ANNEX A

High Density (HD) ENC Production and Maintenance Guidance

Introduction

When ENCs were first introduced most HOs used their paper chart series as the source for this new vector product. Unfortunately, while enabling the relatively quick creation of ENC data, it has also led to some more unforeseen issues. One of the principle advantages of using ECDIS for navigation is that the system enables the setting of a safety contour, differentiating the safe and unsafe water. This can only accurately be achieved if the data within the ECDIS contains enough depth contours. Many of our ENCs today only contain the standard series of contour lines mirroring the paper chart as specified in IHO S-4 B-411. This results in some vessels having to navigate in waters indicated on the ECDIS as dangerous, when in reality the vessel is still safe and has not reached the maximum permitted water depth.

There is also an emerging requirement for Electronic Navigational Charts (ENC) covering commercial ports to include significantly greater scale and bathymetric content levels than any equivalent paper chart. This requirement is driven by:

- the increasing size of vessels in relation to ports and their channels,
- reduced under-keel depth margins as more vessel sailings are required within each tidal window,
- a fundamental shift in the way these vessels are navigated and a change in user expectations.

The preference is to meet these requirements through official S-57 / S-63 ENC rather than unofficial 'closed' proprietary formats. There is a concern that use of a proprietary format creates a situation whereby the ship's Pilot has a considerably different view of the navigation situation compared to the vessel's Master, leading to ineffective Bridge Resource Management, confusion and increased safety risk. In contrast, use of S-57 / S-63 ENC allows for access and use of the same information by all parties.

Navigation Purpose 6 Berthing ENC cells are produced to improve the navigation through areas restricted by depth (e.g navigation through narrow channels) or where increased bathymetric detail in the form of additional depth contours (e.g. every one metre) allow the safe transit of larger vessels (e.g. cruise ships access to offshore reefs, shorter routes through intricate waters etc).

With advances in the processing of high-resolution bathymetry it's now possible to automatically create sets of supplementary contours that can directly feed into the creation of berthing ENCs. This Annex will provide HOs with survey capture, processing and production guidance to enable the effective creation of HD ENCs.

Definitions

High Density ENC (HD ENC)

An ENC product that includes bathymetry depicted with depth area intervals of 1 metre or closer, with the area of coverage generally limited to below the high water line, focussed on a physically constrained waterway, and any relevant infrastructure in or affecting that area. The additional bathymetric information is incorporated in the base ENC dataset. Under the current IMO ECDIS Performance Standards, this product is suitable to be displayed and operated on any type-approved ECDIS and consequently it can be used to fulfil the IMO's chart carriage requirements.

Additional Bathymetric Overlay (ABL)

An overlay product to accompany an ENC that includes bathymetry depicted with depth area intervals of 1 metre or closer, with the area of coverage generally limited to below the high water line, and focussed on a physically constrained waterway. The additional bathymetric information is provided as a transparent overlay, but is not incorporated in the base ENC dataset. Under the current IMO ECDIS Performance Standards, this product is not suitable to be operated on all type-approved ECDIS and therefore it can't be used to fulfil the IMO's chart carriage requirements. ABL is generally used by pilots in PPUs

Bathymetric Surveys for HD ENCs

HD ENCs are of maximum benefit to the Mariner in areas where there are areas of minimal under-keel clearance.

Careful consideration must be given when planning surveys, so that the resulting data can be used to compile areas of HD bathymetry.

Appendix 1

Hydrographic surveys to be used in the compilation of HD bathymetric areas will in the majority of cases need to meet IHO S-44 Special Order requirements survey:

Maximum allowable Total Horizontal Uncertainty (95% confidence):	+/- 2 m
Maximum allowable Total Vertical Uncertainty (95% confidence): A = +/- 0.25m B = 0.0075 (see S-44 extract in Annex A)	TVU for 10m depths = +/- 0.26m TVU for 20m depths = +/- 0.29m
Feature Detection:	Full seafloor search (able to detect features greater than 1 cubic metre in size)

The bathymetry supplied needs to be referenced to:

- WGS84. This is what ships, pilots, and ENC use. Transformation to other reference systems, and back again, increases the THU.
- A specified port tidal datum (such as "zero of the port tide gauge", "x.xx metres below [named] benchmark" or similar). Where multiple tidal stations or nodes have been used, each should be listed to ensure accuracy is maintained through to the ENC. Simply stating "LAT" does not provide sufficient detail to replicate the tidal reference plane within the AHO. LAT within ports is frequently insufficiently defined for levels of accuracy to be maintained through to the ENC.

In cartographic terms, HD bathymetric data must only be depicted in areas categorized as CATZOC of A1.

The exception to this is where the bottom quality is mud/silt and the water column is holding significant amounts of sediment. Given these environmental conditions multibeam as a survey technique is not suited when acquiring depth information. In this situation other survey techniques maybe used and the data

It is recommended that charting authorities consider the following criteria when developing HD ENCs

a. Ability for larger vessels to access the port.

b. Improvement to routes to avoid areas of environmental risk

c. Improvement to routes to improve traffic flow

c) Is it practical to maintain the cells once produced?

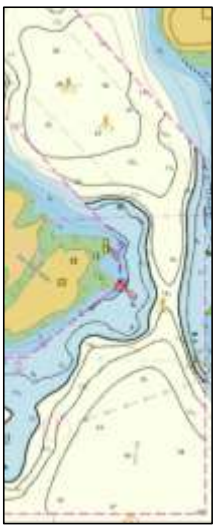
HD ENC Cell Creation

There are two options for creating HD ENCs:

1. **Existing cells** – including additional depth contours in existing commercially available cells

HD bathymetric data can be included in any navigational purpose so long as the product is the largest scale ENC available in the area. In some cases these areas will probably require a larger compilation to support the extra detail provided (M_CSCL).

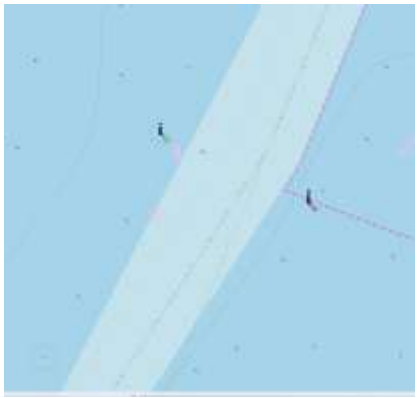
Standard ENC



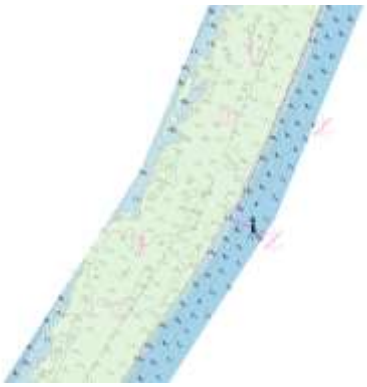
ENC containing HD bathymetric data

The images above show the impact on the available safe water when additional contours are included.

2. **New cells** – Navigational Purpose band 6 berthing cells, standalone product (HD ENC). It is expected that the majority of HD bathymetric data will be included in new cells created in Berthing. This approach is preferred as it simplifies the updating process.



Classic Navigational Purpose 5 ENC view



HD ENC view

Cell Naming

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When ordering or viewing HD ENCs the Mariner should be able to differentiate the HD ENC cells from standard ENCs. Where possible this will be achieved by naming the cells following this specification:

CCPHXXXX.EEE

| | | | | |----- EEE = update number

| | | |---------- XXXX = individual cell code

| | | ---------- H = permanent HD prefix to indicate there is HD data within cell

| |---------- P = navigational purpose

|---------- CC = producer country code

The main part forms an eight-character identifier where:

- the first two characters identify the producer. This list is given in the IHO publication **S-62 List of Data Producer Codes**
- the third character indicates the navigational purpose
- the fourth to eighth characters are used for the cell code. This code can be used in any way by the producer to provide the unique file name. If characters other than numbers are used only uppercase letters are allowed.

A valid base cell file must be uniquely identified worldwide by its name and have the extension 000.

The extension is used for updating. Update cell files have the same name as the original base cell file, with an extension number greater than or equal to 001. They cover the same geographical area as the base cell file to which they apply.

Where its not possible for the cell name to be used to identify an HD ENC its recommended that a Sea Area (SEAARE) be captured over the whole cell. The attribute Information (INFORM) will be populated with the text **'HD ENC, additional contours are present in this ENC cell'**

Cell Size

The current 5mb limit to the size of ENC cells was set many years ago when computer systems had issues with the management and storage of large volumes of data. This no longer poses a problem for ECDIS and with the reduction in cost of satellite communications there now is no longer the sam restraint on the delivery of this data over the internet. As such the HD ENC cell limit will be set at 5mb but can exceed this limit if necessary

Quality of Bathymetric Data

To ensure the mariner has access to all the metadata related to the bathymetric survey the feature M_QUAL must be used. It is strongly recommended that M_SREL and the attributes POSACC, SOUACC and SUREND are also used to relay important information about the survey TECSOU the technique of sounding measurement.

CATZOC values must be A1 or 2 Multi beam +Single beam = A2

Validation tests

Apply existing

Automatic Generation of Depth Contour intervals and sounding spacing

HOs are free to determine density of contours It is recommended that a contour density of 1m is used as this represents the most useful value for the user.

For use in ECDIS HD ~~ENC~~ data does not need to extend from 0m > 50m, the most useful data range is between 5m to 30m.

The use of denser sounding patterns (50-100m spacing) may be beneficial to support the navigation of large vessels that may still require higher accuracy than 1m contour intervals. In these cases, an evenly spaced sounding pattern (automated sounding suppression routine) is preferred over a triangular spacing. The first one is faster to generate and there's no expectation that the mariner may sail 'from sounding to sounding'. It is important to remember that soundings are not part of the S-52 'Standard' display and they can be turned off at any moment.

Note: When DRGAREs exist within the area of HD bathymetry the use of 'supplementary' contours matching the design depth of dredged areas is highly recommended (i.e. 7.6m).

Setting SCAMIN on Contours

SCAMIN must be applied to the standard contours (i.e. 2, 5, 10, etc) in a way they match the values of the same contours outside the area of HD bathymetry. Depth contours having the same VALDCO must appear and disappear at the same time irrespective if they sit within or outside the HD bathymetry area.

To avoid excess clutter within the ECDIS it is recommended that SCAMIN is applied to the intermediate contours so they are either not visible or only visible at compilation scale (of the HD ENC or the M_CSCL). The decision depends on the sea bottom topography and on how close the contours are at compilation scale. S-58 check to see if this is an issue ignore

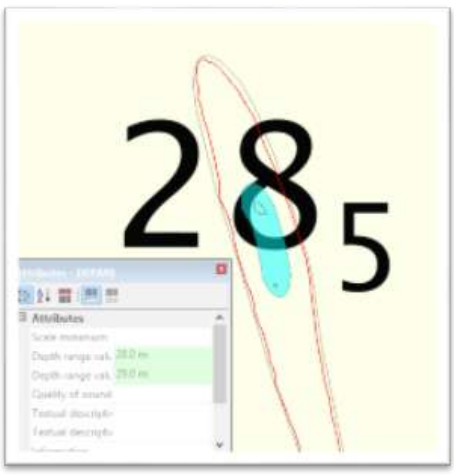
Managing Shoals and Deeps

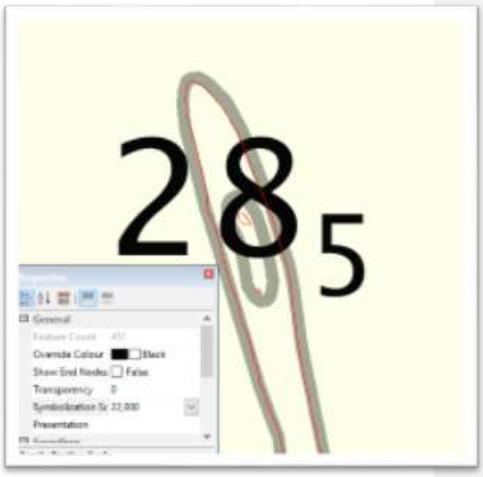
The automated contouring process generates contours that are too small to be easily be displayed at compilation scale, it is advised that no area should be smaller than 2.75mm at compilation scale.

Examples screenshot of generalisation and enlarging of contours.

Commented [AS2]: Lates input from the DQWG is that ther are some discussions at the moment on using the attributes POSACC and SOUACC as part of the safety parameters to be considered by the future S-100 when calculating safety margins during route planning and monitoring.

Commented [AS3]: At the AHO, HDbENCs do not have restrictions regarding the minimum size of isoalted shoals. The view is that mariners won't use visual interpreataion of contours while sailing and they will trust the ECDIS' safety parameters and alarms instead. Our HDbENCs exist in port areas where pilotage is compulsory. Pilots are well aware of the results of post dredged surveys (they receive the data directly from the surveyors) and therefore an alarm trigereed by a very small 'shoaling' shouldn't take them by surprise. The priority in these types of products is to show the depth contours as true to the real worls as possible. On the other hand, for any other product and when contours are generated automatically from a bathymetric surface, we use 4mm diameter as the minimum size of isolated ahoals. This is the diameter for S-52 OBSTRN points and UWTROC with no VALSOU. The AHO presented a paper at NCWG4 (but we haven't seen any recomendations from them yet) about the 'minimum size of isolated shoals'.
More discussions are needed if we want to mention a specific number here !





Maintenance of HD ENC cells

HD ENCs must have an update frequency of at a minimum weekly, however where there is a requirement to release the data more regularly this would be possible with the agreement of the RENCs.

For post-dredged surveys the HO's should be capable of processing the data and releasing an ENC update within 2 weeks from data receipt.

Commented [AS4]: Each area ids different andmay have different reuqirements and expectations from stakeholders. Each HO will have to deal with them on a case by case basis. In our case the survey is asseses and validated (including data cleaning, documentation etc). The time the cartos have to do their job is 5 working days.