WENDWG12-03D

Paper for Consideration by WEND-WG
Solving the Safety Contour Problem in ECDIS with HD ENCs

Submitted by:	Australia, UK
Executive Summary:	User feedback and a major study into the usability of ECDIS have identified the ability to set an appropriate safety contour as a key issue for ECDIS users. S-100 offers a solution to this problem but will not be adopted by many users for a significant period of time. HD ENCs can solve the problem now, using existing technologies. ENC producers are recommended to consider the role that HD ENCs can play in improving the usability and safety of ECDIS within their waters much sooner than will be achieved through the adoption of S-100 ECDIS and S-1XX products.
Related Documents:	Application and Usability of ECDIS, UK Marine Accident Investigation Branch (MAIB) & Danish Maritime Accident Investigation Board (DMAIB), September 2021 S-100 Roadmap for the S-100 Implementation Decade (2020 – 2030), version 2.0, December 2021 S-65 Annex A - High Density (HD) ENC Production and Maintenance Guidance, edition 1.0.0, January 2020 IHO CL 42/2021 - Outcome of the Survey on the Production of High Density ENCs (HD ENCs)
Related Projects:	

Introduction / Background

User feedback on ENCs highlights that there is an urgent need to improve the way the safety contour works in ECDIS to better highlight unsafe water and improve the relevance of alarms and indications. This has repeatedly come up in user feedback. A joint UK Marine Accident Investigation Branch (MAIB) and Danish Maritime Accident Investigation Board (DMAIB) report into the Application and usability of ECDIS[1] highlighted issues setting an appropriate safety contour as one of the key challenges when using ECDIS. The report stated:

The frequent impracticality of the setting of an efficient safety contour, leading to the use of 'official workarounds' (e.g. included in recognised guidance) and 'unofficial workarounds' (e.g.alarm disablement) to optimise the display to make the best of a bad job. Alternatively, the safety contour is ignored altogether.

Furthermore, the inability to set an appropriate safety contour contributes to 2 further challenges faced when using ECDIS:

The distraction of alerts and alarms, particularly during pilotage, that leads to coping strategies ranging between alarm 'normalisation' and physical disablement.

The number and types of alerts generated during automatic route checks that leads to them either being ignored or increases the risk of planners missing safety critical alerts among numerous more trivial ones

Analysis/Discussion

The safety contour in ECDIS is used to show safe and unsafe water on the ECDIS using different colour shading. It is also used to trigger alerts and indications to alert the user that the vessel's course, or planned

[1] Application and usability of ECDIS, MAIB and DMAIB, 02-SEP-2021

course, is expected to cross into unsafe water. ECDIS design and Performance Standards dictate that the safety contour is set by picking from one of the available depth contours in the ENC data set. When the requested contour value is not available, ECDIS defaults to the next available deeper value. The use of standard contour intervals derived from paper charts in ENCs means that there are frequently 5m or 10m between available contour values. For example, a vessel requesting a safety contour of 16m and being shown all water shallower than 20m as being unsafe.

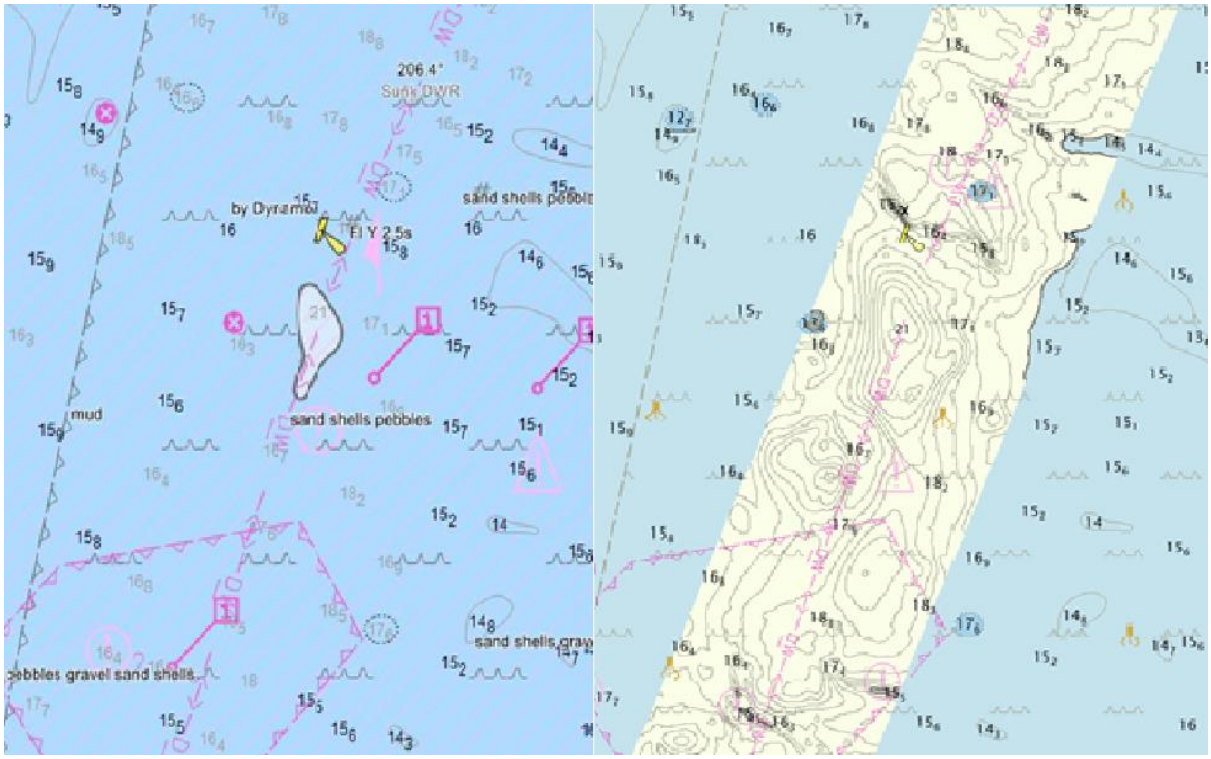

Figure 1 - ECDIS screenshot showing part of a deep-water route with the safety contour set at 16m - standard ENC on the left and HD ENC on the right

IHO CL42/2021 Outcome of the Survey on the Production of High Density (HD ENCs) highlights that some Member States encode higher density bathymetry in their ENCs to meet user needs and that best practices shared by Member States throughout the survey can be used by other producers.

The CL concludes that "it does not seem appropriate to develop specific IHO guidelines for HD ENC production at this stage. A technical operational and effective standard is already in force for HD ENC (Annex A to S-65) and it is expected that it will remain in use during the transition to the operational production of S-101 and S-102".

Standards and Production Issues

S-65 Annex A was published in January 2020 and provides guidance for ENC producers on how to produce and maintain HD ENCs. It builds on the content provided in the S-57 standard and the ENC Product Specification. Although the guidance is likely to evolve as more experience is gained and improvements identified the existing standards and associated guidance are sufficient for the production of HD ENCs.

Many of the production processes required to produce HD ENCs have now been automated by ENC production tool manufacturers. Some manual finishing may be undertaken to improve the usability of the dataset and the level required will depend on the result that the producer wishes to achieve. The most significant activity is generalizing or removing very small shallow patches or deeps that are too small to display on ECDIS but will continue to trigger alerts and indications. The UK experience of producing HD ENCs is that they take broadly the same amount of effort as a standard ENC.

A summary of the approaches to HD ENC production used by Australia and UK are included in Annexes A and B.

Role of S-100

A range of S-100 Product Specifications will help solve the safety contour problem in ECDIS in the future. Specifically, S-102 Bathymetric Surface data will allow safety contours to be defined from a bathymetric surface at any user-defined value. The S-98 Interoperability Specification will allow this safety contour to be used instead of the one selected from the ENC data. When used in combination with S-104 Water Levels data it may additionally be possible to change the safety contour based on tidal information,

Under the Roadmap for the S-100 Implementation Decade (2020 – 2030), the S-101 ENC and S-102 Bathymetric Surface Product Specifications are expected to be operational in 2025, along with the S-98 Interoperability Specification. A revised IMO ECDIS Performance Standard is predicted to be in force by July 2025.

Whilst this framework will make it possible for vessels to use a type-approved S-100 ECDIS with S-101 ENC and S-102 Bathymetric Surface data from mid-2025, there remains significant uncertainty around how quickly this will be adopted by users. ECDIS manufacturers will need to invest in building S-100 ECDIS equipment and shipping companies will need to invest in installing it on their vessels before it will be available to users.

There are currently more than 30,000 vessels using ECDIS worldwide and this number is steadily increasing. Refit cycles for vessels are lengthy, typically around 10 years for bridge equipment. It will take many years from the introduction of S-100 ECDIS before it is widely adopted.

Role of WENDWG

The objective of the WENDWG is to "advise IRCC to enable the highest societal value of Member State effort", including by "facilitating a world-wide consistent level of high-quality, updated official S-57 ENCs". Therefore, WENDWG has a role in advising on requirements for improvements in ENC coverage. Furthermore, WENDWG was tasked by IRCC with conducting a survey of IHO Member States on their HD ENC production, which reported in IHO CL 42/2021.

Conclusions

User feedback and a major study into the usability of ECDIS has identified a significant issue with the way the safety contour works. This issue is driven by the ENC data that supports the safety contour function. Increasing the density of the contours in the ENC data allows the ECDIS to choose from a wider range of safety contour values that can more accurately meet a user's needs. This contributes to better situational awareness and reduced cognitive load for the user through clearer depiction of available safe water and reduced alarms and indications, thus enhancing the safe use of ECDIS.

The S-100 framework and S-100 ECDIS will offer a solution to this problem in the future. A combination of S-101 ENC, S-102 Bathymetric Surface and S-104 Water Levels data with the S-98 Interoperability Specification will allow the ENC-based safety contour to be replaced with a safety contour derived from the bathymetric surface. This will allow the safety contour to be generated at any value set by the user.

It is likely to be at least 5 years before an S-100 solution is available to users, and probably closer to 10 years before it is in use on a significant number of vessels. Some users are only likely to upgrade when required by regulation and a date for this is not yet known.

HD ENCs offer a solution to this problem within existing S-57 ECDIS. No changes to regulations or equipment upgrades are required to make it work. The key challenges are for Hydrographic Offices in the gathering of suitable survey data and production (and maintenance) of the HD ENCs. The guidance set out

in S-65 Annex A and the automation available in ENC production tools are making the production and maintenance of HD ENCs increasingly efficient.

Whilst the survey on the production of HD ENCs carried out by IHO highlights that some Member States are already adopting this approach to meet user needs, it is not consistent and concern about the operation of the safety contour in ECDIS is frequently raised within the maritime industry.

Recommendations

ENC producers should consider the role that HD ENCs can play in improving the usability and safety of ECDIS within their waters much sooner than will be achieved through the adoption of S-100 ECDIS and S-1XX products.

Justification and Impacts

The justification for this recommendation is the need to urgently meet user needs for improved safety contour usability in ECDIS, and therefore enhance the safe use of ECDIS.

The impact of the recommendation will fall on ENC producers who will need to include a higher density of contours in their ENCs. This may require more effort than producing standard ENCs but this is increasingly being mitigated by automated production tools.

Action Required of WEND-WG

The WEND Committee is invited to:

a. endorse the need for the World-wide ENC Database (WEND) to meet the needs of users for improved safety contour usability.
b. consider the role that HD ENCs can play in doing this before S-100 ECDIS becomes widely available.
c. recommend to IRCC that Members States producing ENCs should do so as HD ENCs in areas where safe water is limited.
d. recommend to IRCC that HD ENC coverage should be considered as a strategic performance indicator and monitored accordingly.

Annex A – Australian Approach

Requirement:
Introduce the Business Case of what has changed to create the requirement for a higher level of detail within Electronic Navigational Charts (ENC) covering the port or area of concern. (HD ENC)
Response:
This request normally submitted by the Port Authority will be assessed by the AHO and be based on the reasons and more importantly, the benefits the production of an HD ENC would have on the operation of the port and the prevention of accidents and pollution. The Port Authority may require a product containing higher detail to accommodate larger vessels, better depict under keel clearances and reduce concerns expressed by vessel Masters over differences between information available to the Master and the Marine Pilot. The Port Authority is also to include a survey regime that will indicate the frequency of survey and product update schedule. It is important that new products are not created if not warranted as each new product will require administrative support and also enter the maintenance regime. Stakeholder's needs may be able to be solved by using existing AU5 products by adding additional soundings and additional and more accurate depth contours within a larger M_CSCL object covering a particular area of concern.

Requirement:
Stake holders to agree on extents of HD ENC.
Response:
Extents of the product should align with the port's survey program, ensure the area is large enough to meet perceived requirements without being excessive and not be so large that the resulting file exceeds the 5MB limit. Once agreed, the coverage of the polygon is not to be amended as the AHO relies on the limits of this polygon to for 'cut and replace' update procedures. The surveyor will also use this polygon plus a buffer to determine the area to be surveyed for the first edition and any further updating of bathymetric data.

Requirement:
Acceptance of surveys for inclusion in HD ENCs.
Response:
Surveys intended to support new or updated HD ENCs are to be accompanied by a 'HD ENC Survey Metadata Form' that once satisfactorily completed provides all metadata required to validate the survey including information on vertical and horizontal control and details regarding the execution of the survey. Confirmation that the survey extends beyond the HD ENC limits must also be sort. Once the metadata information and coverage is verified the survey is accepted for charting. This reduced validation places the onus on the Harbour Master to provide quality survey data to the AHO and prevent further delays in incorporating data into the product.

Requirement:
Use automatic tools for compilation of bathymetry features.
Response:
Compiling bathymetric features manually is no longer a standard AHO practice as this is extremely slow and inefficient. All bathymetric features are generated from GIS software and other automated processes within the AHO including the application of the 'AHO Isolated Shoal Policy' and removal of unnecessary deeps.

Requirement:
Visibility of depth contours at optimum display scales.
Response:
Standard depth contours (0, 2, 5, 10, 20, etc.) will have SCAMIN=179999 also being the same value of surrounding NP5 ENCs ensuring consistency of display between products particularly when the user alters the viewing scale. All others (8, 9, 9.5, 11, 12, etc.) have a SCAMIN=7999 and will not display at scales where it is considered that screen clutter will be an issue. Other features have SCAMIN applied in accordance with the 'AHO SCAMIN and Attribute Policy' to ensure optimum viewing of critical features.

Requirement:
Minimalize the effort required to maintain products
Response:

Each resurvey of an HD ENC area must be rendered to the AHO as ‘one piece’ of data to support the ‘cut and replace’ concept that underpins the HD ENC maintenance regime. That is, all the existing bathymetry will be removed and then entirely replaced with new data. The intention is to remove the requirement to merge old and new bathymetry to maintain the size of the original area. Other features encoded in a HD ENC are restricted to those necessary for the safe navigation of vessels - obstructions and navigation aids etc. the fewer features a product contains reduces the maintenance effort. Non-bathymetric data is maintained like any other ENC.

Annex B – UK Approach

Requirement
The wealth of updated and new information from a bathymetric survey is made available to navigators as early and as completely as possible to ensure safe navigation and access to ports and harbours.
Response
UKHO wanted to give the navigator access to updated bathymetric surveys much more quickly than is possible with standard assessment and to give the mariner comprehensive picture of the bathymetry, particularly when Under Keel Clearance (UKC) is minimal. Working with CARIS, tools were developed that greatly assist the compiler in generating contours from the survey data and generalising them where necessary.

Requirement
The ENCs with extra survey information are not time-consuming or difficult to compile, so do not cost significantly more resource or time.
Response
UKHO specified the HD ENC to limit coverage to the survey area. By excluding other features, the compilation task is easier and quicker. On average, an ENC compiled from a single survey takes much the same time as a standard ENC of similar size.

Requirement
It is quick and simple to issue New Editions or Updates when an updated survey arrives and there is no ongoing maintenance burden.
Response
By limiting the ENC coverage to the survey area, future surveys can be specified to match. Checks for changes to other features are minimal since they lie on surrounding ENCs that are not affected by the survey update.

Requirement
Size limits of ENCs are not exceeded.
Response
It is important that the extra contours do not contribute to excessive file sizes so, if necessary, UKHO only includes contours in a depth band that would be useful for users. The ENC coverage limits are clipped to a reasonably simple shape within the bounds of the survey. For future updates, the ENC limits are shared in the survey specification.

Requirement
Usability – On-screen clutter is minimized
Response
To reduce clutter, SCAMIN is used to display selected contours in addition to the safety contour. Contours at 1m intervals are adequate for most situations, but specific contours at key depths can be added. Narrow contour intervals may be appropriate in certain situations if the data can support them.
The usage band and compilation scale, relative to surrounding ENCs is carefully selected to ensure that the HD data is visible at the ECDIS zoom scale being used for navigation. If the scale is too large and the HD ENC overlays a smaller scale ‘normal’ ENC, it is possible that the user will never zoom in sufficiently during navigation to bring the HD ENC onto the display. UKHO may clip surrounding ENCs as necessary, so the HD ENC gets display priority at navigation scales.