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Digital navigation: old skills in new technology

Lessons from the grounding of the Nova Cura

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The Hague, September 2017

Photo cover: Dutch Safety Board

The Dutch Safety Board

When accidents or disasters happen, the Dutch Safety Board investigates how it was possible for them to occur, with the aim of learning lessons for the future and, ultimately, improving safety in the Netherlands. The Safety Board is independent and is free to decide which incidents to investigate. In particular, it focuses on situations in which people's personal safety is dependent on third parties, such as the government or companies. In certain cases the Board is under an obligation to carry out an investigation. Its investigations do not address issues of blame or liability.

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N.B:

This report is published in the Dutch and English languages. If there is a difference in interpretation between the Dutch and English versions, the Dutch text will prevail.

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INTRODUCTION

On 20 April 2016, the Dutch freighter Nova Cura was en route from Eregli on the Black Sea (Turkey) to Aliaga (Turkey). The ship was loaded with 4,400 tonnes of steel products. At 09:55[1] hours the Nova Cura ran aground in Mytilini Strait (to the north of Lesbos) at operating speed. As a result, all of the double-bottom tanks were breached and filled with water, as was the engine room and the bow thruster room. The ship was a total loss.

Figure 1: The Nova Cura grounded in Mytilini Strait (Greece). Source: Dutch Safety Board

The digital chart in the ECDIS (Electronic Chart Display and Information System, see blue box on page 6) indicated that the sea should be 112 metres deep at the ship's position. However, the ship appeared to have run aground in shallow water at Lamnas Reef.

The investigation aims to answer the following question:

1. How could the Nova Cura run aground, while the digital chart indicated that the sea in that position should be 112 metres deep?
2. Which structural safety deficiencies that can be improved reveals the investigation into the incident with the Nova Cura?

This accident is classified as a very serious accident as referred to in the Casualty Investigation Code of the International Maritime Organization (IMO) and EU Directive 2009/18/EC. This means that the Netherlands, as the vessel's flag state, is obliged to ensure that an investigation is conducted. This investigative duty is also set out in the Dutch Safety Board Decree. Immediately after the accident, investigators have travelled to the accident site.

1 All times in this report are local times. Greece = UTC+2

1 THE ACCIDENT

On the day of the grounding, 20 April 2016, the Nova Cura was en route from Eregli (Turkey) to Aliaga (Turkey) carrying 4,400 tonnes of steel products. This gave the ship a draft of 5.80 meters.

Figure 2: Overview of the planned route. Source: Google Earth

Eregli is at the Black Sea. To go to Aliaga the Nova Cura had to pass the Bosporus to the Sea of Marmara and afterwards via the Dardanelles to the Aegean Sea (see figure 2). The passage planning had been done by the second mate before departure. A so-called Electronic Chart Display and Information System (ECDIS, see blue box) was being used on the Nova Cura for navigation.

ECDIS – Electronic Chart Display and Information System

ECDIS is a navigation-information-system with an adequate back up facility that meets the standards of the International Maritime Organization (IMO): IMO Resolution A.817(19)). In particular, an ECDIS meets the requirements of an accurate chart according to the SOLAS[2] Convention of 1974 (V/19 and V/27). An ECDIS allows electronic nautical charts to be used for route planning and route monitoring. In 2002 IMO has accepted the ECDIS as a subsitute for the paper navigational charts to meet the SOLAS obligation to carry all, for the voyage, relevant paper charts. With this ECDIS can be the digital successor for navigation with paper charts. The ECDIS integrates different systems to provide real-time information about the position of the vessel, charted objects, navigation objects and submerged hazards. The information integrated in ECDIS includes position information from the GPS, the gyro compass and the ship's log. In addition to this, ECDIS can display additional navigation-related information and instructions in an overlay, such as radar, echo sounder and the automatic identification system (AIS).

In June 2009 IMO has changed the SOLAS convention and certain ships will be obliged to use ECDIS. From 1 July 2012 onwards, the obligation to use ECDIS was introduced in phases, distinguishing between the type of vessel, size (in GT) and year of build of the vessels (new or pre-existing). An overview is shown in appendix B.

The Nova Cura was certified to use the ECDIS[3] alone for navigation, so for that reason it only needed a small portfolio of paper charts on board. The original destination of the Nova Cura was Izmir (Turkey). First of all, the second mate checked which digital charts he required and whether any updates were available in the ECDIS. Then he read the Pilots for the next port, volume 6[4] of the Admiralty List of Radio Signals (ALRS), and assessed the relevance of the Navtex messages. The Navtex messages were digitised and the temporary and preliminary messages were automatically included. Following this, he roughly plotted the route in the ECDIS first, after which he zoomed in to plan it in more detail. On 19 April 2016 the second mate plotted the route in the ECDIS and had earlier already ordered the digital charts required for the route. The plotted route ran along the west of the island of Lesbos (Greece), see the black line in Figure 3.

During the voyage to Izmir it became clear that the Nova Cura had to go to Aliaga instead of Izmir to load a container destined for Lisbon. During 19 April, when it became clearer what the expected arrival time of the ship in Aliaga would be, it was reported that the container would be loaded right away if the vessel arrived in Aliaga before 16:00 hours. If not, the container would be put on board the next day. The shortest route to Izmir (see Figure 2) was to pass west of Lesbos, as the second mate had planned. But zooming in it seemed that the route north of Lesbos was the shortest route to Aliaga , it was two hours

2 Safety Of Life At Sea.
3 Due to its size (3999 GT) this was not mandatory.
4 Volume 6 includes information about pilot support, Vessel Traffic Services and port information.

less sailing. In response the captain altered the route, so that container could be loaded in Aliaga that same day. He did not redo the passage planning for this new route. A new chart in ECDIS was not required, because the most suitable chart (GR4APP01) was already available in the ECDIS.

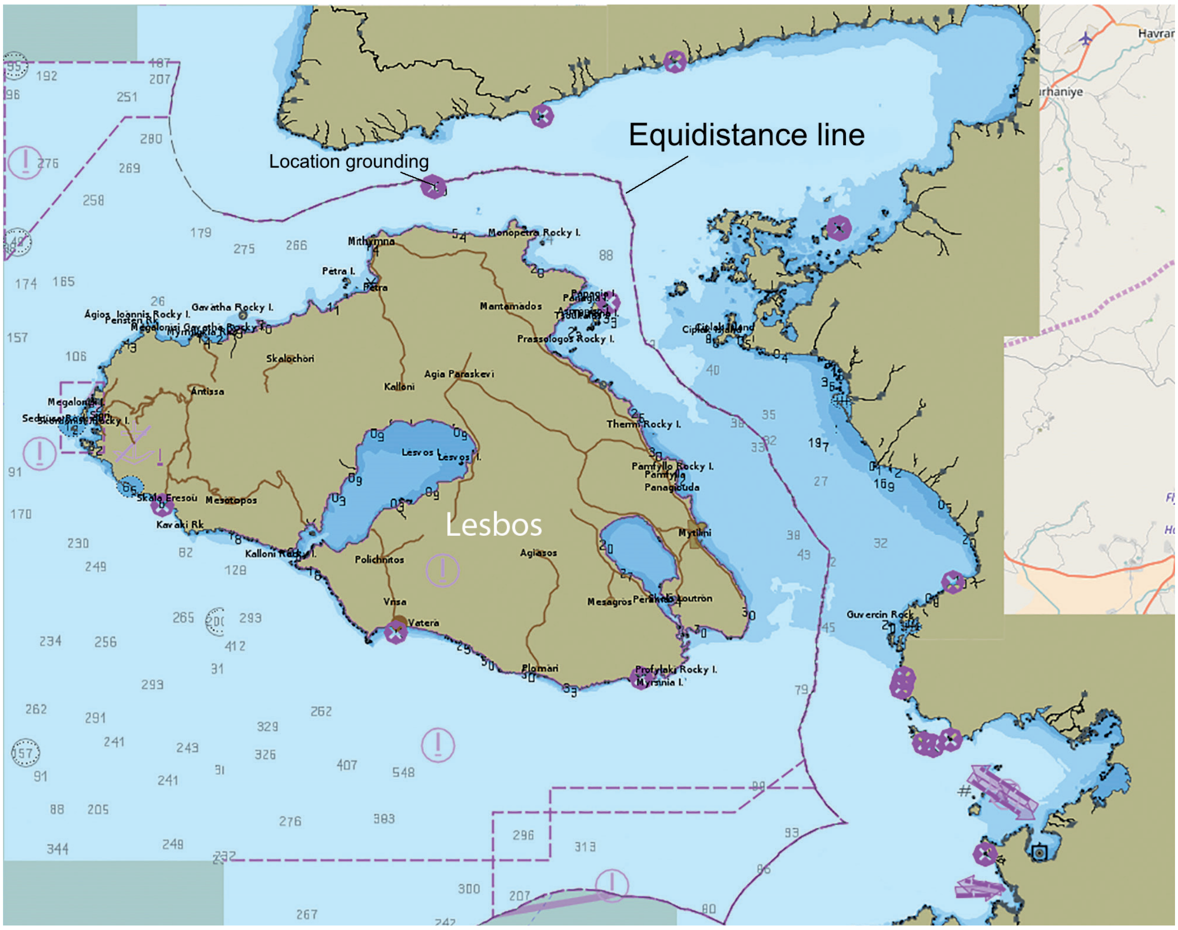


Figure 3: Route to Aliaga north of Lesbos (red), route to Izmir west of Lesbos (black). Source: GR4APP01

In the morning of the vessel running aground (20 April 2016), the first mate took over the watch from the second mate at 04:00 hours. At that time the vessel was sailing through the Dardanelles, a strait connecting the Sea of Marmara and the Aegean Sea. The captain had written orders in the watch order book and until 06:00 hours (during the dark hours) there was, next to the officer of the watch, an additional lookout present on the bridge. Shortly before the first mate would hand over the watch to the captain at 08:00 hours, the first mate zoomed out on the ECDIS to prepare for the watch handover. Among other things, he checked the planned courses in Mytilini Strait. The first mate saw that the waypoint was close to marked shallow water in Mytilini Strait and believed it had been planned too close to this shallow water. The first mate did not move the waypoint, but pointed it out to the captain during the handover.

At 08.00 hours that morning the captain took over the watch. The first mate drew the captain's attention to the waypoint close to the shallow water and in consultation the captain moved the waypoint to the south (from 415 metres to 500–600 metres). The first mate left the watch and the captain stayed on the bridge and concentrated on the navigation.

At around 09:50 hours the captain went to the coffee machine on the bridge to prepare the coffee. It was common practice for the crew to drink coffee on the bridge at 10:00 hours and discuss the work for that day.

At 09:55 hours a heavy vibration went through and the Nova Cura came to a full stop. The ECDIS screen indicated a water depth of 112 metres at that position. The captain immediately moved the telegraph into the neutral position, setting the thruster's pitch to zero. This eliminated the thrust generated by the thruster. It quickly became clear that the vessel had to have run aground. This was confirmed when the captain looked into the water from the bridge wing. The rocks were visible through the clear water from the bridge wing, see Figure 3.

Figure 4: The rocks were visible from the bridge wing of the Nova Cura. Source: Crew Nova Cura

The fore of the Nova Cura extended beyond the shallow water, but from the midship to the stern the Nova Cura was sitting on top of a rock. The ECDIS still indicated that the water depth in that location had to be 112 metres and that the shallow water was about 0.2 nautical miles – about 400 meters - further north (port side) of the vessel.

When the captain realised that the vessel had run aground from the midship to the stern, he sounded the general alarm and the crew came to the bridge. The captain ordered the second mate to let the main engine be stopped urgently. The second mate met the chief engineer on his way down and told him to stop the engine as ordered by the captain. When everyone had arrived back on the bridge, the captain stopped the general alarm.

At that time the captain had informed the Greek Coastguard about the ship running aground, and the coastguard vessel immediately left the port en route to the accident.
On board the Nova Cura the crew then tried to determine the damage. A screen on the bridge showed that the double-bottom tanks, fitted with digital sensors, were filling up with water. The chief engineer reported that a lot of water was also running into the engine room. After the captain had had the ballast tanks gauged and had had the water depth around the vessel determined, it became clear that the stern was lying stable on the rock from the midship down.

Fifteen minutes after running aground, the Greek Coastguard arrived on site. De captain was under the impression that the Greek Coastguard wanted to start pumping water out of the ship using small portable pumps. The captain didn't want this because he wanted to prevent at any cost that water polluted with oil from the engine room would end up in the water outside. Additionally, he believed that the stern with the water present would be more secure in the shallow water, preventing the vessel from moving away from the shallow water after all and possibly sinking.

In consultation with the Greek Coastguard, the captain considered whether the crew had to be evacuated. In addition, the captain informed the authorities about the situation. Investigators from the Dutch Safety Board travelled to the accident site to conduct an investigation.

Until about one week after the accident the entire crew remained on board. When a storm passed over the area, the crew was eventually evacuated by helicopter, apart from the captain. By that time, the bunkers had been removed from the vessel. The waves created by this storm caused the vessel to move on the rock. This damaged the vessel even further and eventually the hold was also breached. The cargo was removed from the hold and a number of leaks were temporarily sealed. When the vessel had been unloaded and was afloat again, the Nova Cura was towed to Piraeus. There the vessel was inspected and declared a total loss. The vessel was sold for demolition and still ended up in Aliaga in the end, to be demolished.

2 BACKGROUND INFORMATION

This chapter contains the background information that was used to analyse this accident. The background information comprises general information, such as the development of nautical charts and making preparations for the voyage and specific information such as the location where the ship ran aground, the contents of the various nautical charts of the area and information on the ship and crew.

2.1 How are nautical charts made?

The tools used for navigation include nautical charts. Traditionally nautical charts were made of paper, but nowadays they are also available in digital format (electronic charts). The SOLAS Convention of the International Maritime Organization (IMO) states, among other things, that coastal states must chart their waters. In the Netherlands this is carried out by the Hydrographic Service of the Dutch Royal Navy. The Hellenic Navy Hydrographic Service is responsible for charting Greek waters.

Hydrography
Hydrography entails measuring the depth and composition of the water and the seabed, and depicting this in nautical publications and (digital) nautical charts. In the Netherlands, the Hydrographic Service (part of the Dutch Royal Navy) is responsible for performing this task. The depth and composition of the water and the seabed are measured using a so-called hydrographic survey vessel. Other countries also carry this out in a similar manner.

Official charts and books for international commercial shipping must be legible for mariners worldwide. That is why they have the same format and naming, among other things. The same symbols are also used, e.g. for lighthouses, obstacles and depths. The International Hydrographic Organization (IHO) sets the specifications in the *Chart Specifications of the IHO*.

International Hydrographic Organization (IHO)
The IHO is an international organization, the aim of which is to ensure that all the world's seas, oceans and navigable waters are inspected and charted. The IHO's mission is to create a worldwide environment in which member states supply adequate hydrographic data, products and services in a timely manner, and to ensure that they are used as widely as possible. The IHO's vision is to be a worldwide hydrographic authority that encourages all coastal states and other parties involved to promote maritime safety and efficiency, which benefits the protection and the long-term use of the maritime environment. Eighty-two member states[5] are affiliated with the IHO, including Greece and Turkey. Each member of the IHO is required to chart its own waters and to keep this data up to date.

These *Chart Specifications* apply to electronic and paper products. But there is a difference between the publication of paper and electronic nautical charts.

Publication of paper nautical charts
Official paper charts that meet the IHO specifications may be given a unique international INT number. Hydrographic services can then use each other's charts to make their own charts. They may also modify them for their own purposes if required (e.g. changing the language). They then publish the chart under their own national number. The INT number is also stated in purple.

The Netherlands is one of the member states that publishes many international charts, but it also copies INT charts from other member states. Paper nautical charts therefore extend beyond national borders and production of these charts is not limited to the country whose waters are involved.

Publication of digital nautical charts
There are two kinds of digital charts, the Electronic Navigational Chart (ENC) and the Raster Navigational Chart (RNC). An ENC may only be produced by or on behalf of the country whose waters are involved. This is in contrast to an RNC. An RNC is a raster chart and basically a scanned paper nautical chart. This is why an RNC looks the same as the paper nautical chart. An RNC has the same worldwide coverage and accuracy as the paper nautical charts. When zooming in too far on an RNC, the pixels of the scan become visible, reducing the reliability. In addition, the objects in the chart do not scale when zooming in, so the objects no longer match the scale of the chart. This can create strange images.

An ENC is a vector chart. Contrary to an RNC, all the elements in a vector chart are stored separately. This makes it possible to create an ENC using so-called layers. The coastlines, buoys, lights, etc. and their characteristic properties, such as position, colour and shape, are stored in a database and these details can be selectively visualised. The appearance of the digital chart displayed on ECDIS may differ greatly fromthe traditional nautical chart. Independently storing information in a database and the possibility to

5 In 2016.

combine it with overlays and other information sources allows an ECDIS presentation to be personalised. This way the user can determine what information is visible. The ENC information itself is bound to a minimum standard of presentation per usage band (scale), like shallow waters and dangerous wrecks. These are entered by certification requirements for safe navigation.

For Dutch vessels using paperless navigation, no RNC may be used if a suitable ENC is available for an area.

2.2 Development of an Electronic Navigational Chart (ENC)

In 2002 the IMO accepted ECDIS as a way to meet the obligation of having on board the relevant nautical charts for the journey (as laid down in SOLAS V/19). Every country that signed the SOLAS Convention is thereby required to produce ENCs for their waters.

The process of creating a digital nautical chart can roughly be divided into five steps as follows:

1. Gathering data
2. ENC production
3. ENC validation
4. ENC distribution

Data gathering and production
The gathering of data for an ENC can be carried out in two ways: 1. by charting the seabed using a hydrographic survey vessel (gathering new data), or 2. by using the data from a paper chart (re-use of old data). If in this case data from a paper chart is used, this does not involve scanning the chart (which is done for a raster chart), but it involves digitising all the elements of the chart to create a vector chart from it. The second method is mainly used for areas that are not given priority for recharting by the hydrographic service (e.g. based on a risk assessment in relationship with the (scarce) capacity of survey vessels).

At the hydrographic service the data is converted to allow it to be displayed in an ECDIS. The IHO has set up a standard for this, S-57 (IHO Transfer Standard for Digital Hydrographic Data). It includes quality standards for the data. The creator of an ENC (the hydrographic service) determines the quality of the data that is used to create the ENC and thus the reliability of the ENC. The reliability of an ENC is expressed in the Category of Zone of Confidence in data (CATZOC or Zone of Confidence[6]). All areas within an ENC have their own CATZOC. CATZOC's give with this a general view on the condition of the hydrography. Next to this the CATZOC's help the user to plan and monitor a safe navigation route. The CATZOC is highly important, as some ENCs may contain an area within which the charted positions may deviate more than 500 metres, or have even been

6 An overview of the various CATZOCs is featured in Appendix C.

given the designation 'unassessed'. The designation 'unassessed' means that the reliability of the data used has not been determined.

Whereas the CATZOC provides the user information on the reliability of the data used, the ENC pick report provides the user with information on the history of the ENC, such as the survey year, the type of survey, changes and the latest updates. The pick report can be retrieved for any position on the chart.

Validation of the ENC

The hydrographic service of a country sends the ENC to one of the two[7] so-called Regional ENC Coordinating Centres (RENCs) for validation. An RENC supports the affiliated hydrographic services in of the production and distribution of ENCs.

The validation is not a content-specific test for correctness of the displayed information, but is mainly aimed at verifying whether the charts comply with an agreed standard and are consistent in the different scales. Also whether there are any gaps in the data and whether the connection and overlap of two neighbouring ENCs show anything special. If there are any discrepancies in the transition and/or overlap of ENCs, this is reported to the country that produced the ENC. If some of the data overlaps but the ENC does comply with the S-57 standard, the producing country can decided for the ENC to be included in the database. As a result, ENCs may be used that do not match up properly or have overlaps. The RENC will make notice of this, for example to the distributors of the ENC's.

Distribution

An ENC that has been included in the database by an RENC is sent to the affiliated chart agencies that distribute the ENCs, so-called Value Added Resellers (VAR). This system was chosen to prevent every country from having to set up its own distribution network. A VAR is a commercial party that distributes the ENCs for several countries. A VAR may not change an ENC, but it may add an additional layer of information, an 'overlay'. In the ECDIS system the user can choose to 'enable' or 'disable' the overlay. Whether an overlay is available or what the content of the overlay is depends on the VAR distributing the ENC.

Finally, an ENC goes from a VAR (sometimes via a VAR distributor) to the user, to be loaded in the ECDIS. To encounter abuse of the data the ENC is often delivered with an encryption in accordance with the S-63 standard. In case the VAR/VAR-distributor is an ECDIS manufacturer it can modify the appearance of the ENC to ensure the best possible view in the manufacturer's ECDIS device. The ENC then becomes a Sysem ENC. In terms of content, a System ENC is no different from an ENC, but is optimised for display in a specific ECDIS system of the ECDIS manufacturer concerned. Currently, around 38 different ECDIS systems are available on the market.

7 See Appendix D.

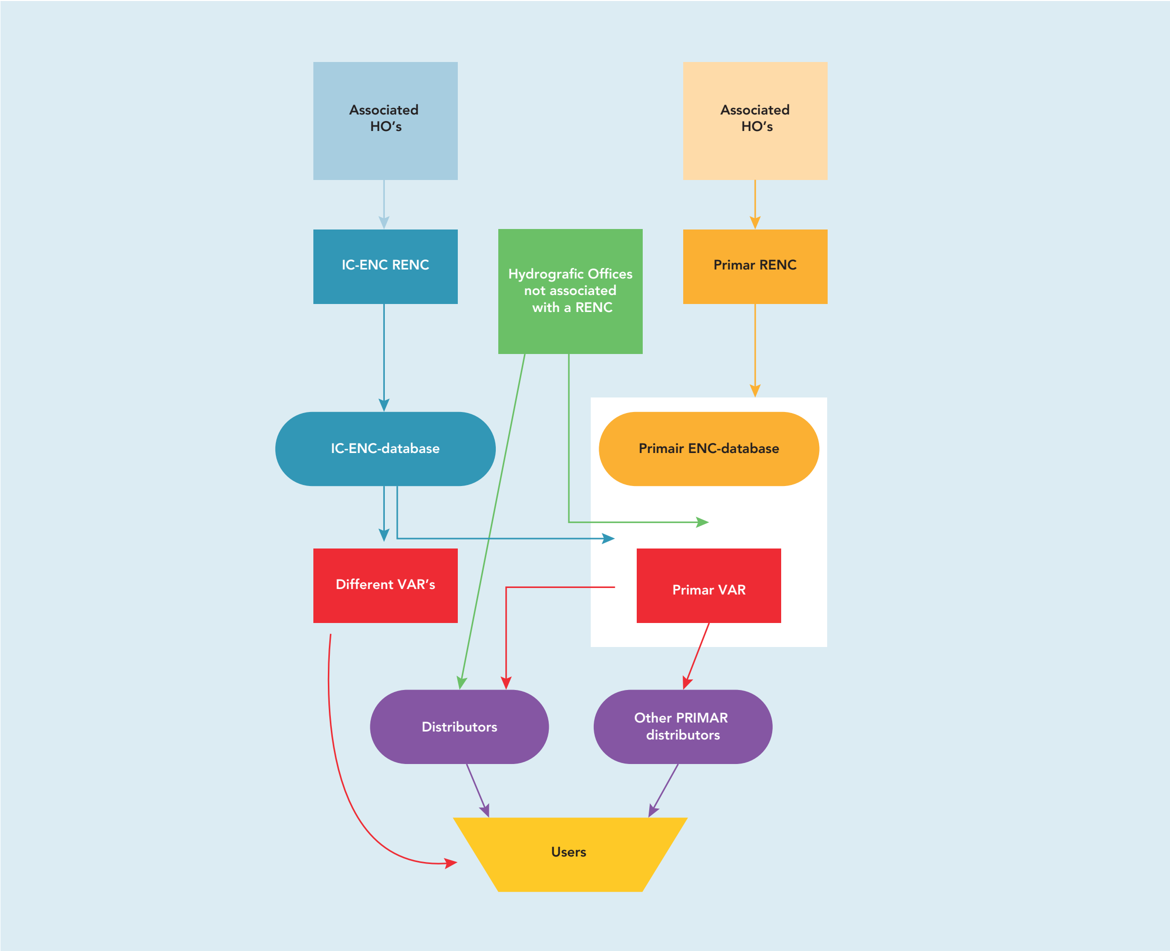


Figure 5: The process of developing digital nautical charts with the actors involved. [8]

2.3 Available nautical charts of Mytilini Strait, the accident site

Mytilini Strait

Lamnas Reef is a shallow area located in Mytilini Strait. Mytilini Strait is a waterway that forms the border between Turkey and Greece (near the Greek island of Lesbos), see Figure 6. Lamnas Reef is located partly in Greek waters and partly in Turkish waters.

8 https://www.iho.int/mtg_docs/com_wg/WEND/WENDWG7/ENC%20DATA%20FLOW%20v2%20January%202017.pdf

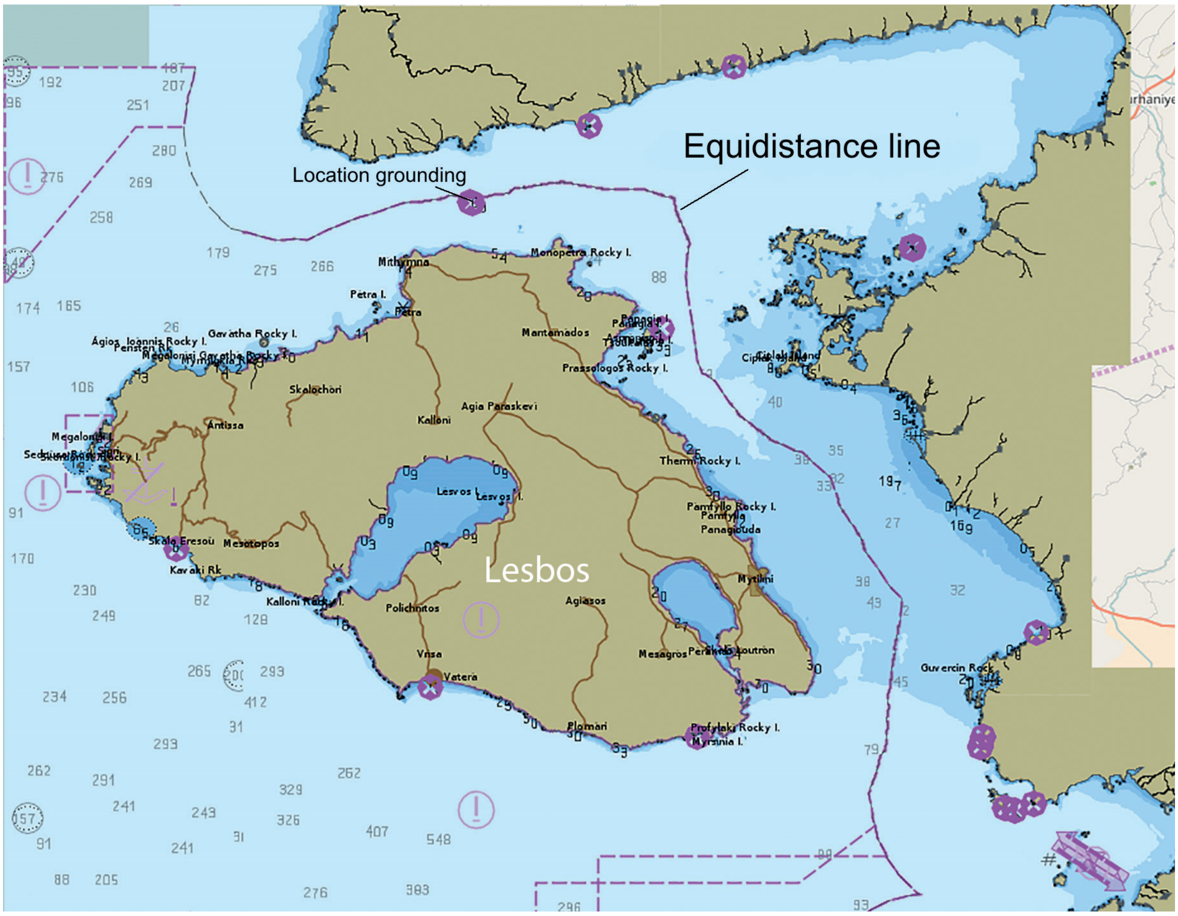


Figure 6: Border between Greece and Turkey in Mytilini Strait. Source: GR4APP01

Hellenic Navy Hydrographic Service

In Greece the Hellenic Navy Hydrographic Service (HNHS) is responsible for the production of Greek paper nautical charts and ENCs.

The HNHS has published a paper nautical chart and an ENC for Mytilini Strait, see Figure 7. The survey of the area was performed in 1967 with the equipment available at that time (analogue). Due to the emerging use of ECDIS and the demand for ENCs, the HNHS produced the first ENC of the area in 2004, based on 1967 data.

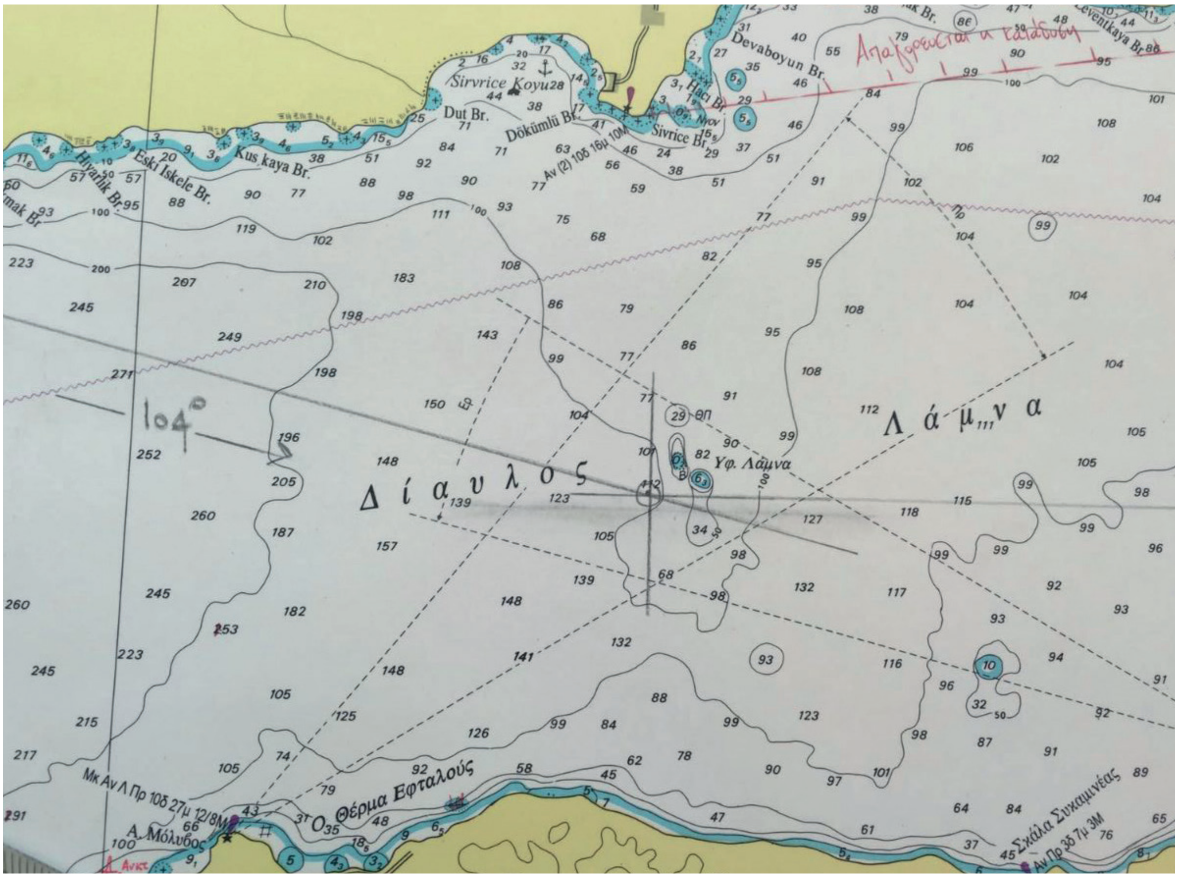


Figure 7: Greek paper nautical chart of the accident site. Source: Crew Nova Cura

The HNHS has four vessels (three large and one smaller vessel). In view of the number of vessels, the HNHS must prioritise areas and has placed emphasis on ensuring the navigability of the major Greek seaports. It was therefore decided to create an ENC based on the Greek paper nautical chart although the data was outdated. This meant that an ENC was available in any case and that the paper and digital nautical charts corresponded to each other.

CATZOC

Due to the age (1967) of the data that was used for the original paper nautical chart (and therefore the ENC), the ENC was designated as CATZOC 'U'. This means that the reliability of the data used has not been determined.

Sector lights

Lamnas Reef was charted with analogue equipment in 1967. The danger associated with Lamnas Reef had been identified by the HNHS at that time. To assist mariners with the passage through Mytilini Strait two sector lights are installed on the Greek island of Lesbos, both of which indicate the danger near Lamnas Reef, see Figure 8.

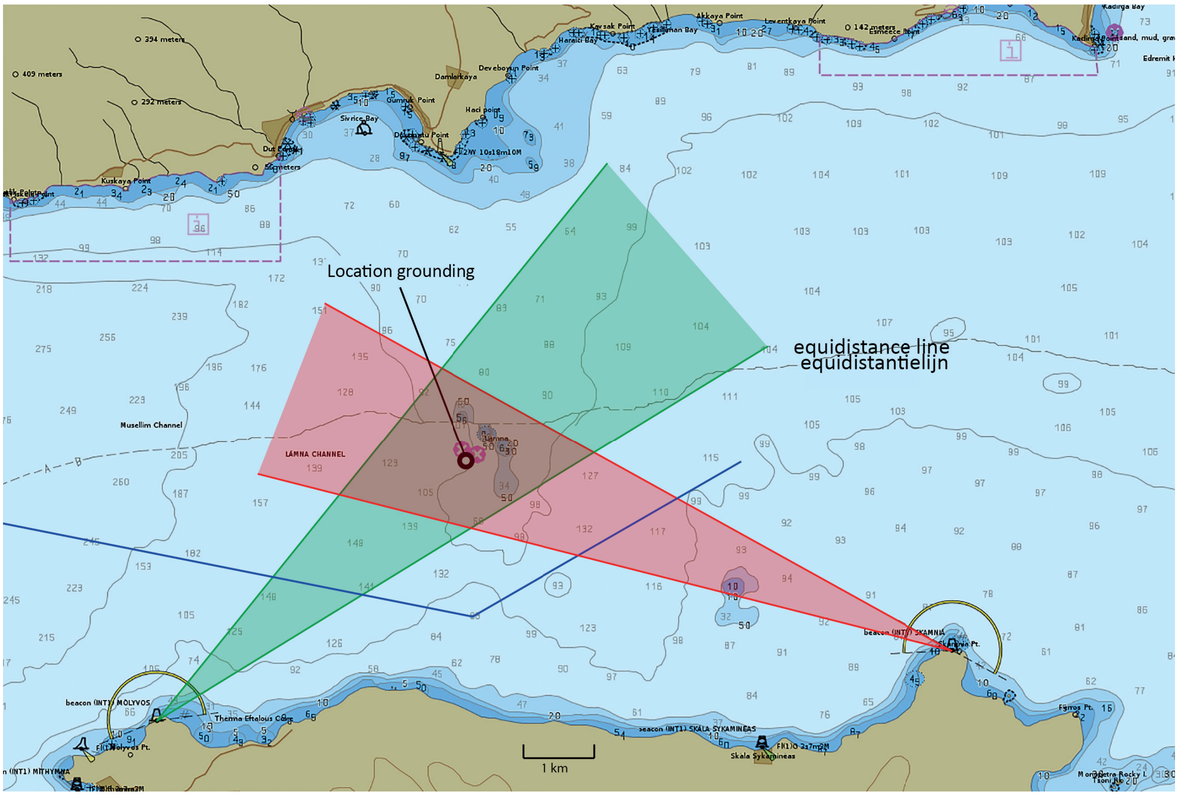


Figure 8: Sector lights in Mytilini Strait. Source: GR4APP01

The sector lights Ák Mólyvos (on the left in Figure 8) and Ák Skamniá (on the right in Figure 8) are both intended to warn of the danger of Lamnas Reef. In this case, the danger is located in the area illuminated simultaneously by both the green and the red sector lights. For the passage south of Lamnas Reef, coming from the west as the Nova Cura had intended (on the left of Figure 8), the vessel should approach in the left white sector of Ák Skamniá (see blue line[9] in Figure 8). Only when the vessel has passed the green sector of Ak Mólyvos, can it go to the port side; in this case both sector lights are white. After that the vessel passes the red sector of Ak Skamniá and has passed Lamnas Reef. The coordinates of the area covered by the sector lights were also stated in the Pilots for the area (NP48). It is not forbidden to sail in the green or red sector of sectorlights.

United Kingdom Hydrographic Office (UKHO)

The UKHO publishes paper nautical charts in the British Admiralty Series through Admiralty Maritime Products & Services. The UKHO copied the Greek paper nautical chart supplemented with the information known to them and published it under number 1061. The chart number is BA1061. The UKHO has satellite images of Mytilini Strait, among other things, and incorporated this information in BA1061, see Figure 9.

9 The blue lines in Figure 8 are for illustration purposes and are not the courses to be followed by definition.

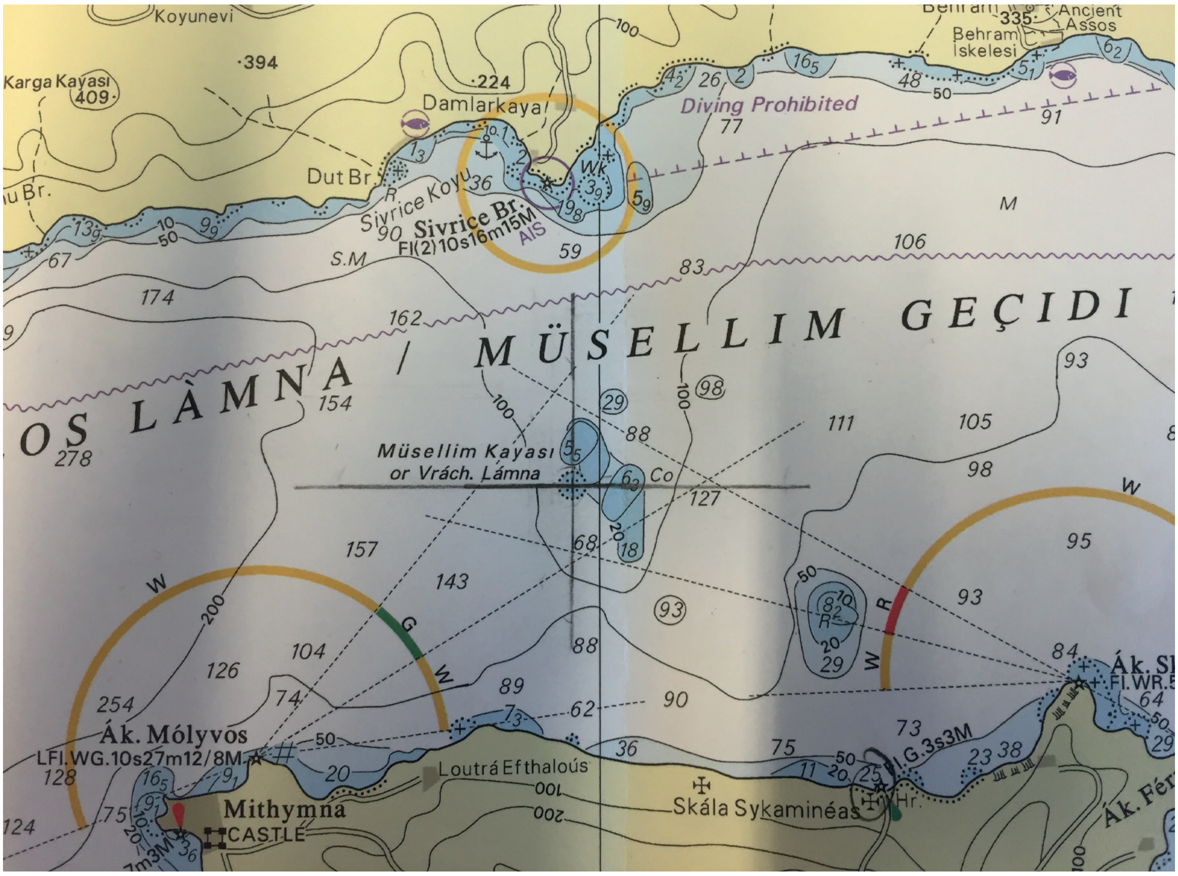


Figure 9: Lamnas Reef in BA1061.

The Admiralty Vector Chart Service[10] (AVCS, the digital Admiralty charts) in 2013 created an Admiralty Information Overlay (AIO)[11] containing the differences between the BA1061 an de the Greek ENC GR 4APP01. The availability of the above AIO in ECDIS depends on the *Value Added Reseller* (VAR) where the ENCs are purchased. The AIO was not available on board the Nova Cura.

2.4 Voyage preparation using ECDIS

Voyage preparation is mandatory and must contribute to safe navigation. The International Maritime Organization (IMO) has set out guidelines to assist the mate or captain when preparing for a voyage. The voyage preparations include preparing for departure from the port, preparing and plotting the route to the next port and preparing for arrival in that next port.

IMO Resolution A.893(21), *Guidelines For Voyage Planning* (see Appendix E), states that all information relevant to the voyage to be undertaken must be taken into account. This also means that the reliability of the nautical charts to be used must be verified. As explained earlier, the various layers of information in ECDIS can be 'enabled' or 'disabled'. The Category of Zone of Confidence (CATZOC) is not visible on the screen by default.

10 https://www.admiralty.co.uk/charts/digital-charts/admiralty-vector-chart-service
11 An additional layer in an ENC, see Production and distribution on page 15

In order to view which CATZOCs the route plotted contains in ECDIS, this layer must be 'enabled' using a menu.

The pick report can be called up for any position in the ENC. The creator of the chart indicates its reliability by means of the CATZOC, but the contents of the ENC cannot be verified by a Regional ENC coordinating centre (see *Data gathering and production*, page 14). The pick report provides the user with information on the history of the ENC, such as the year of survey, the type of survey, changes and the latest updates.

Sector lights are also relevant in preparing for a voyage because they support safe navigation. For sectors lights in ECDIS, sector lines can also be 'enabled' or 'disabled'. If the sector lines are 'enabled', this means that this directly applies to all sector lights stated in the ENC, including those that are not relevant to the route. In the standard display the sectorlights are disabled.

2.5 Ship and crew

The Nova Cura was built in 1999 at Severnav Shipbuilding S.A. in Turnu Severin (Romania) and had been owned by Nova Sea Transport since 2008. The Nova Cura was a freighter with container capacity and sailed under the flag of the Netherlands. The vessel was suitable for worldwide voyages, but mainly sailed in Europe, especially around the Baltic states and in the Mediterranean. See Appendix A for the vessel specifications.

At the time of the accident, the Nova Cura's crew consisted of seven persons. The minimum number of crew members ('minimum safe manning') was six persons. All crew members held the correct certificates of competency. At the time of the accident the captain was keeping watch on the bridge. The captain had already been sailing the Nova Cura for eight years and had 26 years of experience at sea at the time the vessel ran aground.

The Nova Cura had been certified since 2008 for 'paperless' navigation and the officers had taken an ECDIS training course (IMO model course 1.27).

3.1 Position incorrect on the nautical chart used

For the purpose of this investigation, various charts of the area where the ship ran aground were compared with each other, i.e. two paper nautical charts and one digital nautical chart. One of the paper charts and the digital nautical chart (both Greek) correspond to one another, because they were based on the same Greek information source. The other paper nautical chart (British Admiralty) shows deviant information.

The position of Lamnas Reef was found to be incorrectly stated on the Greek charts.

Figure 10 shows the position of the Nova Cura in relation to Lamnas Reef. The GPS position of the Nova Cura was verified by taking cross bearings. The position were the Nova Cura ran aground is 0.2 miles more south than the charted shallow area.

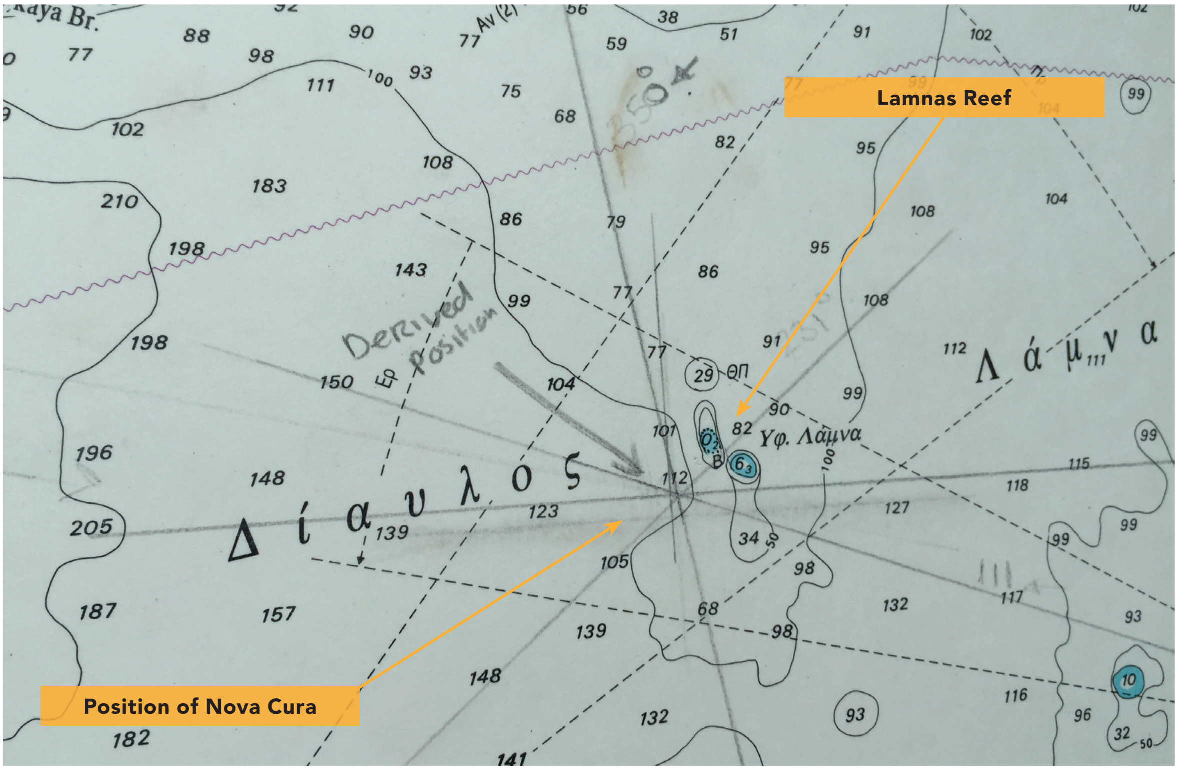


Figure 10: Result of cross bearings showing the position of the Nova Cura on the Greek paper nautical chart. Source: Crew Nova Cura

ECDIS was used on board the Nova Cura for navigation and not paper nautical charts. Figure 11 shows the position of the Nova Cura on ECDIS; it shows the same image as the Greek paper nautical chart. Figures 10 and 11 both show that the depth of the water at the location where the Nova Cura ran aground should be 112 metres, according to the Greek nautical charts.

Another striking point in Figure 11 is the division between two ENCs. The scale of the bottom ENC differs from that of the top ENC (illustrated by the vertical lines) and the shallow water in the top ENC (blue area) ends abruptly on the division between the ENCs. The division between the two ENCs corresponds to the location of the border[12] between Turkey (top section) and Greece (bottom section).

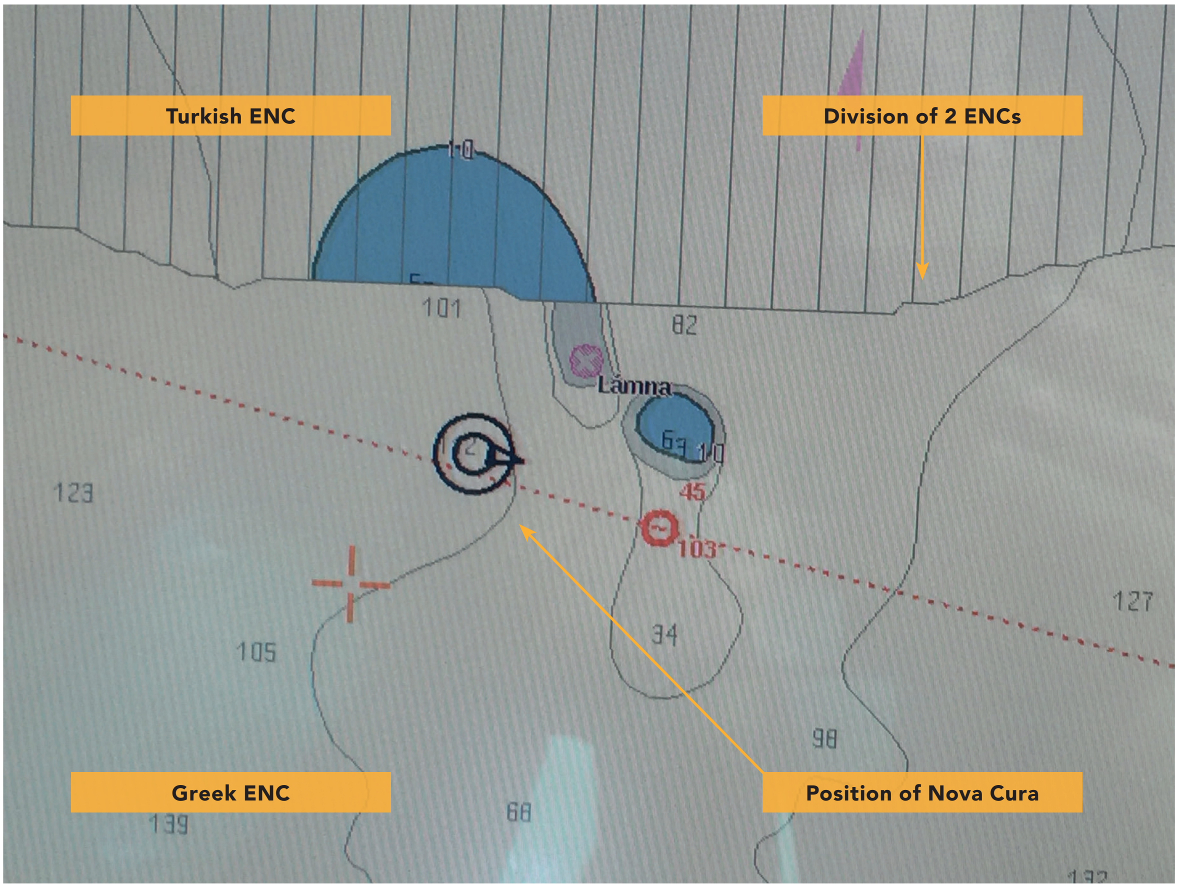


Figure 11: ECDIS image of the accident site. Source: ECDIS Nova Cura

Section 2.3, under Validation and production (page 14), states that if there are any discrepancies in the transition and/or overlap of ENCs, this is reported to the country that produced the ENC. If some of the data overlaps but the ENC does comply with the S-57 standard, the producing county can still decided for the ENC to be included in the database. Figure 11 shows that the two ENCs do not match up properly, but that both ENCs were actually published in this manner.

As stated earlier in this report, only countries whose waters are involved, may create and publish ENCs. Or let other hydrografic offices do this on their behalf. This is in contrast to paper nautical charts. The UKHO's chart, BA 1061, incorporates information from various countries and information sources. Figure 12 shows that BA1061 therefore provides a more complete picture of the accident site. It shows that the shallow water where the Nova Cura ran aground was actually visible.

12 See also Figure 8.

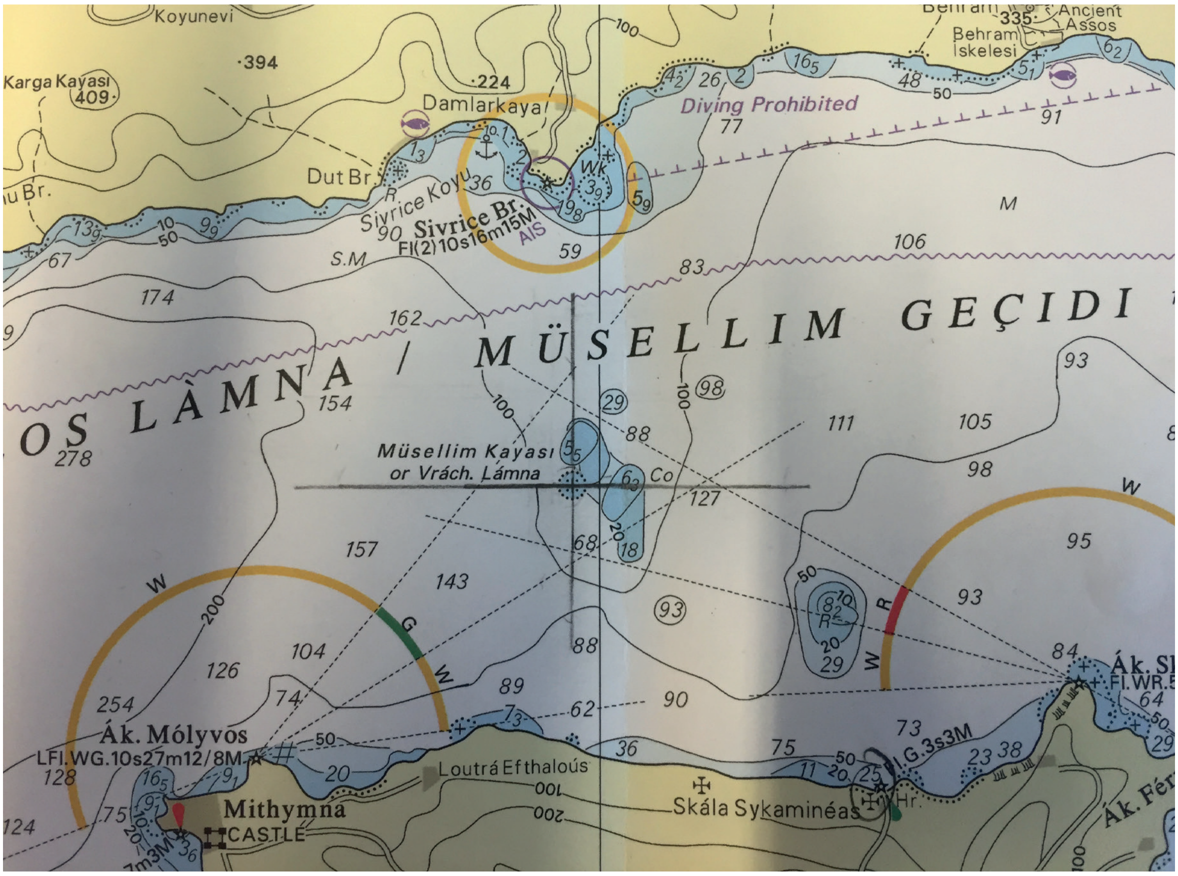


Figure 12: The accident site plotted on BA1061.

3.2 Voyage preparation for safe navigation

Being well-prepared when starting a sea voyage contributes to safe navigation. As already stated in section 2.5, the IMO has set out guidelines in Resolution A.893(21), Guidelines For Voyage Planning, that support the mate or captain when preparing for a voyage. The voyage preparations include preparing for departure from the last port entered, preparing and plotting the route to the next port and preparing for arrival in that next port.

The introduction of ECDIS has made navigation easier in a number of ways. Due to the use of digital charts and real-time information directly displayed on the screen, the officer of the watch no longer has to combine all kinds of information sources himself to know where the ship is sailing. Radar, ARPA[13] and AIS[14] can also be linked to the ECDIS and make sure that the officer of the watch is supported even more while navigating. The fact is, however, that one must think of what information should be displayed on the screen beforehand. By 'enabling' or 'disabling' layers of information, the officer of the watch can personalise the image with information that he or she deems relevant. On the other hand, if certain layers are not 'enabled' or not consulted, like the CATZOC, relevant

13 ARPA: Automatic Radar Plotting Aid.
14 AIS Automatic Identification System.

information can be missed. To be certified an ECDIS always has to display a minimum amount of data to meet the standards for safe navigation (you cannot disable all information.

Reliability of nautical charts

Apart from the fact that the position of Lamnas Reef was incorrectly shown on the Greek ENC, the voyage preparations on board the Nova Cura prior to the ship running aground were not optimal. The captain and the second mate were unaware of the CATZOC of the ENC used. IMO Resolution A.893(21), Guidelines For Voyage Planning, states that all information relevant to the voyage to be undertaken must be taken into account. Checking the reliability of the ENC to be used falls under information relevant to the voyage to be undertaken.

In addition, after making voyage preparations for the initial route south of Lesbos, the route was changed. No completely new voyage preparations were made for the route north of Lesbos. It is true that Lamnas Reef had been noticed on the chart on board the Nova Cura, prompting the decision to move the waypoint slightly further south. The shallow water abruptly ending on the transition zone of the two ENCs was not considered unusual. The fact that the ENC had a CATZOC U classification, which means that the reliability of the data used for the chart was not assessed, was overlooked. As a result, the distance to the shallow water chosen in this case (± 400m) was insufficient to prevent the ship from running aground.

Whereas the source diagram is always included as a separate image on a paper nautical chart (this is called the 'title' in technical terms), one must actively look for it in the ECDIS. Although the pick report can be retrieved in any position on the ENC, a number of menus sometimes have to be navigated to reach the information required (depending on the manufacturer).

Apart from being unaware of the CATZOC, the setting in ECDIS is not very user friendly. The layer which makes the CATZOC visible in ECDIS can be 'enabled' or 'disabled'. If this layer is constantly 'enabled', the image becomes contaminated, as shown in Figure 13. Therefore it is good practice to 'enable' the layer for a while during voyage preparations to verify the different CATZOCs located on the route. It is equally important to check the CATZOC of the new route in the event of deviating from the planned route, particularly if it is the first voyage on that route.

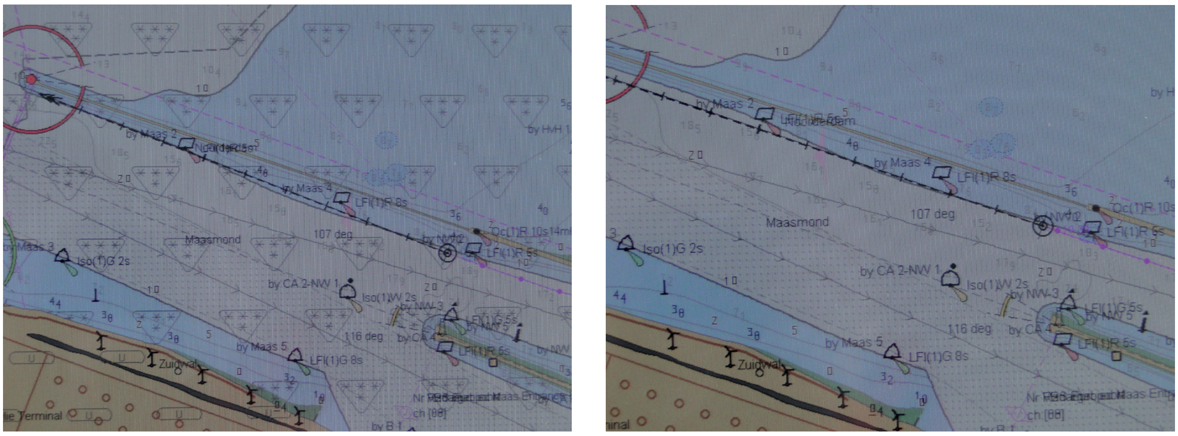


Figure 13: ENC displayed, left with CATZOC 'enabled', right with CATZOC 'disabled'.
Source: Dutch Safety Board

Sector lights
Both during the voyage preparations and during the voyage, another tool to support navigation was not included. The sector lights Ák Mólyvos and Ák Skamniá (on the right in Figure 8) are both intended to warn of the danger of Lamnas Reef. In this case, the danger is located in the area simultaneously illuminated by both the green and the red sector lights. This is also stated in the Pilots of the area. The captain on board of the Nova Cura indicated he had seen the sectorlights, but assumed the sectolight Ák Skamniá was meant for the shallow area north of Skala Sykaminias. The Nova Cura eventually was located precisely in the area where the red and green sectors overlap. This indicates that the passage using these sector lights was not correctly included in the voyage preparations.

Whereas sector boundaries are drawn on a paper chart, in ECDIS the sector boundaries layer (lights) must be 'enabled' or 'disabled'. The ECDIS image and the paper nautical chart are shown next to one another in Figure 14 to clearly show the difference in the view shown. For sector boundaries in ECDIS, again everything must be 'enabled' or 'disabled. If this layer is constantly 'enabled', the image will become contaminated and will be detrimental to navigation. For this reason, it is important to highlight the relevant sector lights during voyage preparations and to 'enable' the layer temporarily, where necessary, during navigation.

Nevertheless it is striking that the sector boundaries do not extend to the danger they are covering. This in contrary to the sector boundaries on paper charts. This is why the sector lights on paper charts work more intuitive than on the ENC's.

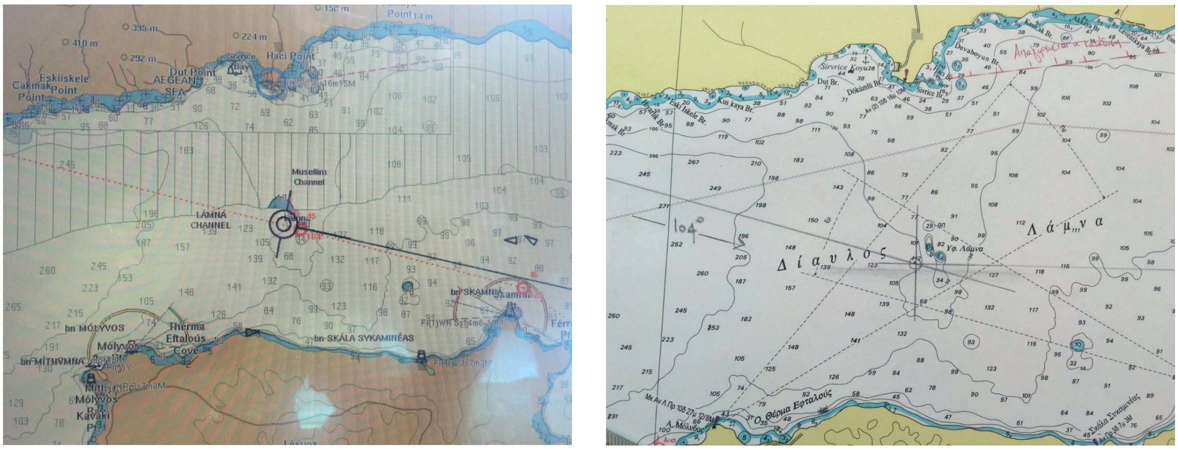


Figure 14: Left: Sector lights in ECDIS, right: sector lights on the Greek paper nautical chart. Source Dutch Safety Board

Zooming in

The possibility of zooming in on an ENC may create the feeling that highly accurate navigation is possible. In Figure 15, the Nova Cura appears to be at a reasonable distance from Lamnas Reef. Partly due to the high accuracy of GPS equipment, the ship's own position can be indicated very accurately. If, however, the ENC used to project this position is unreliable, positioning down to one metre does not count for much.

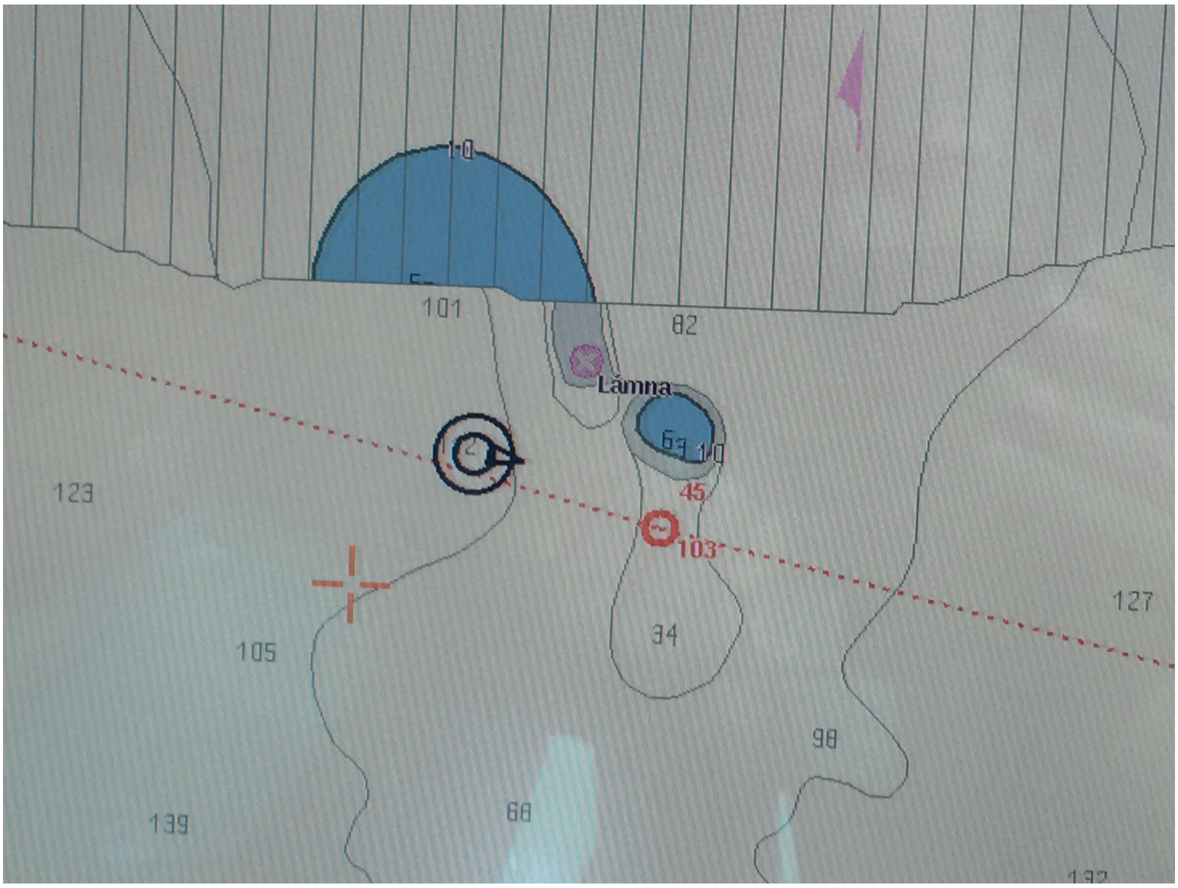


Figure 15: Zoomed in position of Nova Cura on ECDIS. Source: ECDIS Nova Cura

Apart from the fact that zooming in on an ENC may create the feeling that highly accurate navigation is possible, relevant information may also be omitted as a result of zooming in. If the officer of the watch does not regularly zoom out, he runs the risk of losing oversight.

Whereas paper nautical charts depict objects as the cartographer places them, the way in which an ENC is displayed in ECDIS can be personalised. On the one hand, this makes it easier to gather the information required for the voyage (everything in a single device), on the other hand, it makes ECDIS a complicated device. There are many different ECDIS manufacturers, all of which build in many buttons or menu-driven settings in their systems, all using their own methods. The danger of this is that one loses sight of the bigger picture, as a result of which essential information is missed.

4 CONCLUSIONS

How could the Nova Cura run aground, while the digital chart indicated that the sea in that location should be 112 metres deep?

To answer this question starts with the voyage preparations. Preparations had been made on board the Nova Cura for a voyage to Izmir, taking a route west of Lesbos. When the destination was amended to Aliaga, the route was changed. No new voyage preparations were made for the new route, which ran north of Lesbos. Although new waypoints were set, no other information was used in changing the route. The Pilots for the area were not consulted for potential hazards, the sector lights were either not identified sufficiently or not identified at all and the available ENC was not checked for reliability.

The position of the shallows of Lamnas Reef on the available ENC deviated from their actual location. According to the ENC, the shallows were supposed to be 0.2 nautical miles (about 400 metres) further north. Because of unfamiliarity with the concept of CATZOC to assess the reliability of the ENC, the crew were unaware that major deviations could be present on the ENC. In addition, their impression that the shallows ended abruptly at the transition between two ENCs gave the crew no cause to keep a greater distance from Lamnas Reef. The distance to the shallows chosen in this case (± 400 metres) appeared to be insufficient to prevent the ship from running aground.

A consultation of the Pilots for the area (which contained a description of the shallows) and the correct use of sector lights could have contributed to a safe passage of Lamna Reef.

Adequate voyage preparations contribute to safe navigation. ECDIS incorporates various information sources, but this is of no use if the information that is available is not consulted. Even allowing for the fact that the actual position of the Lamnas Reef shallows deviated from their location in ECDIS, the Nova Cura would not have travelled to that position in the first place if adequate voyage preparations had been made when the route was changed. The use of ECDIS must be supplemented by all other available tools to support safe navigation.

Which structural safety deficiencies that can be improved reveals the investigation into the incident with the Nova Cura?

In order to exploit all the functionalities of ECDIS to the full, it is important that ENCs are used. This is because ENCs are composed of layers, which can be enabled or disabled in ECDIS. Given that ECDIS was not accepted as a primary navigation tool until 2002, users might get the impression that the availability of an ENC for ECDIS means that the contents of the ENC are also new. This mindset appears to have promoted the loss of traditional skills, such as the ability to check the used chart for accuracy. However hydrographic services may also choose to digitise old paper nautical charts and convert them into ENCs. By consequence, it is vitally important to view and check the CATZOC and the pick reports for the used charts when preparing ECDIS for the voyage.

> The modernity of ECDIS obscures the fact that the system may be reliant on ENCs with a very low level of reliability. Checking the CATZOC and the pick reports is therefore key to safe navigation.

Besides the need for ECDIS users to be aware that the system may be reliant on ENCs based on very old data, hydrographic services should be aware of how ECDIS is used in practice. While ECDIS users should be able to apply traditional skills to new technology, hydrographic services should stop including old or obsolete information into a new system. The fact that the technology itself is modern could lead to a mistaken belief that the information on which the technology is based is up to date.

> When hydrographic services convert very old nautical charts into ENCs, they tend to overlook practicality issues and the expectations that users have of a relatively new system such as ECDIS. By converting old paper nautical charts into ENCs, hydrographic services unintentionally foster the mistaken assumption among users that the information is up to date.

Aside from their ability to display nautical charts, ECDIS and similar systems contain lots of information that could be of use to the officer of the watch. This wealth of possibilities, settings and supporting information entails the risk that the user loses sight of the bigger picture and may overlook essential information. The fact is that the technology is capable of offering much more information than the user is able to process. Having real-time information available in an ENC and the possibility to zoom in reasonably far may give the crew a false sense of accuracy that is particularly dangerous if the ENC has a low CATZOC classification.

> ECDIS is a relatively new, state-of-the-art navigation system, which may create the impression that it guarantees highly accurate navigation. This can lead to the crew overestimating the reliability of the information at their disposal or even neglecting to check it. As new technology gains traction, traditional skills fall out of use and seem to disintegrate altogether.

In addition to the wealth of information that ECDIS offers, its use for navigation is not as intuitive as navigation with a paper chart. One example of this is the use of the sector light settings. A paper chart provides a clear overview at a glance of the area covered by sector lights, whereas ECDIS does not. In ECDIS' default view, sector lights are disabled. Moreover, unlike a paper chart ECDIS does not allow the user to assess the reliability of an ENC at a glance.

ECDIS technology is capable of offering much more information than the user is able to process. In addition, the retrieval of information from the system is not always intuitive. ECDIS users must be made more aware of this issue, which should be highlighted in the ECDIS user instructions and system training. It should also be a factor in the future development of ECDIS.

5 LESSONS AND RECOMMENDATIONS

The Dutch Safety Board's lessons are as follows:

To ECDIS users and those who make voyage preparations using ECDIS

1. Owners and shipping companies whose vessels are equipped with ECDIS are advised to:
   - determine the extent to which users are familiar with CATZOC, the retrieval of pick reports and the system's sector light settings;
   - remind ECDIS users that they must continue to rely on traditional navigation skills, such as those required when using a paper chart for navigation, alongside modern navigation technology such as ECDIS.

2. In addition, they are advised to update their voyage preparation procedures to include the following:
   - Check the CATZOC of the used ENCs for the entire route and mark the areas where the CATZOC constitutes a threat to safe navigation.
   - Always consult the pick report for additional information about those areas that are relevant for safe navigation.
   - Mark the relevant sector lights for the route and enable sector lines whenever a section light is passed.
   - Repeat all relevant voyage preparations whenever a route is changed during a voyage, and in particular consult the Pilots and the CATZOC and mark the relevant sector lights.

The Dutch Safety Board's recommendations are as follows:

To the International Hydrographic Organization (IHO)

1. Impose conditions for the age and reliability of the data used to compile ENC's and stimulate the decrease of ENC's with CATZOC U.

To the International Maritime Organization (IMO)

2. Make the practical use of ECDIS a factor in the future development of the system.

3. Compile an inventory of and evaluate ECDIS' inherent safety risks, as described in this investigation.

4. Take measures to mitigate these risks, e.g. draw up more extensive guidelines for the layout of ECDIS' default view, the layout of the menus, the amount of information available in ECDIS and its proper use.

5. Evaluate the effectiveness of these measures and amend them if required.

APPENDIX A

Vessel specifications	Nova Cura
Photo:	
Call sign:	PCFP
IMO number:	9166479
Flag state:	The Netherlands
Home port:	Stavenisse
Vessel type:	General Cargo with Container Capacity
Classification society:	Bureau Veritas
Year of build:	1999
Shipyard:	Severnav Shipbuilding S.A. Turnu Severin
Length overall (LOA):	107,09 m.
Length between perpendiculars (LPP):	100,71 m.
Breadth:	15,0 m.
Actual draught:	6,41 m.
Gross Tonnage:	3999
Engines:	MAK 6M32
Propulsion:	1 propeller – controllable pitch, 1 bow thruster
Maximum propulsion power:	2919 kW
Maximum speed:	12.0 knots
Ship certificates:	All valid

APPENDIX B

Carriage requirements for ECDIS

The International Maritime Organization (IMO), at the 86th session of the Maritime Safety Committee (MSC) in June 2009, approved amendments to the International Convention for the Safety of Life at Sea (SOLAS) requiring ships to be fitted with an Electronic Chart Display and Information System (ECDIS).

The amendment to SOLAS means that all large passenger-, tanker- and cargo ships will be required to be fitted with ECDIS on a rolling timetable that begins in July 2012:

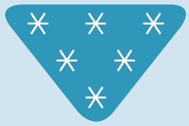
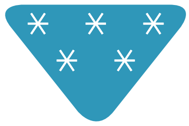
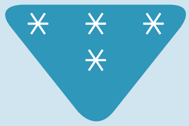
	Size	New ship*	Existing ship**
Passenger	≥500 gross tons	1 July 2012	No later than 1st survey after 1 July 2014
Tankers	≥3,000 gross tons	1 July 2012	No later than 1st survey after 1 July 2015
Dry cargo	≥50,000 gross tons	1 July 2013	No later than 1st survey after 1 July 2016
	≥20,000 gross tons	1 July 2013	No later than 1st survey after 1 July 2017
	≥10,000 gross tons	1 July 2013	No later than 1st survey after 1 July 2018
	≥3,000 gross tons	1 July 2014	Not required

** A new ship is defined as one in which the keel is laid on or after the cut-off date.*

*** Ships may be exempted from these requirements if they will be taken permanently out of service within two years of the implementation date specified.*

https://www.ilent.nl/english/merchant_shipping/ship_owners_dutch_flag/developments/ecdis/

APPENDIX C

1	2	3		4	5	6
ZOC	**Position Accuracy**	**Depth Accuracy**		**Seafloor Coverage**	**Typical Survey Characteristics**	**Symbol**
A1	± 5 m	= 0.50 + 1%d Depth (m) 10 30 100 1000	 Accuracy (m) ± 0.6 ± 0.8 ± 1.5 ± 10.5	Full area search undertaken. All significant seafloor features detected and depths measured.	Controlled, systematic survey, high position and depth accuracy achieved using DGPS or a minimum three high quality lines of position (LOP) and a multibeam, channel or mechanical sweep system	
A2	± 20 m	= 1.00 + 2%d Depth (m) 10 30 100 1000	 Accuracy (m) ± 1.2 ± 1.6 ± 3.0 ± 21.0	Full area search undertaken. All significant seafloor features detected and depths measured.	Controlled, systematic survey achieving position and depth accuracy less than ZOC A1 and using a modern survey echosouder and a sonar or mechanical sweep system	
B	± 50 m	= 1.00 + 2%d Depth (m) 10 30 100 1000	 Accuracy (m) ± 1.2 ± 1.6 ± 3.0 ± 21.0	Full area search not achieved; uncharted features, hazardous to surface navigation are not expected but may exist	Controlled, systematic survey achieving similar depth but lesser position accuracies than ZOC A2, using a modern survey echosouder but no sonar or mechanical sweep system	
C	± 500 m	= 2.00 + 5%d Depth (m) 10 30 100 1000	 Accuracy (m) ± 2.5 ± 3.5 ± 7.0 ± 52.0	Full area search not achieved, depth anomalies may be expected.	Low accurancy survey or data collected on an opportunity basis such as soundings on passage	
D	Worse than ZOC C	Worse than ZOC C		Full area search not achieved, large depth anomalies may be expected.	Poor quality data or data that cannot be quality assessed due to lack of information	
U	Unassessed – The quality of the bathymetric data has yet to be assessed					

APPENDIX D

IC-ENC

Mission:
IC-ENC aims to provide services, at a low cost, to national Hydrographic Offices that ensure their ENCs are compliant to the international standards, consistent across the global dataset, and readily available for use. This is so that shipping can navigate safely, efficiently and confidently, whilst ensuring other maritime users are using the same approved data.

http://www.ic-enc.org/

PRIMAR
PRIMAR is an international collaboration dedicated to providing a consistent and reliable electronic navigational chart (ENC) service, and operated on a non-profit basis by the Norwegian Hydrographic Service (NHS) in close cooperation with Electronic Chart Centre AS (ECC).
Our core aim is to support authorised partners with flexible, user-friendly, efficient and timely solutions. This ensures that end users are provided with an ENC service which is recognised for its quality and for its overall contribution to marine safety and efficiency at a global level.

In pursuing this vision, we focus on giving our partners freedom to choose between a variety of services and solutions. The primary aim is to make data available to everyone at a reasonable cost in order to enable value creation and safety at sea.
Although the technology is advanced, the idea underlying our service is simple. We gather all ENCs in a single database and create a one-stop-shop for distributors and users of such charts. This has allowed us to acquire a leading role in providing the best navigational solutions for the world's merchant fleet, navies, marine pilots and government agencies.

https://www.primar.org

INTERNATIONAL MARITIME ORGANIZATION

IMO

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ASSEMBLY
21st session
Agenda item 9

A 2/Res.893
4 February 2000
Original: ENGLISH

RESOLUTION A.893(21)
adopted on 25 November 1999

GUIDELINES FOR VOYAGE PLANNING

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety and the prevention and control of marine pollution from ships,

RECALLING ALSO section A-VIII/2, Part 2 (Voyage planning) of the Seafarers' Training, Certification and Watchkeeping Code,

RECALLING FURTHER the essential requirements contained in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers and the International Convention for the Safety of Life at Sea concerning voyage planning, including those relating to officers and crew, shipborne equipment, and safety management systems,

RECOGNIZING the essential importance for safety of life at sea, safety of navigation and protection of the marine environment of a well planned voyage, and therefore the need to update the 1978 Guidance on voyage planning issued as SN/Circ.92,

NOTING the request of the Assembly in resolution A.790(19) that the Maritime Safety Committee consider the issue of voyage planning in conjunction with its review of the Code for the Safe Carriage of Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes in Flasks on Board Ships (INF Code), and the Committee's decision that consideration of the issue of voyage planning should not be restricted to vessels carrying materials subject to the INF Code but should apply to all ships engaged on international voyages,

HAVING CONSIDERED the recommendation made by the Sub-Committee on Safety of Navigation at its forty-fifth session:

1. ADOPTS the Guidelines for voyage planning set out in the Annex to the present resolution;

2. INVITES Governments to bring the annexed Guidelines to the attention of masters of vessels flying their countries' flag, shipowners, ship operators, shipping companies, maritime pilots, training institutions and all other parties concerned, for information and action as appropriate;

3. REQUESTS the Maritime Safety Committee to keep the said Guidelines under review and to amend them as appropriate.

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ANNEX

DRAFT GUIDELINES FOR VOYAGE PLANNING

1 Objectives

1.1 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.

1.2 The need for voyage and passage planning applies to all vessels. There are several factors that may impede the safe navigation of all vessels and additional factors that may impede the navigation of large vessels or vessels carrying hazardous cargoes. These factors will need to be taken into account in the preparation of the plan and in the subsequent monitoring of the execution of the plan.

1.3 Voyage and passage planning includes appraisal, i.e. gathering all information relevant to the contemplated voyage or passage; detailed planning of the whole voyage or passage from berth to berth, including those areas necessitating the presence of a pilot; execution of the plan; and the monitoring of the progress of the vessel in the implementation of the plan. These components of voyage/passage planning are analysed below.

2 Appraisal

2.1 All information relevant to the contemplated voyage or passage should be considered. The following items should be taken into account in voyage and passage planning:

.1 the condition and state of the vessel, its stability, and its equipment; any operational limitations; its permissible draught at sea in fairways and in ports; its manoeuvring data, including any restrictions;

.2 any special characteristics of the cargo (especially if hazardous), and its distribution, stowage and securing on board the vessel;

.3 the provision of a competent and well-rested crew to undertake the voyage or passage;

.4 requirements for up-to-date certificates and documents concerning the vessel, its equipment, crew, passengers or cargo;

.5 appropriate scale, accurate and up-to-date charts to be used for the intended voyage or passage, as well as any relevant permanent or temporary notices to mariners and existing radio navigational warnings;

.6 accurate and up-to-date sailing directions, lists of lights and lists of radio aids to navigation; and

.7 any relevant up-to-date additional information, including:

.1 mariners' routeing guides and passage planning charts, published by competent authorities;

.2 current and tidal atlases and tide tables;

.3 climatological, hydrographical, and oceanographic data as well as other appropriate meteorological information;

.4 availability of services for weather routeing (such as that contained in Volume D of the World Meteorological Organization's Publication No. 9);

.5 existing ships' routeing and reporting systems, vessel traffic services, and marine environmental protection measures;

.6 volume of traffic likely to be encountered throughout the voyage or passage;

.7 if a pilot is to be used, information relating to pilotage and embarkation and disembarkation including the exchange of information between master and pilot;

.8 available port information, including information pertaining to the availability of shore-based emergency response arrangements and equipment; and

.9 any additional items pertinent to the type of the vessel or its cargo, the particular areas the vessel will traverse, and the type of voyage or passage to be undertaken.

2.2 On the basis of the above information, an overall appraisal of the intended voyage or passage should be made. This appraisal should provide a clear indication of all areas of danger; those areas where it will be possible to navigate safely, including any existing routeing or reporting systems and vessel traffic services; and any areas where marine environmental protection considerations apply.

3 Planning

3.1 On the basis of the fullest possible appraisal, a detailed voyage or passage plan should be prepared which should cover the entire voyage or passage from berth to berth, including those areas where the services of a pilot will be used.

3.2 The detailed voyage or passage plan should include the following factors:

.1 the plotting of the intended route or track of the voyage or passage on appropriate scale charts: the true direction of the planned route or track should be indicated, as well as all areas of danger, existing ships' routeing and reporting systems, vessel traffic services, and any areas where marine environmental protection considerations apply;

.2 the main elements to ensure safety of life at sea, safety and efficiency of navigation, and protection of the marine environment during the intended voyage or passage; such elements should include, but not be limited to:

.1 safe speed, having regard to the proximity of navigational hazards along the intended route or track, the manoeuvring characteristics of the vessel and its draught in relation to the available water depth;

.2 necessary speed alterations en route, e.g., where there may be limitations because of night passage, tidal restrictions, or allowance for the increase of draught due to squat and heel effect when turning;

.3 minimum clearance required under the keel in critical areas with restricted water depth;

.4 positions where a change in machinery status is required;

.5 course alteration points, taking into account the vessel's turning circle at the planned speed and any expected effect of tidal streams and currents;

.6 the method and frequency of position fixing, including primary and secondary options, and the indication of areas where accuracy of position fixing is critical and where maximum reliability must be obtained;

.7 use of ships' routeing and reporting systems and vessel traffic services;

.8 considerations relating to the protection of the marine environment; and

.9 contingency plans for alternative action to place the vessel in deep water or proceed to a port of refuge or safe anchorage in the event of any emergency necessitating abandonment of the plan, taking into account existing shore-based emergency response arrangements and equipment and the nature of the cargo and of the emergency itself.

3.3 The details of the voyage or passage plan should be clearly marked and recorded, as appropriate, on charts and in a voyage plan notebook or computer disk.

3.4 Each voyage or passage plan as well as the details of the plan, should be approved by the ships' master prior to the commencement of the voyage or passage.

4 Execution

4.1 Having finalized the voyage or passage plan, as soon as time of departure and estimated time of arrival can be determined with reasonable accuracy, the voyage or passage should be executed in accordance with the plan or any changes made thereto.

4.2 Factors which should be taken into account when executing the plan, or deciding on any departure therefrom include:

.1 the reliability and condition of the vessel's navigational equipment;

.2 estimated times of arrival at critical points for tide heights and flow;

.3 meteorological conditions, (particularly in areas known to be affected by frequent periods of low visibility) as well as weather routeing information;

.4 daytime versus night-time passing of danger points, and any effect this may have on position fixing accuracy; and

.5 traffic conditions, especially at navigational focal points.

4.3 It is important for the master to consider whether any particular circumstance, such as the forecast of restricted visibility in an area where position fixing by visual means at a critical point is an essential feature of the voyage or passage plan, introduces an unacceptable hazard to the safe conduct of the passage; and thus whether that section of the passage should be attempted under the conditions prevailing or likely to prevail. The master should also consider at which specific points of the voyage or passage there may be a need to utilize additional deck or engine room personnel.

5 Monitoring

5.1 The plan should be available at all times on the bridge to allow officers of the navigational watch immediate access and reference to the details of the plan.

5.2 The progress of the vessel in accordance with the voyage and passage plan should be closely and continuously monitored. Any changes made to the plan should be made consistent with these Guidelines and clearly marked and recorded.

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