gross tonnage and upwards constructed before 1 July 2013, not later than the first survey on or after 1 July 2016;*

.8 cargo ships, other than tankers, of 20,000 gross tonnage and upwards but less than 50,000 gross tonnage constructed before 1 July 2013, not later than the first survey on or after 1 July 2017; and*

.9 cargo ships, other than tankers, of 10,000 gross tonnage and upwards but less than 20,000 gross tonnage constructed before 1 July 2013, not later than the first survey on or after 1 July 2018.'*

1.12.2 Flag State

The Malta Transport Authority requirements for the carriage of ECDIS were set out in Transport Malta's Administration Requirements Document, Section 1, Article 1.20 which stated:

'Ships fitted with an ECDIS type approved in accordance with relevant international standards, including IMO Resolution A.817(19) as amended, and with adequate back up arrangements are accepted as meeting the chart carriage requirements of SOLAS 74 Chapter V regulation 27 when navigating in waters covered by Electronic Navigation Charts (ENC) officially issued by an authorised Hydrographic Office.

The following arrangements are accepted as fulfilling the back-up requirement:

- *A second type-approved ECDIS'*

The document did not specify the training standards required for ships' crews navigating solely using ECDIS.

1.13 ECDIS PERFORMANCE STANDARDS

The performance specifications for ECDIS are detailed in IMO Resolution MSC 232(82) which was adopted by the Organization on 5 December 2006. The requirement for performance standards includes:

5.8. It should be possible for the mariner to select a safety contour from the depth contours provided by the system ENC. ECDIS should emphasize the safety contour over other contours on the display, however, if the mariner does not specify a safety contour, it should default to 30m.

6.1. ECDIS should provide an indication if:

1. *the information is displayed at a larger scale than that contained in the ENC: or*

2. *own ship's position is covered by an ENC at a larger scale than that provided by the display.*

11.3.4. An indication is required if the mariner plans a route across an own ship's safety contour.

11.4.3. ECDIS should give an alarm if, within a specified time set by the mariner, own ship will cross the safety contour.

11.5.1. ECDIS should store and be able to reproduce certain minimum elements required to reconstruct the navigation and verify the official database used during the previous 12 hours. The following data should be recorded at 1 minute intervals:

1. *to ensure a record of own ship's past track: time, position, heading and speed; and*

2. *to ensure a record of official data used: ENC source, edition, data, cell and update history.*

11.5.2. In addition, ECDIS should record the complete track for the entire voyage, with time marks at intervals not exceeding 4 hours.

11.5.3. It should not be possible to manipulate or change the recorded information.

Appendix 5 lists the ECDIS features which are specified as alarms or indications. The 5 mandated alarms are;

- *'Crossing safety contour*
- *Deviation from route*
- *Positioning system failure*
- *Approach to critical point*
- *Different geodetic datum'.*

An alarm is defined as *'an alarm or alarm system which announces by audible means or audible and visual means, a condition requiring attention'.*

1.14 OPERATOR STANDARDS

1.14.1 OOW

The International Convention for Standards of Training and Certification of Watchkeepers 1995 (STCW) Table A-II/1 sets out the requirement for competence of officers in charge of a navigational watch in ships of 500gt or more. Specifically for those officers serving on ships fitted with ECDIS, their knowledge of the capability and limitation of ECDIS operations should include:

- *'a thorough understanding of ENC data, data accuracy, presentation rules, display options and other chart data formats*
- *the dangers of over-reliance*
- *familiarity with the functions of ECDIS required by the performance standards in force'.*

Proficiency in operation, interpretation and analysis of information obtained from ECDIS should include:

- *'safe monitoring and adjustment of information, including own position, chart data displayed and route monitoring*
- *efficient use of settings to ensure conformance to operational procedures, including alarm parameters for anti-grounding*
- *situational awareness while using ECDIS including safe water and proximity of hazards, set and drift, chart data and scale selection and suitability of route'.*

1.14.2 Senior officers

STCW Table A-II/2 specifies the minimum standard of competence required for masters and chief mates on ships of 500gt or more. It expands the knowledge levels detailed in Table A-II/1 to include, among other things:

- *'Use ECDIS log-book and track history functions for inspection of system functions, alarm settings and user responses*
- *Use ECIDS playback functionality for passage review, route planning and review of system functions.'*

1.15 OPERATOR TRAINING REQUIREMENTS

1.15.1 International Safety Management Code

The International Safety Management Code (ISM Code) provides a standard for the safe management of ships. Guidance in the ISM Code includes:

> *'6.2 The company should establish procedures to ensure that new personnel and personnel transferred to new assignments related to safety and protection of the environment are given proper familiarization with their duties.'*

1.15.2 Generic training

IMO model course 1.27 was issued by the IMO's STW sub-committee and offered guidance on generic ECDIS training. The model course 1.27 syllabus was intended to meet the requirements of the STCW Code, specifically the requirements of tables A-II/1 and A-II/2. Students completing the course should be equipped with the knowledge, skill and understanding to keep a safe navigational watch using an ECDIS system.

1.15.3 Familiarisation

The IMO published guidance regarding ECDIS familiarisation to member states in STCW.7 Circular Note, dated 22 May 2012. This guidance included:

'.5 Masters and officers certified under chapter II of the STCW Convention serving on board ships fitted with ECDIS are to be familiarized (in accordance with STCW regulation 1/14) with the ship's equipment including ECDIS;

.6 ECDIS manufacturers are encouraged to provide resources, such as type-specific materials, which could be provided on a CD or DVD. These resources may form part of the ECDIS familiarization training;

.9 Regulation 1/14, paragraph 1.5 of the STCW Convention, as well as sections 6.3 and 6.5 of the International Safety Management (ISM) Code requires companies to ensure that seafarers are provided with familiarization training. A ship safety management system should include familiarization with the ECDIS equipment fitted including its backup arrangements, sensors and related peripherals. To assist Member Governments, Parties to the STCW Convention, companies and seafarers, a record of such familiarization should be provided;

.10 Administrations should inform their Port State Control officers of the requirements for ECDIS training as detailed in paragraph 9 above. A certificate of competency issued in accordance with the 2010 Manila Amendments would be prima facie evidence of generic ECDIS training; however, a record of the ship specific familiarization of the ECDIS should be provided.'

1.16 VOYAGE PLANNING

STCW Section A-VIII/2, Part 2, states that:

'*Prior to each voyage the master of every ship shall ensure that the intended route from the port of departure to the first port of call is planned using adequate and appropriate charts and other nautical publications as necessary for the intended voyage, containing accurate, complete and up-to-date information regarding those navigational limitations and hazards which are of a permanent or predictable nature and which are relevant to the safe navigation of the ship.'*

1.17 WATCHKEEPING STANDARDS

STCW Section A-VIII/2, Part 3, states that:

'9. The master of every ship is bound to ensure that watchkeeping arrangements are adequate for maintaining a safe navigational watch. Under the master's general direction, the officers of the navigational watch are responsible for navigating the ship safely during their periods of duty, when they will be particularly concerned with avoiding collision and stranding.

14. The lookout must be able to give full attention to the keeping of a proper lookout and no other duties shall be undertaken or assigned which could interfere with that task.

20. Prior to taking over the watch, relieving officers shall satisfy themselves as to the ship's estimated or true position and confirm its intended track, course and speed, and UMS[9] controls as appropriate and shall note any dangers to navigation expected to be encountered during their watch.

36. Officers of the navigational watch shall…bear in mind that the echo sounder is a valuable navigational aid.

42. The officer in charge of the navigational watch shall give watchkeeping personnel instructions and information which will ensure the keeping of a safe watch, including a proper lookout.

48. The officer in charge of the navigational watch shall positively identify all relevant navigational marks.'

1.18 CHANNEL NAVIGATION INFORMATION SERVICE

1.18.1 Purpose

The CNIS was introduced in 1972 and provides a 24-hour radio and radar safety service for shipping within the Dover Strait. By collecting, recording and disseminating maritime information, the CNIS aims to provide the latest safety information to shipping in the CNIS area. CNIS is jointly provided by the UK and French Maritime authorities in Dover and Gris Nez respectively. In the UK, the MCA is responsible for the operation of CNIS, which it delegates to Dover Coastguard. The CNIS area is shown at **Figure 14**.

[9] Unmanned Machinery Space

Image courtesy of NP 286, Volume 1, Admiralty List of Radio Signals, Pilot Services, VTS Services and Port Operations (UK)

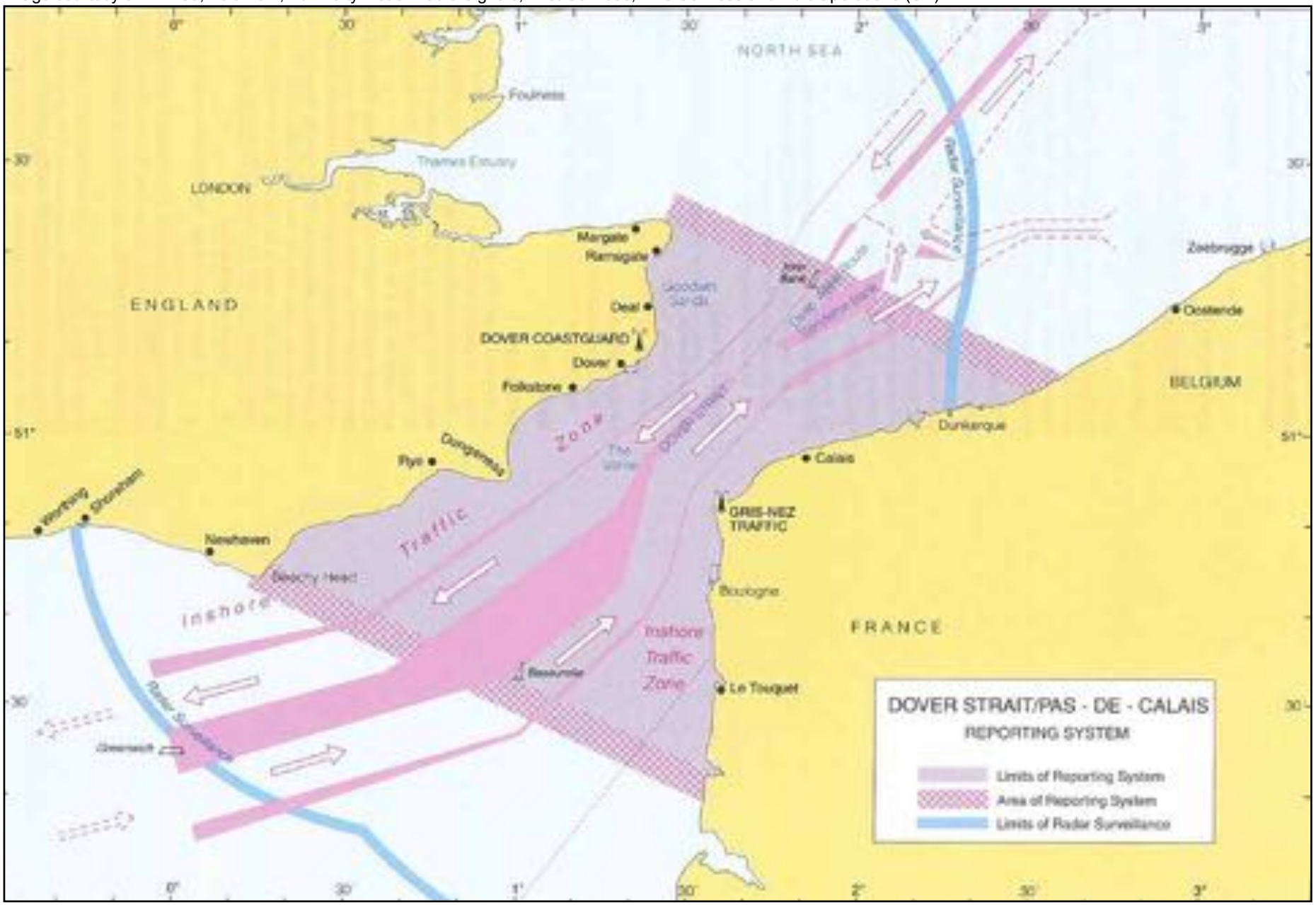


Figure 14: CNIS - coverage

1.18.2 Vessel traffic services

Merchant Shipping Notice (MSN) 1796, issued by the MCA in April 2006, designated vessel traffic service (VTS) stations in the UK in accordance with the Merchant Shipping (VTS Reporting Requirements) Regulations 2004. This notice defined the level of service available to shipping operating in designated VTS areas. Annex A of MSN 1796 designated the CNIS as an 'information service', which it defined as:

- *'A service to ensure that essential information becomes available in time for on-board navigational decision making'.*

1.18.3 Equipment and manning

The CNIS station within Dover Coastguard contains an array of displays showing integrated radar and AIS information which provide operators with a good situational awareness of shipping in the area. Operators also have access to VHF voice and digital selective calling (DSC) communication systems.

The CNIS operator's tasks include preparing and transmitting routine broadcasts as well as managing reports from ships entering the area. The CNIS station is continuously manned by a suitably qualified watch officer. However, it is acceptable for a trainee to operate the CNIS station provided a fully qualified operator is supervising.

1.18.4 Varne Bank alerting system

One of the duties of a CNIS watch officer is to monitor the Varne Bank alerting system. A warning activates in two stages:

- When a vessel's radar vector (based on the distance a vessel will travel in 6 minutes) **(Figure 5)** enters a radar guard zone set around the Varne Bank.

- When the vessel itself enters the guard zone.

When a vessel's vector crosses the boundary of the guard zone, an audible alarm is activated and the ship's symbol on the radar display changes colour from black to red, and flashes. The alert is shown as '*Approaching Varne*' on the operator's display. The operator then has two options:

1. *Acknowledge* – this mutes the audible alarm but the radar target continues to flash red. If this option is selected, the audible alarm will reactivate when the ship enters the radar guard zone.

2. *Authorise* – this mutes the audible alarm and the flashing red ship symbol turns black and stops flashing. The alarms do not reactivate when the ship enters the radar guard zone.

When the alarm first sounds, the operator is required to establish the vessel's intentions and, if a risk of grounding is identified, issue a warning via VHF radio. When the alarm is activated by a vessel which is able to navigate safely across the bank and is permitted to so, the vessel's movement is '*authorised*'.

The procedure to be followed on activation of the Varne Bank alerting system was circulated to all watch officers by e-mail by the CNIS manager on 29 April 2013. It was not included in Dover Coastguard's written procedures.

1.18.5 CNIS operator training

In order to qualify as a CNIS operator, watch officers were required to hold a VTS certificate (V103) and complete the '*CNIS Operator Assessment and Endorsement Procedure'.* The V103 qualification is the nationally recognised VTS operators' training scheme, which is endorsed by the MCA as the National Competent Authority for VTS services in the UK. The syllabus covers all aspects of VTS operations including traffic management, VHF radio work, communication co-ordination and dealing with emergency situations.

The '*CNIS Operator Assessment and Endorsement Procedure'* is also endorsed by the MCA and is a detailed training scheme covering the specifics of the CNIS system. Candidates were required to demonstrate a thorough knowledge of the system through supervised watchkeeping and a written exam. However, the syllabus did not contain a specific requirement for training on the Varne Bank alerting system.

1.18.6 Watch system

To provide 24 hour coverage, Dover Coastguard operates a four watch system. The duty watch is responsible for four key functions: CNIS, Sunk VTS[10], the monitoring of VHF channel 16 and search and rescue (SAR). This requires a minimum of four qualified operators within each watch to be available at all times. However, it was policy to have six operators (including trainees) available for day watches[11] and five for night watches[12].

The watch on duty overnight on 17/18 September 2013 comprised:

- a watch manager
- a watch officer
- two trainee watch officers (one from a different watch)
- a watch assistant.

Only three qualified operators were on watch because the senior watch manager and a part-time watch officer were both on leave. At the time of the grounding, the watch manager and watch officer were both absent from the operations room on a meal break. The responsibilities of the personnel remaining were:

- Sunk VTS - watch assistant (V103 qualified)
- CNIS - trainee watch officer
- VHF channel 16/SAR - trainee watch officer

[10] The North Sea Sunk area VTS is operated by Dover Coastguard

[11] 0800-2000 local time

[12] 2000-0800 local time

None of the three remaining operators were nominated by the watch manager to be 'in charge' during his absence.

1.18.7 CNIS manpower

Manpower shortfalls meant the duty watch was frequently unable to meet watch commitments without augmentation by operators from the 'non-duty' watches. As a result, it was commonplace for members of staff to work overtime on other watches to ensure the minimum manning levels were maintained. The risk associated with this difficulty in sustaining appropriate manning had been reported by Dover Coastguard managers to the MCA headquarters, but its actions were ineffective in easing the manning shortfall.

The *Watch Staffing Planning and Risk Evaluation* for the period 15-18 September 2013 is at **Annex H**. This assessment shows that, at the time of the grounding, the watch was at minimum manning. It also shows that the day watch on 15 September 2013 was two watch officers below the minimum manning level. The shortages highlighted in the evaluation were typical of the shortages experienced at other times.

1.19 PREVIOUS ACCIDENTS

1.19.1 *Lowlands Maine*

On 26 April 2006, the bulk carrier *Lowlands Maine* ran aground on the Varne Bank. During passage through the Dover Strait, the ship's chief officer made an alteration of course to regain track. The new course headed directly for the Varne Bank. Before the vessel had regained track, the third officer took over the bridge watch. The third officer fixed the ship's position and saw that the ship had regained track. However, he did not adjust the ship's heading back to the base course and the ship continued to head for the Varne Bank until grounding.

1.19.2 *LT Cortesia*

On 2 January 2008, the container ship *LT Cortesia* ran aground on the Varne Bank, causing the buckling of an internal bulkhead. The accident report published by the German Federal Bureau of Maritime Casualty Investigation concluded that the OOW had not properly assessed the shipping situation and that communications with the lookout were ineffective. The report also identified that the contour and alarm settings on the ECDIS were inappropriate.

1.19.3 *CFL Performer* – MAIB report 21/2008

On 12 May 2008, the Netherlands registered dry cargo ship, *CFL Performer*, ran aground on Haisborough Sand. The grounding occurred after the chief officer adjusted the passage plan in the ECDIS. The adjusted route, which took the vessel directly over Haisborough Sand, was not checked by the master. The MAIB investigation established that, despite ECDIS being used as a primary means of navigation, none of the ship's officers had been trained in its use. A recommendation was made to the MCA to support a proposal that ECDIS competencies were included in the STCW Convention.

1.19.4 ***CSL Thames*** – MAIB report 02/2012

On 9 August 2011, the Malta registered self-discharging bulk carrier, *CSL Thames*, grounded in the Sound of Mull. The grounding occurred after the OOW had made an alteration of course to avoid another vessel, but had not noticed that the new course would take the ship into shallow water. The audio alarm on the ship's ECDIS system, which could have alerted the OOW to the danger, was inoperative. In addition, the master and other watchkeepers' knowledge of the ECDIS system was insufficient.

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 safety recommendations to prevent similar accidents occurring in the future.

2.2 OVERSIGHT AND SCRUTINY

It is evident from the planned track over the Varne Bank **(Figures 1** and **2)** that the route planned by the third officer was unsafe and had never been properly checked. The third officer had zoomed in on each leg of the route on the ECDIS in order to visually identify navigational hazards. However, this very basic approach was unlikely to identify all the dangers associated with the passage. The ECDIS check-route page **(Figure 11)** would have been more accurate and reliable. Nonetheless, the danger of passing over the Varne Bank should have still been readily apparent had the visual check been completed diligently.

The requirement to prepare a safe passage plan underpins safe navigation. Therefore, it is important that officers responsible for this task are sufficiently experienced and competent. In this case, the master's decision to direct the third officer to plan the passage was reasonable. The second officer's departure from the vessel was imminent and the third officer was soon to be promoted. The third officer had also been trained in the use of ECDIS and had used the Maris 900 during his 5 months on board. However, the complexity of the route and the inexperience of the third officer warranted a high degree of supervision and scrutiny. Instead, there was none. It is astonishing that the second officer did not assist, advise or monitor the third officer, and that the master did not check the intended route himself.

Although the second officer had been expecting to leave the ship, no formal handover of navigation officer responsibilities had taken place. The second officer was, therefore, still the navigating officer. He was demotivated because he had not been able to leave the ship in Hamburg, but this should not have impinged on the second officer's professional responsibility to provide oversight of the third officer and pass on the benefits of his experience. Indeed, it is a task that the master should have directed him to undertake.

2.3 BRIDGE WATCHKEEPING PRACTICES

2.3.1 Events leading to the grounding

When the chief officer arrived on the bridge, he did not check the route ahead to identify potential navigational hazards or the navigational marks likely to be encountered during his watch. Consequently, he was unaware that the ship's intended track passed over the Varne Bank. He was also ignorant of the cardinal marks marking the danger.

When *Ovit* grounded, the chief officer had been on watch for 2 hours. During this time, he had mainly remained seated in the chair in front of the ECDIS and radar displays **(Figure 3)**. However, his alignment of the scale set on the ECDIS with the

range scale on the adjacent radar display resulted in the ECDIS being on a scale of 1:151712, which was totally inappropriate for the area. Consequently, safety critical information was not displayed.

The chief officer did not appear to be concerned that the ECDIS display was showing 'jail bars' **(Figure 6)** which he could not avoid seeing. He was using ECDIS solely to monitor the vessel's position relative to its intended track, nothing more. The chief officer probably did not see on the display that *Ovit* crossed the safety contour at 0251 and 0417. Given the ECDIS settings, crossing the safety contour was a routine event which was likely to have been frequently ignored.

It is evident that the chief officer either did not look out of the bridge window, or he did not try and associate and correlate what he saw ahead of the ship with the information available from his radar, AIS and ECDIS. Therefore, even if the lookout had reported his sighting of lights ahead, it is uncertain whether the chief officer would have recognised their significance.

During the reconstruction **(paragraph 1.9)** the east and west cardinal marks became visible at a range of 5nm. Consequently, they could potentially have been seen by the OOW and the lookout 25 minutes before *Ovit* grounded. This was ample time in which to identify the buoys, highlight the error in the passage plan, and take corrective action.

2.3.2 Events following the grounding

At 0434, when *Ovit* stopped in the water between the cardinal marks delineating the limits of the Varne Bank **(Figure 4)**, the chief officer's situational awareness was so poor that he did not know that the vessel had grounded. It was only when an engineering alarm sounded at 0437 that he became aware that something was wrong. Even then, it is evident that he thought that the ship was stopped because of a machinery breakdown. Nonetheless, that the chief officer called the master after he moved the azipod control levers to zero pitch, indicates that he appreciated the seriousness of being without propulsion in a traffic separation scheme (TSS).

It was probably Dover Coastguard's call on VHF radio **(Table 1)** stating that *Ovit* might be on the Varne Bank that prompted the chief officer to change the scale on the ECDIS in order to see more information. Only then, at 0453, 19 minutes after *Ovit* had stopped, did the chief officer realise that the tanker had grounded.

Although the chief officer then again telephoned the master, the general alarm was not sounded and no crew muster was undertaken. Furthermore, it was not until prompted by the CNIS operator at 0507 that the chief officer informed Dover Coastguard that *Ovit* was aground **(Table 2)**. The vagueness and lack of accuracy of the chief officer's responses to the subsequent questions asked by the CNIS operator were unhelpful, particularly as the operator was trying to establish what had happened and the level of assistance that might be required.

2.4 BRIDGE ORGANISATION

An important element of passage planning is ensuring that the ship is adequately prepared to meet the demands of any navigational situation. In this case, the master was aware that when *Ovit* sailed from Rotterdam, several hours of pilotage would be followed by a long transit through the TSS, including the Dover Strait.

The Dover Strait is a demanding passage which presents a series of significant navigational hazards for shipping, including dangerous shallows and a high traffic density. However, the area is well surveyed and charted, dangers are marked by navigation aids and it is closely monitored by VTS stations in the UK and France. Nevertheless, it is coastal navigation and requires a high state of alertness and the ability to react quickly to the potential dangers.

The watch conditions detailed in *Ovit*'s SMS **(Annex G)** provided guidance on the levels of bridge manning in differing situations. In this case, *Ovit* was following a traffic lane, visibility was good and there were few other ships in the immediate area. Therefore, the applicable watch condition to be used arguably rested between 'watch condition A' (OOW and lookout) and 'watch condition B' (master, OOW and lookout). Namely, the master would probably be required to be on the bridge when approaching and passing key choke points, such as the Varne Bank.

However, although the potential dangers of heavy traffic and the proximity of navigational hazards warranted a cautious approach, they did not trigger any additional precautions on board *Ovit*. The passage through the Dover Strait was treated in exactly the same way as a passage in open water. Indeed, the master's decision to remain in his cabin when called by the chief officer at 0437, indicates an astounding level of complacency given that his vessel was apparently drifting in the Dover Strait with no propulsion available.

2.5 ECDIS

2.5.1 Use on board *Ovit*

ECDIS was the primary method of navigation on board *Ovit*; no paper charts were carried. Therefore, it was vital that the system was set up appropriately and that the officers operating the equipment were fully familiar with its functions. The circumstances of the accident show that the Maris 900 was not used effectively. In particular:

Safety contour

The safety contour setting is intended to offer the OOW a distinct difference between safe and potentially unsafe water; crossing the safety contour initiates an alarm to alert the watchkeeper. Using the formula in *Ovit*'s SMS,[13] **(Annex E)**, the safety contour value should have been set at 13.35m. The ECDIS would then have defaulted to the nearest deeper contour on the chart in use, which was the 20m contour. Instead, the safety contour was set to 30m, which was the manufacturer's default setting. A comparison of ECDIS displays using 30m and 20m safety contours **(Figure 13)** shows that use of the 20m setting would have provided a much clearer picture of where there was safe water available.

Route monitoring

A deviation from the planned route is a mandatory ECDIS alarm. However, the XTD alarm is only effective when the planned route is safe in the first place and an appropriate value for XTD is set. In this case, the XTD value was 0.00nm and therefore the XTD alarms were of no value.

[13] (Draft + squat) x 1.5 = (7.9 + 1) x 1.5 = 13.35m

ENC management

During the Dover Strait passage, the ENC in use was GB202657 which was a 'general' chart on a scale of 1:350,000 **(Figure 15)**. In coastal waters, this scale of chart would only be effective for planning purposes. ENC, GB401892 on a scale of 1:45,000 **(Figure 16)**, which was suitable for coastal navigation, was available on board but it was not in use. The ECDIS 'auto-load' feature, which would have automatically selected the best scale chart, was switched off.

Although the presence of the jail bars **(Figure 6)** should have alerted the OOW that something was wrong with the ECDIS display, the chief officer did not recognise their significance. Consequently, he did not manually load the better scale ENC.

Audible alarm

The ECDIS audible alarm is a mandated feature and is vital for alerting the operator to navigational danger or system failures. Without the correct configuration of the communications port, *Ovit*'s audible alarm was inoperable. Although the installation report **(Annex D)** stated that all configurations had been completed, it is possible that the audible alarm had never worked on board. However, it is also possible that the configuration of the alarm's communication port had been tampered with during *Ovit*'s time in service. Either way, the evidence gathered during this investigation indicates that the vessel's deck officers had operated the ECDIS without an audible alarm for a considerable period of time.

2.5.2 The Maris 900 system

In addition to the incorrect operation of the ECDIS by *Ovit*'s deck officers, some features of the Maris 900 ECDIS on board the vessel were either difficult to use or appeared not to comply with international standards, notably:

- At the top of the check-route page, it clearly stated that the selected route was unsafe **(Figure 11)**. However, it was unhelpful that the words 'no alarms' could be seen in the bottom left of the same page. The 'no alarms' information refers to system input data but, as shown by *Ovit*'s deck officers' understanding of the system, it can be inadvertently linked with the navigational safety data above it.

- Despite its critical importance, the safety contour setting is one of several indistinguishable settings on the same page **(Figure 9)**. The importance of the safety contour setting is not emphasised to the operator.

- The safety contour alarm should have activated shortly before *Ovit* crossed the 30m contour at 0417. However, the ECDIS display during the grounding **(Figure 6)** shows that only the XTD and grounding alarms were active. As the safety contour alarm is intended to activate when a vessel is about to cross the designated contour, it is almost certain that it did not function because the 'display and highlight dangers' option on the guard zone page was set to 'never' **(Figure 10)**. Effectively, this disabled a mandatory alarm.

- The ability to record and then retrieve a vessel's track history is a mandatory feature listed in the ECDIS performance standards **(paragraph 1.13)**. Other than the vessel's position at 0412, *Ovit*'s track history could not be recovered from the system after the grounding.

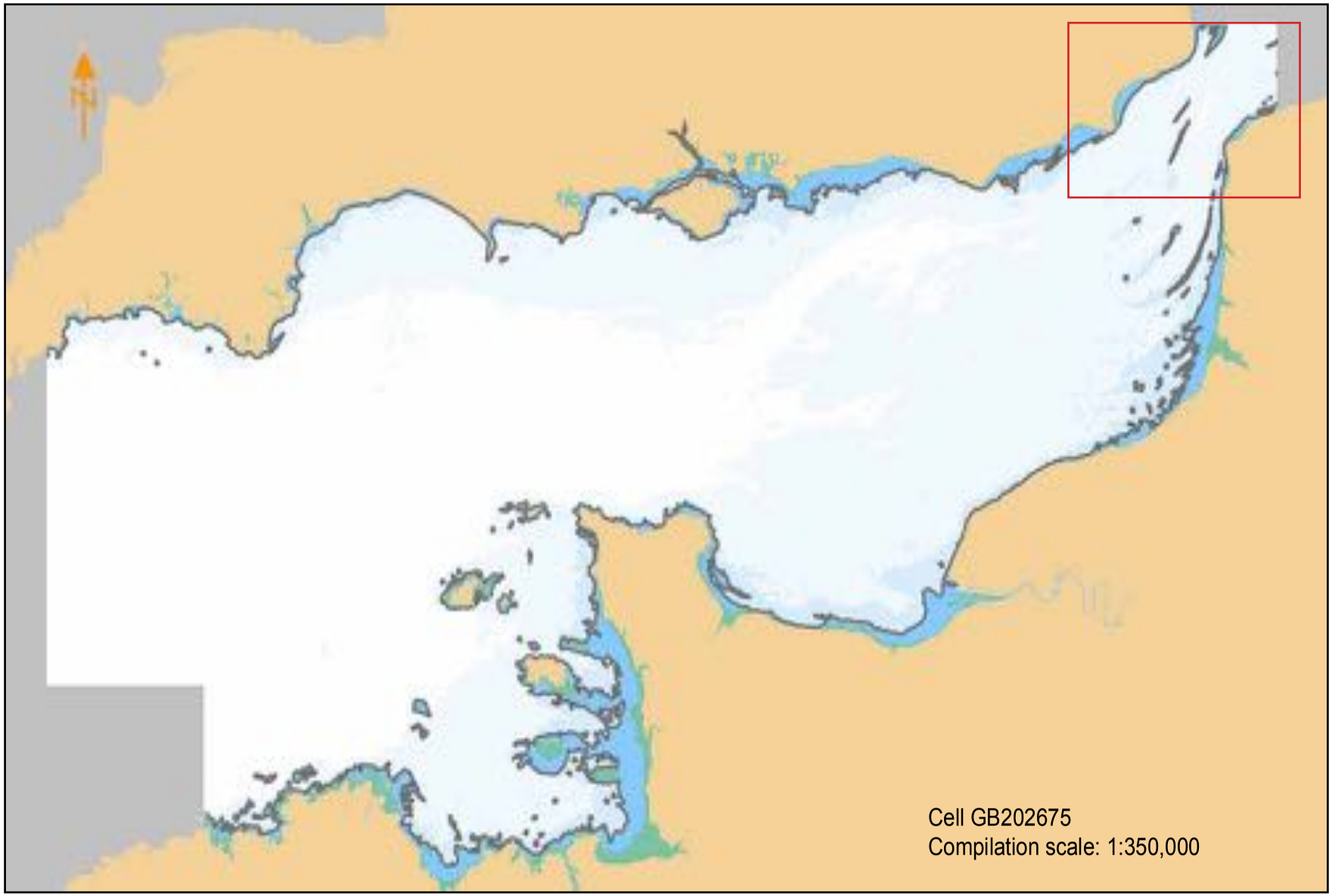


Figure 15: Area coverage of ENC cell 202675

Figure 16: Area coverage of ENC cell 401892

2.6 ECDIS TRAINING AND FAMILIARISATION

Ovit's master and its deck officers had completed generic training on the use of ECDIS. They had also completed type-specific training on the Maris 900 system before joining *Ovit*. Nonetheless, it is evident that they were unable to safely and confidently operate the ECDIS on board the vessel. Therefore, while the officers' training satisfied the requirements of STCW and the ISM, they were unaware of the importance of critical safety settings and the significance of the system's alarms. In short, the training which the ship's officers had attended was apparently either ineffective, or insufficient, or both.

The relatively rapid introduction of ECDIS has led to a situation where large numbers of deck officers are having to be trained in its use in a short timescale. In this case, it led to ships' officers of varying ranks and experiences being trained in the same classroom. From the outside, this did not appear to have been a problem. However, it clearly presented difficulties for *Ovit*'s master, who felt unable to ask questions or admit a lack of knowledge because it could be identified as a weakness. Consequently, he gained little from the type-specific training and was unable to use the Maris 900 when he arrived on board. Therefore he was unable to meet his many responsibilities with regard to SOLAS and STCW.

The requirements for the delivery and content of ECDIS familiarisation has been debated for some time. Currently, it is left to the discretion of Flag States and ship owners to decide. The options available include shore-based courses and computer-based training from a variety of training providers. However, Flag States seem to differ on the suitability of including training on specific ECDIS models during generic courses.

Irrespective of the way the requirement for ECDIS familiarisation is met, it is essential that ship owners and managers ensure that it is effective. Given that some deck officers are familiar with and understand modern technology more than others, and that cultural influences also affect learning, this will not always be easy to achieve.

2.7 ONBOARD LEADERSHIP

The SMS bridge procedures provided on board *Ovit* by Ayder Tankers Ltd were comprehensive and included extensive guidance on the conduct of navigation using ECDIS. The master had also been briefed on the SMS by the ship managers during his visit to its offices before he joined *Ovit*. However, it is evident that the master and deck officers did not implement the ship manager's policies for safe navigation and bridge watchkeeping.

The serious shortcomings in the supervision of the passage planning and bridge watchkeeping practices, the lack of awareness of the increased risk when transiting the Dover Strait, and the incorrect or inappropriate use of the ECDIS, have already been discussed **(paragraphs 2.3, 2.4, 2.5** and **2.6)**. There are, however, a number of other departures from the onboard guidance which removed important safety barriers. These included:

- No pre-sailing brief took place among the deck officers before the ship sailed. Indeed, it is likely that such briefs were rarely held.

- The inoperative ECDIS alarm had not been reported. Instead, the deck officers were content to 'live' with the defect.

- The BNWAS was switched off and no safety depth setting was selected on the echo sounder.

- The *ECDIS –Voyage Plan – Check List* **(Annex B)** was not used.

The on board management of *Ovit* was dysfunctional. Morale was low; the second officer did not want to remain on board and the newly promoted chief officer had been put under pressure by the delays in crew handover and the unavailability of cigarettes on board. More importantly, the master provided insufficient leadership for a safety culture to be developed and instilled on his bridge.

A ship's master should have the confidence to set the standards for his bridge team, which should include leading by example and identifying and addressing training shortfalls. To achieve this, a master should have the necessary technical knowledge and professional skill. In this case, ECDIS was the primary means of navigation, but *Ovit*'s master was not confident using it. Therefore, he was reliant on his junior officers, who were also unable to operate the ECDIS effectively.

At the time of the vessel's grounding, the master had been on board *Ovit* for 3 months. This was ample time for him to better familiarise himself with the ECDIS operation, particularly its check-route function, which would have enabled him to oversee the work of his officers. By not making the effort to do this, the master set a poor example. Although *Ovit's* master had been qualified as a master for 8 years and had completed a BRM course 6 months earlier, it is evident that his technical and management skills had not fully developed.

2.8 NAVIGATION AUDIT AND INSPECTION

2.8.1 Navigation audits

The serious shortcomings with the navigation on board *Ovit* highlighted in this investigation had not been identified during the vessel's recent audits and inspections **(paragraph 1.11)**. However, other than the SIRE inspection, the audits and inspections pre-dated the vessel's crew at the time of grounding, and the SIRE inspection occurred when the second officer was the ship's navigator.

Although the SIRE inspection occurred only 10 days before the grounding, the two navigation-related observations reported indicate that the inspection went into some detail. Nevertheless, the inspection did not identify the crew's lack of competence in using ECDIS, or the significant defect with its audible alarm.

It is recognised that audits and inspections are a sampling process; it would be impossible to check every facet of a ship's navigation within a reasonable timescale. However, as ECDIS is replacing paper charts as the primary means of navigation on many vessels, it is imperative that auditors and inspectors are able to identify problems in the way ECDIS are managed, maintained and used. The degree of understanding required of an auditor to check that ENC data in an ECDIS is up to date is clearly more complex than that required to check a written passage plan, and the correction status of paper charts and nautical publications.

Many auditors and inspectors do not have a background in navigation, and those that do might not have been trained in ECDIS. Consequently, few will have even a basic understanding of the system, leaving them ill-equipped to assess a core safety-critical function, that of safe navigation. Therefore, there is a strong case for the development and provision of tools that will enable auditors and inspectors to properly check the use and performance of this equipment.

2.8.2 Routine performance testing

Establishing that the VDR in a ship is performing correctly can be difficult due to the 'black box' nature of the system. As a result, VDR systems are subject to installation and annual performance checks. This IMO requirement[14] has to be conducted by a competent person and aims to confirm compliance with international performance standards.

As ECDIS is increasingly widely fitted in accordance with mandatory IMO carriage requirements, there would potentially be significant benefit from a testing regime similar to that for VDRs. This would enable Flag State, PSC and other inspectors such as OCIMF to be assured that a ship's ECDIS system had been subject to thorough and frequent performance testing.

2.9 DOVER COASTGUARD

2.9.1 Varne Bank alerting system

While the responsibility to avoid grounding lies with the ship's master, the Varne Bank alerting system provides a valuable additional safety barrier against this significant hazard in the Dover Strait. In this case, the alerting system did not work as intended.

An audible alarm sounded in the Dover Coastguard operations room at 0411 when *Ovit* approached the radar guard zone. At the time, the CNIS operator was communicating with another vessel and, instead of calling *Ovit* on VHF radio to determine the tanker OOW's intentions and if there was a risk of grounding, the operator cancelled both the audible and visual alarm by selecting '*authorise'*. By selecting *'authorise*' rather than '*acknowledge*' the alarms did not reactivate when the vessel entered the guard zone.

Ovit grounded 23 minutes later, but the CNIS operator did not investigate the possibility that the tanker had grounded until 0449 **(Table 1)**. Although it is evident that the operator was distracted at a crucial time, it is also apparent that the operator was not qualified for the role and was not supervised. In addition, there was no specific training for operators in the use of the alerting system and the alerting procedure had not been formalised.

2.9.2 Supervision

As the CNIS operator at the time of the grounding was unqualified for the role, it was inappropriate for the two fully qualified members of the watch to be absent from the operations room at the same time, leaving no one in charge. The presence in the operations room of either the watch manager or the watch officer could easily have been achieved through better management of the watch rota.

[14] IMO MSC.1/Circ.1222 dated 11 December 2006

Had the CNIS operator been properly supervised when the Varne Bank alarm sounded, it is highly likely that a rapid re-prioritisation and re-allocation of tasks would have been prompted. As Dover Coastguard communicated with *Ovit* without difficulty after the grounding, it is reasonable to conclude that, had a clear verbal warning been issued by Dover Coastguard on VHF radio at 0411, there would have been a good prospect of attracting the attention of either *Ovit*'s OOW or lookout in ample time to prevent the grounding.

2.9.3 Manpower

Notwithstanding that better management of the watch rotation could have avoided the trainee operator being left unsupervised, it is of concern that the chronic manpower shortages within Dover Coastguard constantly resulted in watches being under-manned and/or augmented by members of other watches. The *Watch Staffing Planning and Risk Evaluation* covering the period between 15 and 18 September 2013 **(Annex H)** shows that the duty watches at Dover Coastguard were below the minimum manning levels required to maintain an efficient service in its areas of responsibility. As this evaluation was typical of other evaluations, the watch managers were clearly placed under considerable and enduring pressure.

SECTION 3 - CONCLUSIONS

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

1. The passage plan, which was prepared by an inexperienced and unsupervised junior officer, passed directly over the Varne Bank and was unsafe. [2.2]

2. The passage plan was not properly checked for navigational hazards using the ECDIS check-route function and it was not checked by the master. [2.2]

3. When taking over the watch, the OOW did not check the ship's intended track relative to any dangers to navigation that would be encountered on his watch. [2.3.1]

4. The OOW monitored the vessel's position solely against the intended track. Consequently, his situational awareness was poor. [2.3.1]

5. Although the lights from the cardinal buoys marking the Varne Bank were seen by the lookout, they were not reported. [2.3.1]

6. The passage through the Dover Strait was treated in exactly the same way as a passage in open water. Moreover, the master demonstrated an astounding level of complacency when his vessel was apparently drifting in the Dover Strait without propulsion. [2.4]

7. The deck officers were unable to safely navigate using the vessel's ECDIS. The route was not properly checked, inappropriate depth and cross track error settings were used, and the scale of ENC in use was unsuitable for the area. [2.5.1]

8. The ECDIS audible alarm was inoperative. Although the crew were aware of this defect, it had not been reported. [2.5.1]

9. ECDIS training undertaken by the ship's master and deck officers had not equipped them with the level of knowledge necessary to operate the system effectively. [2.6]

10. The SMS bridge procedures provided on board *Ovit* by Ayder Tankers Ltd were comprehensive and included extensive guidance on the conduct of navigation using ECDIS. However, it is evident that the master and deck officers did not implement the ship manager's policies for safe navigation and bridge watchkeeping. [2.7]

11. The on board management of *Ovit* was dysfunctional and the master provided insufficient leadership for a safety culture to be developed and instilled on his bridge. [2.7]

12. The serious shortcomings with the navigation on board *Ovit* highlighted in this investigation had not been identified during the vessel's recent audits and inspections. There is a strong case to develop and provide tools for auditors and inspectors to check the use and performance of ECDIS. [2.8.1]

13. The Varne Bank alerting system operated by Dover Coastguard did not work as intended. A VHF warning was not broadcast to *Ovit* because the CNIS operator was distracted. Also, the operator was not qualified for the role and was not supervised. In addition, there was no specific training in the alerting system, and the alerting

procedure had not been formalised. [2.9.1]

14. It was inappropriate for the two fully qualified members of the Dover Coastguard watch to be absent from the operations room at the same time, leaving the unqualified operator unsupervised. [2.9.2]

15. It is of concern that chronic manpower shortages within Dover Coastguard resulted in watches constantly being under-manned and/or augmented by members of other watches. [2.9.3]

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

1. Several of the features of the Maris 900 ECDIS on board *Ovit* were either difficult to use or appeared not to comply with international standards. [2.5.2]

2. As ECDIS is increasingly widely fitted in accordance with mandatory IMO carriage requirements, there would potentially be significant benefit from a testing regime similar to that required for VDRs. [2.8.2]

3.3 OTHER SAFETY ISSUES NOT DIRECTLY CONTRIBUTING TO THE ACCIDENT

1. It took the OOW 19 minutes to realise that *Ovit* was aground and a further 14 minutes to report the accident to Dover Coastguard. The OOW's vagueness when subsequently answering the coastguard's questions was unhelpful and potentially could have delayed assistance. [2.3.2]

SECTION 4 - ACTIONS TAKEN

Ayder Tankers Ltd has:

- Issued a company safety bulletin highlighting the issues raised by the grounding with the aim of increasing crew knowledge and safety culture.
- Included training on defect reporting system in in-house training.
- Directed all vessels to conduct a master-led risk assessment for navigation in the Dover Strait.
- Agreed a contract with a third party company for provision of navigational audits of ships.
- Moved to computer-based training for the familiarisation of deck officers in type-specific ECDIS.
- Taken action to ensure that ECDIS training imparted ashore is effectively implemented on board its vessels.

The Maritime Coastguard Agency/Dover Coastguard has, inter alia:

- Included the Varne Bank alerting procedure in its written instructions and embedded the use of the procedure in its operator training and assessment. The procedure has also been updated to limit the authorisation of the Varne Bank alarm to senior watch managers and watch managers only.
- Issued instructions that, where a CNIS operator has not completed a V103/1 VTS Operator course, the trainee operator is to be accompanied by a fully qualified operator sitting alongside at all times.
- Taken action to ensure that watch rotations over meal breaks are properly managed.
- Included the composition of the Dover Coastguard watches as a standing agenda item at monthly management meetings.
- Made arrangements for adjacent coastguard stations to take over Dover's SAR responsibilities in extremis to enable Dover Coastguard to focus on its VTS responsibilities (CNIS and Sunk).
- Invited watch officers at other coastguard stations to move to Dover Coastguard.
- Taken steps to ensure that incursions by vessels into the guard zone around the Varne Bank, which require CNIS operator intervention, are recorded and submitted to the UK Safety of Navigation Committee.

Marine Information Systems AS has:

- Introduced a software upgrade to the Maris ECDIS 900 system to ensure that logbook data recording is always active.

SECTION 5 - RECOMMENDATIONS

The Maritime and Coastguard Agency is recommended to:

139/2014 Forward a submission to the IMO Navigation, Communication and Search and Rescue Sub-committee, promoting the concept of carrying out annual performance checks on all ECDIS systems fitted to ships and in use as the primary means of navigation.

140/2014 Monitor the measures adopted to improve the quality of the VTS services provided by Dover Coastguard to ensure that vessel safety is not compromised, taking into account the importance of sufficient qualified operators being available.

Transport Malta, in co-operation with the Maritime and Coastguard Agency, is recommended to:

141/2014 Propose to the Paris Memorandum of Understanding Committee that a Concentrated Inspection Campaign be conducted of ECDIS-fitted ships to establish the standards of system knowledge among navigators using a list of pre-defined questions.

The International Chamber of Shipping (ICS) and the Oil Companies International Marine Forum (OCIMF) are recommended to:

142/2014 In conjunction with ECDIS experts, develop and promulgate a set of focused questions for use by surveyors and auditors when conducting audits and inspections on ECDIS fitted ships.

Ayder Tankers Ltd is recommended to:

143/2014 Take steps through audit and assessment to monitor the effectiveness of the ECDIS familiarisation provided to its deck officers.

Marine Information Systems AS is recommended to:

144/2014 Improve the management of safety critical information in its ECDIS 900 system, focusing on:

- The protection of recorded positional data in accordance with IMO standards.
- Highlighting the importance of safety contour data to the user.
- The activation of an alarm when the safety contour is about to be crossed in accordance with IMO standards.

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

Annex A

Voyage Planning checklist

Voyage planning checklist

Charts	Yes	No	Comments
• Are the charts we have in the largest scale available? Have we corrected for the latest Notice to Mariners	☑	☐	
• Navigational warnings?	☑	☐	
• Do our charts completely cover the area?	☑	☐	
• Are there any routing hazards?	☐	☑	

Sailing Directions			
• Are we following recommended routes?	☑	☐	
• Are we following local regulations?	☑	☐	
• Are we aware of potential hazards?			

Port information			
• Are we aware of local conditions?	☑	☐	
• Is berthing information available?	☑	☐	
• Is a VTS manual available?	☑	☐	
• Is a terminal book available?	☑	☐	
• Is a tug escort required?			

Tidal Atlas/Tables			
• Have we discussed stream strength directions?	☑	☐	
• Have we discussed tidal heights?	☑	☐	

Weather Reports			
• What is local forecast?	☑	☐	EGC & NAVTEX

Vessel Conditions			
• What is the draft and air draft?	☑	☐	
• What is the underkeel clearance?	☑	☐	Check Relevent Page

Maneuvering Data			
• Are we taking into consideration squad when sailing on shallow water..	☑	☐	Check Relevent Page

Chart Information (Following determined on the chart)

	Yes	No	Comments
• No-go Areas?	☐	☐	
• Margins of safety plotted?	☐	☐	
• Plotted [illegible]	☐	☐	
• Have we calculated the wheel-over points	☐	☐	
• [illegible]	☐	☐	

(Safety depth , safety contour, shallow depth, shallow contour)--------------------
(Safety depths, alarms must not be changed without master approval)

- Parallel Index References.. ☑ ☐ ---------------------
- Required speed at differing way points.. ☑ ☐ ---------------------
- Are land fall lights showed on the charts
- VTS calling points.. ☑ ☐ ---------------------
- Tidal Stream anticipated.. ☑ ☐ ---------------------
- Crew call out position... ☑ ☐ ---------------------
- Tug meeting area.. ☑ ☐ ---------------------
- Abort position... ☑ ☐ ---------------------
- Emergency Anchorages or emergency tracks?........................ ☑ ☐ ---------------------
- What are our alternative or emergency tracks?........................ ☑ ☐ ---------------------

Briefing

- We all navigators present?.. ☑ ☐ ---------------------
- Have fixing intervals been determinate?...................................... ☑ ☐ ---------------------
- Have fixing points determinate?... ☐ ☐ ---------------------
- Have the primary navigation aids been determinated?.................. ☑ ☐ ---------------------
- Have the secondary means been discussed?.................................. ☑ ☐ ---------------------
- Have the areas of high risk been determinated and discussed? ☑ ☐ ---------------------
- Has the bridge team discussed the information flow and agree upon it?.. ☐ ☐ ---------------------
- Has the charted plan been discussed?...................................... ☑ ☐ ---------------------
- Has the watch condition been determinated?............................. ☑ ☐ ---------------------
- Have duties been assigned and understood?............................... ☑ ☐ ---------------------
- Have the conditions for increasing the watch been determinated? ☐ ☐ ---------------------
- Have the team members been made aware of any defective Equipment?.. ☑ ☐ ---------------------

Annex B

ECDIS - voyage plan - checklist

ECDIS - VOYAGE PLAN - CHECK LIST

Vessel :
Voyage from : **To:** **Date:**

		YES	NO	NA
1	ENC charts with Permit for the entire voyage available in the ECDIS catalogue? *Tum seferi kapsayan ENC haritaları ve permitleri ECDIS katalogunda mevcut mu?*			
2	ENC charts updated with latest Base and Update CDs? *ENC haritalar enson baz ve guncelleme CD'si ile güncellenmis mi?*			
3	Is the route prepared using safe settings for draught, Safety Contour and Depth Contours in compliance with the company Under Keel Clearence policy and with due to Squat Effect (Including Trim & Heel) ? *Rota hazırlanirken şirketin UKC polikası ve Squat effect (trim ile meyil'ide içeren) gerekliliklerini karşılayacak derinlik emniyet limitleri (Safety Contour, Depth Contours vb) ayarlarlanmış mı?* Shallow Contour:..... m Safety Depth :..... m XTD alarm : _____NM Safety Contour :..... m Offcourse alarm : _____.deg Depth Contour :.....m Max Height : _____ m			
4	Estimated speed for each leg entered into voyage plan? *Sefer planının her ayağı için hız değerleri plana girilmiş mi?*			
5	Confirm WGS-084 has been selected for ECDIS, GPS and used charts. *WGS-084 datumunun ECDIS. GPS ve kullanılan haritalarda seçili olduğu kontrol edilmiş mi ?*			
6	Calculated ETA in route planning tool using present departure date? *Rota planlama modundaki kalkis tarihi doğru olarak girilmis mi?*			
7	Are USER CHARTS & NOTES created and/or updated for the voyage with containing as a minimum following items ? *Asağidaki minimum kriterleri iceren kullanıcı haritaları ve notları yaratılmış ve/veya güncellenmiş mi?*			
8	Pilot Reporting Points ? *Pilot raporlama noktaları ?*			
	MandatoryReporting Points ? *Mecburi raporlama noktaları ?*			
	Point Of No Return for Narrow Passages? *Dar kanallar için No Return noktası ?*			
	Contincency Anchorage ? *Acil demirleme mevkileri ?*			
	No Go Areas (Usuing Channel Limits & User Danger Areas) ? *Girilmez alanlar (kanal limitleri ve kullanıcı tehlike alanları secilerek) ?*			
	Conspicuous targets for position fixing and Cross Checking reference? *Mevki koymak için şüpheli hedefler ve çapraz referans noktaları ?*			
	Paralel Index ?			
	Areas with high speed vessel ? *Yuksek hizli gemilerin calisma bolgesi ?*			
	Relevant Navtex warnings and T&Ps entered using Manual updates and Notes? *Yayınlanan Navtex uyarıları ve T&P düzeltmeleri manual update ve not kullanılarak girilmiş mi?*			
	Echo Sounder programmed in DBS mode ? Vessel draft + UKC ? Echo sounder karinadan(sensorden) derinliği ölçecek şekilde ayarlı mı ? draft +UKC ?			
9	Chart Alert Setting used for planning the Route: *Planlanan rota için ayarlanan harita uyarı kriterleri*	Alarm	Indicator	On
	User chart Danger *Kullanıcı harita uyarısı*			
	Areas to be avoided *Uzak gecilecek alanlar*			
	Traffic Seperation Zone Trafik Seperasyon Bölgeleri			
	Restricted Area *Sınırlandırılmış Alanlar*			
	Caution Area *Dikkatli gecilecek Alanlar*			
	Offshore Production Area *Acikdeniz Uretim Alanlari*			

	Seaplane Landing Area *Deniz Uçaklari inis Bölgeleri*			
	Submarine Transit Lane *Denizaltı Geçiş Hatları*			
	Marine Farm *Deniz Çiftlikleri*			
10	Voyage Plan checked together with User Charts & Notes using Voyage Specific Contour ? *Sefer planı kullanıcı haritaları ve notlarıyla birlikte sefere tanımlı limitlerle (madde 3) kontrol edildi mi ?*			
11	Voyage plan, Notes and User Charts switched to monitoring mode ? *Sefer planı, notları ve kullanıcı haritaları takip moduna alınmış mı ?*			
12	Voyage Log, Danger Targets Log and Distance Log resetted ? *Sefer kayıtları, tehlikeli Hedef Kayıtları ve Mesafe sayacı silindi mi (reset) ?*			
13	Print Passage Plan Report ? *Pasaj Planı yazdırıldı mı ?*			

The methods to be used for cross-checking are by all other means available- such as visual bearings, radar position by range/distance, parallel Index etc. It is important for the Navigator practice all the traditional navigational skills and not to be overly confident in the information from the ECDIS During the voyage GPS signal should be monitored continuosly.
Gemi mevki mümkün olan her türlü çapraz mevki kontrol sistemleri (görsel kerteriz, radar mevkisi, paralel index vb.) ile kontrol edilmelidir. Her türlü geleneksel yöntemi kullanarak seyir yapmak ve sadece ECDIS'den gelen bilgilere bağlı kalmamak gözlemcı (vardiya zbt) için önemlidir. Sefer boyunca GPS sinyal kalitesi sürekli olarak takip edilmelidir.

Navigation Officer **Master**

Annex C

Maris 900 classification society approval

DET NORSKE VERITAS

EC TYPE-EXAMINATION CERTIFICATE

Application of: Council Directive 96/98/EC of 20 December 1996 on Marine Equipment as amended by directive 2008/67/EC, issued as "Forskrift om Skipsutstyr" by the Norwegian Maritime Directorate. This certificate is issued by Det Norske Veritas under the authority of the Government of the Kingdom of Norway.

CERTIFICATE NO. **MED-B-5430**

This is to certify that the
Electronic Chart Display and Information System (ECDIS) with backup, and Raster Chart Display System

with type designation(s)
MARIS ECDIS900
Multi Display and Rack computer

Manufacturer
Maritime Information Systems AS
NØTTERØY, Norway

is found to comply with the requirements in the following Regulations/Standards:
Annex A.1, item No. A.1/4.30 and Annex B, Module B in the Directive SOLAS 74 as amended, Regulation V/18, V/19 & X/3, IMO Res A.694(17) & A.817(19), IMO Res. MSC. 64(67), 86(70),191(79) & 232(82) and 2000 HSC Code 13

Further details of the equipment and conditions for certification are given overleaf.

Høvik, 2009-11-20
for Det Norske Veritas AS

[redacted]

Head of Department

Notified Body No.: 0575

DNV local office:
DNV Sandefjord

This certificate is valid until
2014-11-20

[redacted]

Surveyor

In accordance with Council Directive 96/98/EC, as amended.
The Mark of Conformity may only be affixed to the product and a Declaration of Conformity may only be issued when the production conforms with the approved module referred to in the council directive, is fully complied with.

Annex D

Ovit Maris 900 installation certificate

PRODUCT SERVICE REPORT

STT DENİZ TİCARET VE SERVİS LTD. ŞTİ.
POSTANE MAHALLESİ, RAUF ORBAY CADDESİ, SARMAŞIK SOKAK, NO: 28
TUZLA - İSTANBUL / TÜRKİYE
Tel: +90 216 447 13 00 (pbx) Fax: +90 216 447 13 44
http://www.stt.com.tr E-mail: stt@stt.com.tr

NORTHROP GRUMMAN
Sperry Marine
SAILOR.
Thrane & Thrane

CONTRACT: ☐	CALL: ☐	WARRANTY: ☐	INSTALLATION: ☒	SERVICE GUARANTEE: ☐	SERVICE REPORT NO: NB64-021
VESSEL: M/T OVIT NB64				OWNER: YARDIMCI GEMI INSA A.S	
LOCATION: TURKTER / ISTANBUL TURKEY		DATE: 01/04/2011		ETA:	ETD:
EQUIPMENT: MARIS ECDIS 900 (2 SET)				MOD:	SERIAL NO:
REASON FOR CALL:					

SERVICES CARRIED OUT — SHIP'S POWER: 24 VDC 220 VAC 60 HZ 3 PHASE

FAULT CONFIRMED AS REPORTED ____ FAULT NOT OBSERVED ____ FAULT INTERMITTENT ____ CABLING/GROUNDING CHECKED ____

FAULT REPAIRED ____ FAULT CODE ☐☐☐☐ NOT REPAIRED ____ GIVE REASON: NO SPARE ____ NO TIME ____ NEED INFO ____ OTHER ____

MATERIAL SUPPLIED									MATERIAL REMOVED				
QTY	PART NUMBER	REV	DESCRIPTION	SERIAL NO	NEW	SPEX	SHIP SPARE	OTHER	SERIAL NO	SPEX CENTER	SCRAP	EXCHANGE	OTHER

ENGINEER REPORT

2 SET MARIS ECDIS DISPLAY UNIT, PROCESSOR UNIT, DANGLE, KEYBOARD AND MAUSE HAVE BEEN FITTED. ALL CABLES HAVE BEEN RUN. ALL CONNECTION HAVE BEEN DONE. GYROCOMPASS, GPS1, GPS2, SPEED LOG, ECHOSOUNDER, WIND SPEED, AIS HAVE BEEN CONNECTED TO THE ECDIS SYSTEM.
SYSTEM IS POWERED ON. ALL CONFIGURATION HAVE BEEN DONE. SYSTEM IS TESTED IN SEATRIAL AND SEEN OK. ECDIS SYSTEM HAS BEEN DELIVERED TO THE VESSEL UNDER THE NORMALLY OPERATION CONDITION.

HATTELAND	20.1 LCD Display	JH20T08MMD-E11-10316
A3300M	ECDIS Processor Unit	A3300M171803910
EX700	700V UPS	1YOL10050
403601E	Compact Keyboard	80170718
MARIS ID	MONITORING ECDIS	5757
ARCS USER PERMIT	35663E9EB6D74856	
ARCS PIN CODE	2938	
PRIMER USER PERMIT	36274A93DAC333D831750CEF3135	
HATTELAND	20.1 LCD Display	JH20T08MMD-E11-10307
A3300M	ECDIS Processor Unit	A3300M171803913
EX700	700V UPS	1YOL10056
403601E	Compact Keyboard	80170739
MARIS ID	PLANNING ECDIS	5758
ARCS USER PERMIT	35683E9EB6D74856	
ARCS PIN CODE	2938	
PRIMER USER PERMIT	36274A93DAC333D831750CEF3135	

[redacted]

ENGINEER NAME: [redacted] ENG SIGNATURE:

JOB COMPLETE: YES X NO ____ FOLLOW UP REQUIRED: YES ____ NO X NEXT PORT: ETA:

LABOR									EXPENSES	CUSTOMER ACCEPTANCE
DATE	ONBOARD IN	ONBOARD OUT	SHOP ST	SHOP OT	TRAVEL ST	TRAVEL OT	WAIT ST	WAIT OT	MILES	THE WORK DESCRIBED ABOVE HAS BEEN CARRIED OUT TO MY SATISFACTION
01/04/2011									HOTEL	PRINT NAME:
									MEALS	TITLE:
									AUTO	SIGN:
									AIR	SHIP STAMP:
									TTL EXP	
									TTL LABOR	
									TTL PRS	

THANK YOU FOR USING STT DENİZ TİCARET VE SERVİS LTD. ŞTİ.

F-STT DO2 / 4-0808

Annex E

SMS depth and cross track distance setting formulae

7.12.13 SAFETY CHECKS

The Master and officers should be ensure that ECDIS both visual and audible alarms KEPT ON in the ECDIS.

After completion planned passage plan, planned passage should be checked with entered parameters in ECDIS, in ENC mode. This is called by safety checks. When safety checks carried out, ECDIS will warn you, If there are some unsafe situations. All alarms should be carefully read, checked and passage plan should be corrected as necessary. This parameters can be change as a name depending on to ECDIS model. The parameters shall be be adjusted minimum as below

SAFETY CONTOUR: The first thing that the navigator needs to do is to enter the ship's draft and air draft and establish the safety contour based on draft and the required Under keel Clearance (UKC).

The safety contour provides a visible boundary between "safe" and "unsafe" water with respect to depth, and is highlighted on the display to enable easy identification

For example, with a vessel of 6m draft the depth contour could be chosen as 8m. However, since most ENC data is supplied with preset contours, typically at 5m intervals the display will default to the next deepest contour which in this case would be 10m. All areas of less than 10m will show as blue and areas deeper than 10 will be displayed as white (see below diagram). So as long as the ship remains in the white area, she is, in theory, safe.

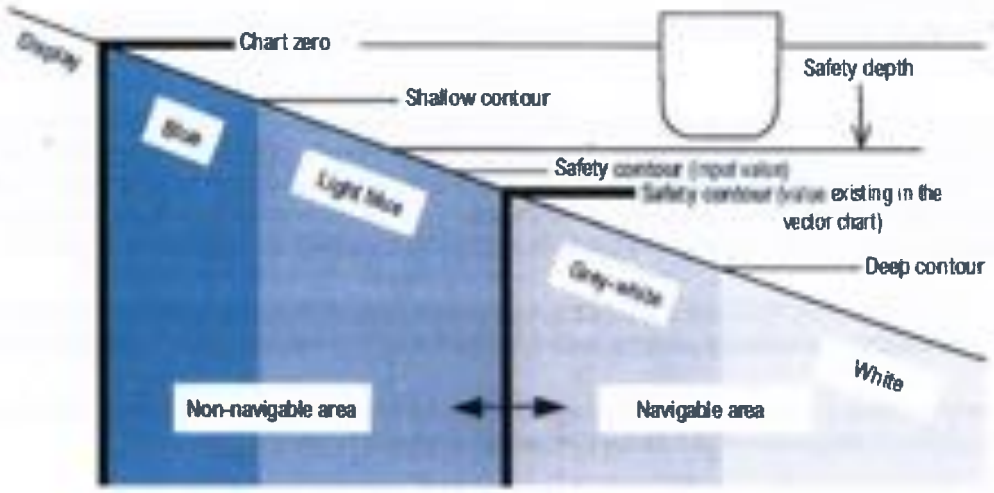
SAFETY DEPTH : The safety depth applies to spot soundings, the depth of which is insufficient for a vessel to safely pass over. In addition to the safety contour, this same depth of 8m can be set as the safety depth. In this case, if the navigator sets the ECDIS to display depths then all depths of less than 8m will show in bold type and those deeper than 8 will be a pale grey. This means that a depth of 9m, although within the 10m blue safety contour it will displayed in pale grey text whereas a depth of 7m will be displayed in bold black.

7.12.14 THE WHOLE SAFETY OF THE PASSAGE IS DEPENDENT ON THIS INFORMATION BEING CORRECT SO, IF A NAVIGATOR FAILS TO SET THIS CORRECTLY, THE SCENE IS SET FOR A DISASTER!

SHALLOW CONTOUR: The shallow and deep contours are utilised when the multi-colour depth display is selected. The area between the 0m contour and the shallow contour is coloured dark blue, the area between the shallow and safety contour is coloured light blue, and the area between the safety contour and the deep contour is coloured grey. This allows the gradient of the seabed to be graphically displayed. All of the area between the 0m contour and the safety contour is also hatched.

GUARD ZONE -NAVIGATIONAL DANGER: This is an anti-grounding alarm. Entered value shown in the ECDIS as a circle centred in your position. If a danger/depth enters inside the circle alarms sounds and warn the duty officer.

XTE: CROSS TRACK ERROR: cross track error should be entered leg by leg in the passage plan considering intended safety distance from the dangers, because of ECDIS consider only area, between the port and starboard XTE, during the safety checks. So if you enter XTE:0,1 nm for all passage leg, during the safety check ECDIS will not give you alarm if the danger far away from your planned route more than 0,1 nm, even 0,11 nm. During the channel passage 0,1 nm could be acceptable (wherever possible and practible) but in the open waters could not be less than 1nm.



NO	NAME	MINIMUM VALUE	OVERVIEW	
1	Depth Contour	20 meters	The area between the safety contour and the deep contour is coloured grey-white	
2	Safety Contour	(Draft + squat) x 1,5 in open water (Draft + squat) x 1,1 in pilotage water Draft: max draft	All areas of less than minimum entered value will show as blue	All areas deeper than minimum entered value will be displayed as white
3	Shallow Contour	(Draft + squat)	The area between the 0m contour and the shallow contour is coloured dark blue	
4	Safety Depth	(Draft + squat) x 1,5 in open water (Draft + squat) x 1,1 in pilotage water	all depths of less than minimum entered value will show in bold black type	All depths deeper than minimum entered value will be a pale grey
5	Safety Height	Air draft + 2 meters	Alarm will be given if not sufficient height	
6	XTE: Cross Track Error	Confined water: at least 0,1 nm wherever possible and practible Coastal water: min 1 nm Open water : min 4 nm	Alarm will be given if any danger available in the guard zone	
7	Guard zone (navigational danger)		Entered value shown in the ECDIS as a circle centred in your position. If a danger/depth enters inside the circle alarm sounds and warn the duty officer	

Annex F

SMS watch conditions

BASIC WATCH CONDITIONS

WATCH CONDITION - A

TRAFFIC - LITTLE OR NIL VISIBILITY - GOOD

1 O.O.W - COLLISION AVOIDANCE , NAVIGATION , CONNING

2 WATCH A.B - STEERING OR LOOKOUT AS MAY BE REQUIRED , DURING DAYLIGHT HOURS MAY WORK NEAR VICINITY TO BRIDGE PROVIDED HE IS READILY AVAILABLE.

WATCH CONDITION - B

TRAFFIC - HEAVY VISIBILITY - POOR

NAVIGATION AREA - LEAVING/ENTERING PORT , CROSSING/ENTERING SEPARATION ZONE

1 MASTER - CONNING , COLLISION AVOIDANCE

2 O.O.W - NAVIGATION + COMMUNICATION

3 WATCH A.B - STEERING/ LOOKOUT/ AS REQUIRED.

WATCH CONDITION - C

TRAFFIC - HEAVY VISIBILITY - DENSE FOG

1 MASTER - CONNING

2 2/MATE - NAVIGATION

3 C/MATE - ESSENTIAL BACKUP FOR MASTER

4 WATCH A.B - STEERING OR LOOKOUT

5 STAND BY A.B - LOOKOUT , AS MAY BE REQUIRED.

conn = control

MASTER TAKES THE CONN **VERBALY** WHENEVER !!!

Annex G

Ovit Deck risk assessment

AYDER TANKERS INC.

RISK ASSESSMENT - *RISK DEĞERLENDİRMESİ*

Description

Department DECK Deck ☐ Engine ☐ Chartering ☐ Company ☐ **Ref No** **Date**

Hazard	Consequence	Severity	Likelihood	Initial Risk	Control Measures	Revised Severity	Revised Likelihood	Revised Risk	Reference Publications / Comments
Heavy Vessel Traffic	Property Damage Accident,	4	4		Master's Company's Standing And Daily Orders	2	3		
Main Engine Failure, Black	Property Damage Accident	4	3	12	Inspection/ Maintenance Of Main/aux engines Should	2	2		
Restrited Visibility	Property Damage Accident,	4	4		Master's, Company's Standing And Daily Orders	3	2		
Navigation During Voyage By	Property Damage Accident,	4	4		Master Should Coordinate The Crew's Resting	2	2		
Vessel Security	Loss Of Containment,	3	3	9	Proper Security Level's Requirements To Be	2	1		
Adverse Weather Conditions	Property Damage Accident,	5	3		Local Weather Forecast To Be Monitored And	3	2		
Unsufficient Communication	Property Damage Accident	5	3		Ensure All Communication Means Functioning	3	2		
High Draft/ Less UKC	Property Damage Accident	5	3		UKC To Be Calculated And Passage/anchorage	3	2		
Uncorrect Position Fixing	Property Damage Accident	5	3		All Available Position Fixing Methods To Be Used	3	1		
Defective Navigational	Property Damage Accident	5	3		All Equipments To Be Checked Before	3	2		
Failure At Updating	Property Damage Accident	5	3		Ensure All Charts And Publications Corrected Up To	3	1		
Navigation In/out Of Pilotage	Property Damage Accident	5	3		Navigational Checklists / Bridge Procedures Guide /	3	2		
Faulty Passage Plan	Property Damage Accident	5	3		Navigational Checklists / Bridge Procedures Guide /	3	2		

Annex H

Dover coastguard manpower risk assessment

MRCC : Dover
Watch: B

Watch Staffing Planning and Risk Evaluation

Annex A

A

Non-SAR Activity Levels	Y / N
High	Y
Moderate	N
Low	N
Result	High

B

SMC Co-ordination Levels	Annual Inc	Month Inc
A	882	0
B	38	0
C	23	0
	943	0
Result		High

Evaluation Results **HIGH**

RCC Suggested Staffing Level

		WM	WO	CWA
Low				
Moderate				
High	8	2	4	2

Area Suggested Staffing Level

	WM	WO	CWA
Low			
Moderate			
High			

Events in Diary C — Yes/No:

Weather Conditions D — Yes/No:

Indicate the Qualified Staffing level required:

E

	Date	WM *	WO	CWA
D	15/09/2013	2	4	2
D	16/09/2013	2	4	2
N	17/09/2013	2	4	2
N	18/09/2013	2	4	2

*or SMC qualified WO

Indicate the Qualified Staff level achieved

F

WM*	WO	CWA
1	2	1
2	2	1
1	3	1
1	3	1

G

Does each watch have the sufficient mix of competencies — Yes / No: Yes

H

	Date Reviewed	Signature	Comments
1st Watch	15/08/2013		Watch 2 below minimum
2nd Watch	16/08/2013		1 overtime cover, Watch 1 below mm
3rd Watch	17/08/2013		1 overtime cover, Watch at mm
4th Watch	18/08/2013		1 overtime cover, Watch at mm

Marine Accident Report

INVESTORS IN PEOPLE

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

ACCIDENT REPORT

SERIOUS MARINE CASUALTY | REPORT NO 2/2012 | MARCH 2012

Grounding of *CSL THAMES* in the Sound of Mull 9 August 2011

This investigation has been conducted with the co-operation and assistance of the Malta Marine Safety Investigation Unit.

Extract from The United Kingdom Merchant Shipping (Accident Reporting and Investigation) Regulations 2005 – Regulation 5:

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

NOTE

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

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All reports can be found on our website:
www.maib.gov.uk

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Summary

At 1026 (UTC +1) on 9 August 2011, *CSL Thames,* a Maltese registered self-discharging bulk carrier, grounded briefly in the Sound of Mull while on passage from Glensanda to Wilhelmshaven. The vessel sustained bottom damage to her hull, including a 3-metre fracture to one of her water ballast deep tanks, which flooded. There were no reported injuries or pollution.

The MAIB investigation found that *CSL Thames* ran aground after the third officer had altered the vessel's course to starboard of the planned track to avoid another vessel. He did not notice that the alteration would take *CSL Thames* into shallow water, and the audio alarm on the electronic chart display and information system (ECDIS) that should have alerted him to the impending danger was inoperative. Further, the master's and other watchkeepers' knowledge of the vessel's ECDIS was insufficient and therefore no-one within the bridge team questioned the absence of the ECDIS audio alarm, or recognised that the system's safety contour setting was inappropriate for the planned voyage.

Alfa Ship & Crew Management GmbH has taken a number of actions designed to prevent a similar accident in the future. Additionally, the MAIB has issued a recommendation to the company designed to ensure the introduction of written instructions and guidance on the use of ECDIS and emergency preparedness, and measures to verify that these will be properly implemented throughout its fleet.

CSL Thames

FACTUAL INFORMATION

Narrative

At 0820 on 9 August 2011, *CSL Thames* completed loading a cargo of 28,962 tonnes of aggregates at Glensanda for discharge at Wilhelmshaven. A pilot boarded and, at 0840, the vessel departed. In addition to the pilot, the bridge was manned by the master, third officer and a helmsman. The vessel's deepest draught was 10.63 metres. At 0848, the pilot disembarked and the master set the engine to full ahead. Visibility was good with a moderate west-north-west breeze.

At 0935, *CSL Thames* entered the Sound of Mull. To assist with navigation during the transit, the master used two radars and an ECDIS. The ECDIS was set with the following safety parameters: a safety contour of 10 metres; a cross-track deviation limit of 0.2 mile either side of the planned track; and an anti-grounding warning zone that covered an arc 1º either side of the vessel's track out to a distance equivalent to 10 minutes steaming. The alarm on the ECDIS should therefore have activated if *CSL Thames* deviated more than 0.2 miles from her planned track, or the anti-grounding warning zone crossed a safety contour or other user-defined danger.

At 1006 **(Figure 1)**, with *CSL Thames* on a heading of 290º(T) at a speed of 12 knots, the master instructed the helmsman to engage the autopilot and then handed the con to the third officer, who stood facing the starboard radar display, with the ECDIS display to his right **(Figure 2)**. The master increased the volume on a portable compact disc player that had been playing music on the bridge since the pilot disembarked, and moved to the communication centre on the port side of the bridge to send routine departure messages.

At 1010, the third officer interpreted from the ECDIS display that *CSL Thames* was about 1 mile from the next planned waypoint; he also estimated that a sailing vessel he could see on the starboard bow would be ahead of *CSL Thames* when she was steady on her new course. Intending to leave the sailing vessel to port, he decided to turn early and, by adjusting the autopilot, initiated a slow alteration of course to starboard towards the next planned course of 314º (T).At 1014 **(Figure 3)**, as *CSL Thames*'s heading was passing 308º(T), the third officer acquired on the radar an automatic identification system (AIS) target of the sailing vessel at a range of 3.6 miles and on a bearing of 318.5º(T). At 1016, with *CSL Thames* approaching her planned course of 314º (T), he decided to continue the alteration to starboard to place the sailing vessel onto the port bow. At 1018, *CSL Thames* was on a heading of 321º (T) when the third officer observed another small vessel right ahead at about 1 mile range. With the intention of leaving the small vessel to port, he continued altering course to 324º (T). The ECDIS anti-grounding warning zone alarm then activated on the display, but no audible alarm sounded.

At 1021, the third officer sounded two long blasts on the ship's whistle to alert the small vessel to the

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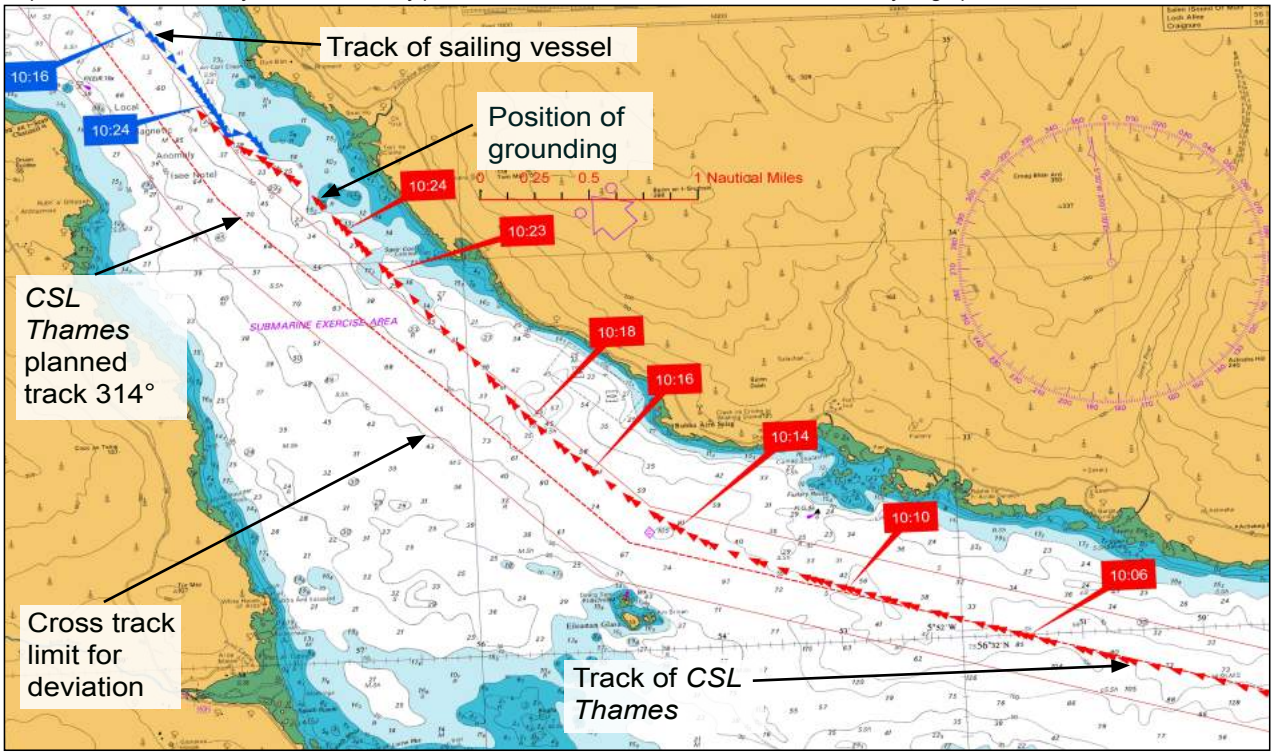

Figure 1: AIS tracks of *CSL Thames* and sailing vessel

Figure 2: View of ECDIS and position of bridge team

presence of *CSL Thames* and, at about 1023, the small vessel passed clear on *CSL Thames*'s port side. The third officer then focused his attention on the sailing vessel ahead, which was now at about 1 mile range.

At 1025, *CSL Thames* grounded in position 56º 34.3'N, 005º57.2'W at a speed of about 12 knots **(Figure 4)**. The contact with the seabed lasted 16 seconds and caused the vessel to vibrate loudly. This prompted the master to return to the conning position and to look at the ECDIS display. Recognising that his vessel had run aground, he instructed the helmsman to switch to manual steering and ordered the wheel to hard-a-port. The sailing vessel also altered course to port and both vessels narrowly avoided colliding with each other.

Post-grounding events

At 1029, the master steadied *CSL Thames* on a heading to return her to the planned track. He instructed the third officer to check the automated ballast tank sounding display located on the bridge. The third officer reported a sounding in No 3(P) ballast deep tank, which had previously been empty, indicating an ingress of water to that tank. The master then telephoned the engine room. He informed the chief engineer about what had happened, and instructed him to monitor the tank soundings and to check for any damage in the engine room. At 1047, the master informed the ship's management company's technical superintendent of the accident and of the ingress of water in No 3(P) ballast deep tank. At 1055, the master reduced the vessel's speed to 9 knots and, at 1057, notified the company's designated person ashore (DPA).

Soon afterwards, the chief engineer reported that all other tank soundings were stable and that there were no other signs of damage. On instruction from the master, the chief officer started to pump out water from the damaged deep tank; he reported that the ballast pump was able to cope with the rate of ingress and that the level of water in the tank was reducing. The master then instructed the chief officer and chief engineer to attempt to enter the tank to establish the extent of damage. When the sounding had reduced to about 50cm, the chief officer, chief engineer and a seaman entered the tank and identified a 3-metre longitudinal fracture in the hull bottom plating.

At about 1315, with No 3(P) ballast deep tank vacated and its access re-secured, the master increased the vessel's speed to full ahead. At 1400, he informed the DPA of his initial findings and of his assessment that it was safe for *CSL Thames* to continue her passage to Wilhelmshaven. At 1600, the vessel's classification society agreed to the vessel continuing to Wilhelmshaven to discharge her cargo on the condition that *CSL Thames* proceeded to the nearest repair facility immediately afterwards.

At 1445 on 12 August, *CSL Thames* was berthed safely at Wilhelmshaven. At 0800 on 13 August, having discharged her cargo, the vessel left Wilhelmshaven and, later on the same day, entered Emden dry dock for repairs. She re-entered service on 27 August.

ECDIS training and guidance

CSL Thames was fitted with two ECDIS units that were used as the primary means of navigation, thus removing the need for paper charts to be carried. All bridge officers, including the master, had completed a generic ECDIS training course in the Philippines. This course was based on IMO Model Course 1.27[1] with a duration of 40 hours. No training or familiarisation on the type of ECDIS fitted on board *CSL Thames* had been provided by the ship's management company (Alfa Ship & Crew Management GmbH) or by previous employers. There is currently no mandatory requirement for bridge officers to receive such 'equipment specific' training, and reliance is placed on the vessel's

[1] The IMO Model Course 1.27 on the Operational Use of Electronic Chart Display and Information Systems is regarded as a minimum requirement to receive an ECDIS certificate.

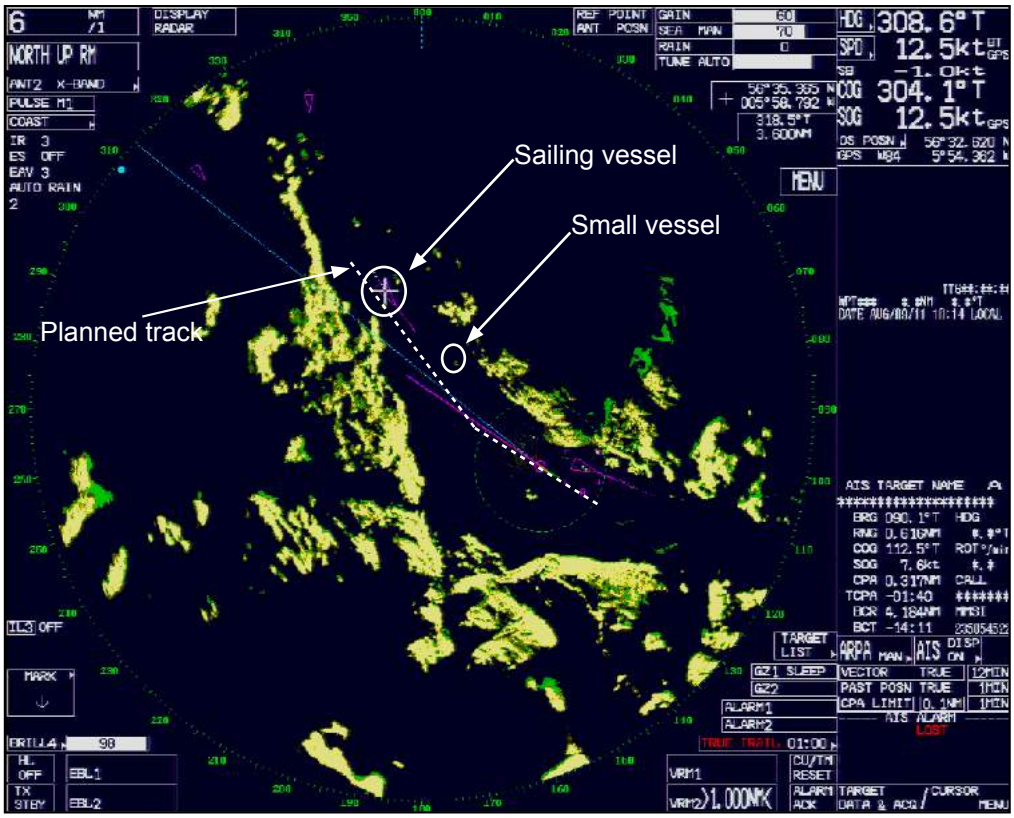

Figure 3: Radar display at 1014 - overlaid with planned track

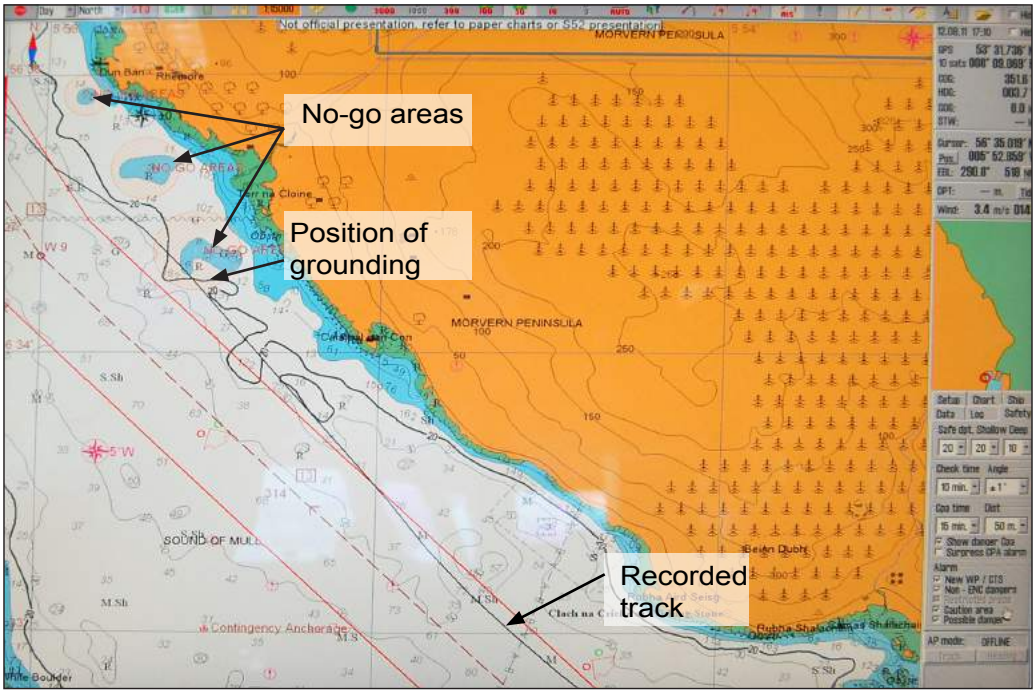

Figure 4: ECDIS display showing recorded track

technical management company to provide familiarisation training in compliance with the ISM Code. However, for UK registered vessels, the MCA, through its Marine Information Note 405[2], has clarified what generic and 'equipment specific' training it regards as acceptable. The company had not provided any instructions or guidance on the use of the ECDIS fitted to *CSL Thames*.

The third officer

The third officer, a Phillippines national, started his sea career as a deckhand in 1990. In November 2008, he obtained his first watchkeeping certificate of competency (STCW II/I officer of a watch[3]),and was promoted to the rank of third officer in October 2009. Since then, he had served a total of about

[2] Training for ECDIS as Primary Means of Navigation, available at www.dft.gov.uk/mca/min_405.pdf

[3] STCW: International Convention on Standards of Training, Certification and Watchkeeping (as amended 1995).

15 months as officer of the watch on four different vessels, including *CSL Thames*, which he had joined in March 2011.

ANALYSIS

The grounding

The following events were significant leading up to the grounding of *CSL Thames*:

- The third officer prematurely initiated a turn to starboard before *CSL Thames*'s next planned waypoint and then continued to alter course to starboard for collision avoidance purposes.
- After initiating the course alteration, the third officer did not monitor *CSL Thames*'s position and projected track on the ECDIS display.
- The third officer did not see the activated anti-grounding warning zone alarm on the ECDIS display.
- The ECDIS audible alarm did not function.

The safety issues arising from these events are considered below.

Action to avoid collision

The third officer's decision to prematurely initiate a turn to starboard before *CSL Thames*'s next waypoint was based on an assumption that the sailing vessel would follow an approximately reciprocal course to *CSL Thames*'s next planned course. He perceived that the planned alteration of course would result in the two vessels being placed at risk of collision, and therefore he opted to alter course early to keep to the starboard side of the Sound. Soon afterwards, he acquired the sailing vessel's AIS target on the radar display bearing 318.5º (T). This required him to alter *CSL Thames*'s course further to starboard than originally intended to bring the sailing vessel onto *CSL Thames*'s port bow. The third officer then saw another small vessel ahead, which he presumed to be crossing from starboard to port. In again opting to leave this vessel to port, the third officer altered course further to starboard and onto a track that would cause *CSL Thames* to run aground within 10 minutes.

A course alteration to starboard might have been an appropriate action in open sea conditions. However, the third officer had prematurely initiated the turn to starboard in an area of restricted sea room, and the vessel was already heading further to starboard than the planned course. This should have prompted him to confirm *CSL Thames*'s current position and projected track before deciding on an appropriate action.

The third officer was required by Rule 7 of the COLREGS[4] to determine if a risk of collision existed before taking action. Analysis of *CSL Thames*'s radar recording indicates that, had the third officer followed the planned track in accordance with the passage plan, the other two vessels would have passed clear on her starboard side **(Figure 3)**.

Position monitoring

The third officer was unaware that *CSL Thames* was heading into danger. He had last looked at the ECDIS display immediately before initiating *CSL Thames*'s turn to starboard at 1010. The ECDIS display anti-grounding warning zone alarm activated at about 1018. However, the focus of the third officer's attention was on collision avoidance, and involved him looking ahead through the bridge windows and monitoring the radar display.

While the third officer relied on the ECDIS as the primary means of navigation, he did not appreciate the extent to which he needed to monitor *CSL Thames*'s position and projected track in relation to the planned track and surrounding hazards. The ECDIS display was orientated so that the OOW had to face to starboard to look at the screen **(Figure 2)**. Although this might have been ergonomically satisfactory for routine navigational watchkeeping, the third officer's overriding priority during the period leading up to the accident was collision avoidance, which required him to look ahead. Had the ECDIS display been located in front of him, he would have been more likely to routinely consult it when monitoring the navigational situation.

Traditional navigational techniques require an officer of the watch to regularly plot a series of historical positions on a paper chart from which to project the vessel's track. The ECDIS display provided the third officer with an ability to immediately identify the vessel's current position and projected track at any time without the need for regular plotting. Furthermore, the third officer was aware the ECDIS anti-grounding warning zone feature was designed to automatically determine and alarm if the vessel was running into danger.

[4] The International Regulations for Preventing Collisions at Sea 1972 (as amended)

Consequently, he felt no obligation to check the vessel's position and projected track during the 15-minute period leading up to the grounding.

ECDIS

A safety contour setting of 10 metres was inappropriate for *CSL Thames*'s draught of 10.63 metres. Taking into account the height of tide of 1.4 metres and an estimated squat of 0.9 metre, the vessel would have grounded at a charted depth of 10.13 metres, before crossing the safety contour. Although the ECDIS anti-grounding warning zone visual alarm activated, the audible alarm, which should have alerted the third officer to the fact that *CSL Thames* was heading into danger, did not function. This was because the ECDIS unit was not connected to a loudspeaker or buzzer capable of sounding an audible alarm, contrary to the IMO's performance standards[5].

The ECDIS on board *CSL Thames* was originally configured to alarm through the bridge alarm monitoring system but this was found disconnected following the accident. On joining *CSL Thames*, neither the master nor the other bridge officers had questioned the absence of an ECDIS audible alarm.

Despite having attended training courses that met the standards of the IMO model course for ECDIS, *CSL Thames'*s master and bridge watchkeepers lacked an understanding of the ECDIS equipment's safety features and/or their value. ECDIS provides the officer of the watch with an efficient and effective means of navigation. However, its ability to continuously provide the vessel's current position and projected track, and to warn of approaching dangers, can lead to over-reliance and complacency. The officer of the watch still needs to monitor the vessel's position and projected track at regular intervals and to fully understand the equipment's safety features in order to make best use of them.

The above shortfalls can be addressed through equipment-specific training and onboard instructions and guidance.

Bridge team management

During the period leading up to the grounding, the third officer remained confident that he was in control of the navigational situation, and felt no need to defer to the master. However, at 1021, he was sufficiently concerned about the intentions of the small vessel ahead of *CSL Thames* that he sounded the ship's whistle. The master was sitting at the communications centre at the rear of the bridge and the activation of the ship's whistle should have alerted him to the developing situation. Had he taken more interest in the navigational situation faced by the OOW, he might have been prompted to challenge the third officer's actions, particularly as a sound signal of two long blasts has no meaning in the COLREGS in respect of collision avoidance in clear visibility. The master may then have identified that *CSL Thames* was running into danger and taken remedial action.The Sound of Mull is a regular route for coastal traffic and does not pose a challenge for small vessels. However, *CSL Thames* was a large vessel and required careful navigation in view of the restricted sea room and the likelihood of her encountering other traffic. The master was confident of the third officer's abilities and, on handing him the con, was content for him to navigate alone. However, his confidence was misplaced. The third officer lacked experience and, given the navigational demands of the passage, needed the support of the master, who should have avoided sending the routine departure messages until *CSL Thames* was clear of the Sound.

Bridge environment

The master routinely encouraged music to be played on the bridge, and the volume was particularly loud during the period leading up to the grounding. Loud music can impair the keeping of a proper lookout as required by Rule 5 of the COLREGS. Had the ECDIS audible alarm been functioning, it might still not have been heard by the third officer due to the background noise pollution provided by the loud music.

Post-accident actions

Following the accident, *CSL Thames*'s bridge team did not use the grounding checklist or record the times of follow-up actions taken on board, contrary to the company's instructions. Although most of the required actions specified on the checklist were carried out, some important items were missed: sounding the general alarm, stopping the vessel after clearing the immediate danger to establish the extent of damage, and checking the vessel's damage stability and strength.

The master was keen to establish the extent of damage to No 3(P) ballast deep tank. Before the tank was entered, he reduced the vessel's speed to 9 knots. However, no risk assessment was

[5] International Maritime Organization (IMO) MSC.232(82) and International Electrotechnical Commission (IEC) 61174 ed.3/4).

undertaken, particularly with regard to the potential consequences of opening a breached tank. As the ballast pump was capable of stemming the inflow of water, tank entry was an unnecessary risk. An assessment of the rate of water ingress should have been sufficient for the master to decide whether to continue on passage or to divert to a nearby port for assistance and further assessment.

CONCLUSIONS

1. The third officer's decision to prematurely initiate a turn to starboard before *CSL Thames*'s next waypoint was based on an assumption that the sailing vessel would follow an approximately reciprocal course to *CSL Thames*'s next planned course.

2. Analysis of *CSL Thames*'s radar recording indicates that, had the third officer followed the planned track in accordance with the passage plan, the other two vessels would have passed clear on her starboard side.

3. Had the ECDIS display been located in front of him, the third officer would have been more likely to routinely consult it when monitoring the navigational situation.

4. The third officer did not detect activation of the anti-grounding warning zone visual alarm because he was not monitoring the ECDIS display.

5. The ECDIS anti-grounding warning zone audible alarm, which should have alerted the third officer to the fact that *CSL Thames* was heading into danger, did not function.

6. The ECDIS safety contour setting was inappropriate for *CSL Thames*'s draught at the time of the accident, and neither the master nor the other bridge officers had questioned the absence of an ECDIS audible alarm. This indicates a lack of understanding of the equipment's safety features and/or their value.

7. The master's confidence in the third officer's abilities was misplaced. The third officer lacked experience and, given the navigational demands of the passage, needed the support of the master.

8. Even if the ECDIS audible alarm had been functioning, the third officer might not have heard it over the loud music being played on the bridge.

9. Following the accident, *CSL Thames*'s bridge team did not use the available grounding checklist or record the times of follow-up actions taken on board. This resulted in some important actions not being taken.

10. No risk assessment was undertaken before No 3(P) ballast deep tank was entered to assess the extent of damage. As the ballast pump was capable of stemming the inflow of water, tank entry was an unnecessary risk.

ACTIONS TAKEN

Alfa Ship & Crew Management GmbH has:

- Repositioned the main ECDIS unit adjacent to the starboard radar to enable the officer of the watch to view the display while facing forward.

- Reconnected the ECDIS unit to the bridge alarm monitoring unit to provide a functioning audible alarm.

- Arranged for *CSL Thames*'s bridge officers, and the management company's DPA and nautical superintendent to attend an 'equipment specific' training course on the ECDIS type fitted on board.

- Arranged for the fleet's bridge officers to attend a bridge resource management course.

- Arranged for the nautical superintendent to provide onboard ECDIS training to the fleet's other vessels fitted with ECDIS or electronic charts.

RECOMMENDATION

Alfa Ship & Crew Management GmbH is recommended to:

2012/102
Introduce written instructions and guidance to its fleet and carry out verification visits to its vessels as necessary to ensure that:

- Its bridge watchkeeping officers have a clear understanding of how ECDIS should be used on board the company's vessels, and

- its officers and crew understand the vessel's emergency procedures, and the need to properly evaluate routine operations after an accident to ensure that any new risks are identified and mitigated as appropriate.

SHIP PARTICULARS

Vessel's name	*CSL Thames*
Flag	Malta
Classification society	American Bureau of Shipping
IMO number	9440447
Type	Bulk Carrier
Registered owner	Pelican Water Investments Ltd
Manager(s)	Alfa Ship & Crew Management GmbH
Construction	Steel
Length overall	175m
Registered length	170.12m
Gross tonnage	19538
Minimum safe manning	16
Authorised cargo	Bulk

VOYAGE PARTICULARS

Port of departure	Glensanda, Scotland
Port of arrival	Wilhelmshaven, Germany
Type of voyage	International
Cargo information	Aggregates
Manning	19

MARINE CASUALTY INFORMATION

Date and time	9 August 2011, 1025 (UTC +1)
Type of marine casualty or incident	Serious Marine Casualty
Location of incident	Sound of Mull – 56º34.3'N, 005º57.2'W
Place on board	Bridge
Injuries/fatalities	None
Damage/environmental impact	Bottom damage including a 3-metre fracture to No3 (P) deep ballast tank
Ship operation	Normal operation
Voyage segment	Mid-water
External & internal environment	Wind: WNW force 4 Visibility: Good Tide: Low watwer at 0939 (UTC+1) Height of tide: 1.4 m
Persons on board	19


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