

Enhance Berth to Berth Navigation Requires High Quality ENC's – The Port ENC – a Proposal for a New Port Related ENC Standard

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ABSTRACT: The Hamburg Port Authority (HPA) was about 42 month, between May 2006 and October 2009, the work package leader for the Port ECDIS work package within the integrated European research project named EFFORTS (Effective Operation in Ports). The Port ECDIS team was completed by the company's SevenCs (Germany), CARIS BV (The Netherlands) and the ISSUS Maritime Logistics / TUHH (Germany). The HPA was responsible for the development of a proposal for a new Port ENC standard which can be used for navigation in ports on board of vessels, in PPU's (Portable Pilot Units), in VTMI-Systems, in a state of the art marine simulator, for port maintenance and other harbor related tasks. Masters and pilots approaching a seaport usually use an Electronic Chart Display and Information System (ECDIS) to obtain the required navigational information they need. Also the Harbor Master needs the same up-to-date information for the admission process and to organize a safe and ease navigation in the port area. The common ECDIS standard supports navigation in the open sea and coastal areas; the Inland ECDIS standard was developed for navigation on inland waterways. The chart requirements for maneuvering big ships in confined waters like narrow fairways (harbor access channels), turning and harbor basins, for port maintenance (dredging), fairway and channel design and construction work, for TUG operation and for traffic management (VTMIS) are not sufficiently covered by the current ECDIS and Inland ECDIS standard with respect to chart scale, accuracy, chart objects, attributes ("object catalogue", in future "feature catalogue") and topicality and call for a special Port ENC. Managing bigger vessels, increasing traffic, less harbor space, berth organization, dredging purposes etc. requires accurate and up-to-date high-resolution geographic and bathymetric data to provide all necessary information. The Port ENC it is not just about producing better electronic charts (the Port ENC or PENC) to be shown in the navigation displays of various applications. Port-ECDIS addresses user groups of other domains as well (maintenance, dredging, planning, simulation, engineering, TUG assistance, VTMIS, voyage or route planning). Often they have the need to look at the data not only as a chart but also in 3D. That means additional data representations are required. The Port ENC must be able to interact with other port related data sources for a more beneficial use and to improve the interoperability of harbor related tasks. The Port ENC could also play a fundamental role in the e-Navigation concept!

1 WHY A PORT ECDIS?!

1.1 Introduction

Ports are the hubs of global trade with the need of the highest level of topographic and hydrographic information to fulfil special requests regarding safe and ease of navigation, manoeuvring, turning, docking, berthing et cetera. That takes into account the special requirements Harbor Masters, Pilots, Ship Officers, TUG operators, Transport Execution and Port Maintenance have! This requirement should be

fulfilled by the Port Hydrographer! That's a real challenge, because safe and efficient arrival/departure of ships and their cargo is most crucial for ports!

Increase of vessel sizes versus less harbor and manoeuvre space, Minimum Under Keel Clearance and special requirements for minimum dredging call for the highest level of accuracy and reliability of digital chart information for navigation in fairways, turning and port basins currently not met by equipment according to SOLAS V Carriage requirements!

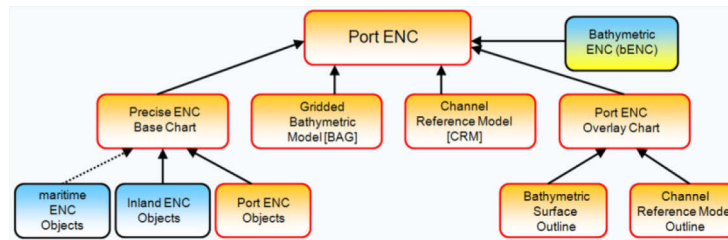


Fig. 1: The Port ENC component

The common IHO ECDIS standard for maritime ENC's supports navigation in the open sea, coastal areas and in seaports (like the Port of Hamburg), the Inland ECDIS standard for Inland ENC's (IENCs) and was developed for navigation on inland waterways and uses the same accuracy and quality definitions like the maritime ECDIS standard, but both without meeting the requirements ports have regarding precise navigational, manoeuvring, berthing, turning, docking, maintenance, up to-dateness, scale and accuracy aspects!

Port ENC requirements go far beyond the current maritime ECDIS and Inland ECDIS standards regarding up-to-dateness, quality, accuracy, large scale charts, chart features/objects and attributes and reliability of hydrographic data (Bathymetry) and geographic data (Topography). For Port operations, there are special requirements for vertical and horizontal accuracy. That is achieved by using modern sensor technology. The same accuracy must be inherent in the underlying electronic charts, the Port ENC's. This type of source data (e.g., topography and hydrographic data) has to be made available by the Port Authorities using a standardized data format, the proposed Port ENC standard, because they are responsible for this task. So the Port Authorities as a kind of public institution should be an approved Port ENC producer, I think!

At present, there is no standard or extensions considering the special requirements of port operations! That calls for a specific "Port ECDIS", the Port ENC standard. The following figure shows the different components of the Port ENC, including gridded bathymetry and a 3D channel reference model and also ready for using the 7Cs bathymetric ENC.

The Port ENC standard should be an independent but complementary standard to maritime ENC and Inland ENC (see below).

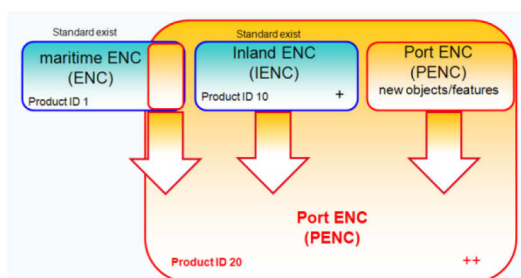


Fig. 2: ENC gradation including the Port ENC

The development of a Port ENC standard focuses on high precision operations in ports. A Port ENC intended to align with the ongoing developments for maritime and Inland ENCs with respect to the new IHO standard S100. And Port ENC data should serve as the missing link between maritime and Inland ENCs, because seaports are often the link between maritime and inland shipping.

Using a Port ENC as the base, it must be possible to overlay other types of information to improve the interoperability of harbor-related tasks, for example navigation and ship – manoeuvring and docking by Pilots using Portable Piloting Units (PPUs) including the Port ENCs. Also the Port Authority can use the Port ENC for dredging and maintenance activities at channels, piers and berths and the same Port ENC can be used as base for traffic management and route planning in the nautical centre (VTMIS).

1.2 IHO S57 and S44 Standards – comments

IHO Standards do not provide significant topographic source data for integration in ENC's. No dedicated accuracy requirements are defined that apply for different navigational purposes / categories (e.g., port operations). Within ENC's and Inland ENC's, the IHO S-57 Zone of Confidence (ZOC) assessment is used to describe the quality of bathymetric data, but the Zone of Confidence (ZOC) is not used for topographic data!

| ID | | S-52 representation |
|-------------|-------------|---------------------|
| bathymetric | topographic | |
| 1 | 1 | Zone A ** |
| 1 | 2 | Zone B * |

Tab.3: S-52 representation for the meta object "Accuracy of ENC data"

Fig. 3: Port ENC encoding guide proposal

The IHO S57 Standard and the latest IHO S44 Minimum Standard for hydrographic surveys should be harmonized in terms of their accuracy data.

As in figure 3 shown, within the Port ENC we combined accuracy arguments for the bathymetric and topographic information and represent these two classes with a Zone A or Zone B symbolisation. The highest accuracy level for a Port ENC (Zone A) has to fulfil IHO S44 Special Order Survey and a horizontal and vertical accuracy for fixed topographical objects relevant for berthing, docking et cetera better than $\pm 0,1$ m. The second level (Zone B) has also to fulfil S44 Special Order Survey and a topographic accuracy level better than $\pm 0,5$ m. This is much higher than in the current ECDIS standard!

An example is the official ENC of Hamburg, produced and issued by BSH (Federal Maritime and Hydrographic Agency / Germany). It meets all the relevant ENC related standards and fulfills the requirements for maritime navigation (SOLAS V carriage requirements), but the ENC is too small in scale, does not have any bathymetric detail, does not show up-to-date information and includes poorly defined horizontal accuracy for topographic features such as quay walls, piers, pontoons, et cetera. A comparison of the official maritime ENC and the new developed Port ENC reveals the following: the official maritime ENC is not suitable for special operations within the port area! To be fair, the official BSH - ENC has a different purpose to meet (usage band 5 - harbor), but must be used as official ENC in the Port of Hamburg to fulfil SOLAS V carriage requirements.

2 THE PORT ECDIS WORK PACKAGE – TASK OVERVIEW

Task 1 – Potential user requirements (Meetings, workshops, structured questionnaire)

Task 2 - Port ENC - Technical specification

- accuracy; precision of topography and aids of navigation; special new Port ENC objects (features and attributes); precise 3D depth information using Digital Terrain Models (DTM) technologies; 3D gridded bathymetry, 3D reference DTM (the Channel Reference Model CRM)

Task 3 – Prototype of a Port ENC

- Port ENC dataset of the Port of Hamburg, including precise Port ENC chart data, so named 3D gridded bathymetry (in BAG format), bathymetric ENC's (bENC) and a 3D channel reference model (CRM).

Task 4 – Testing of prototype(s)

- Tests on board of HPA survey vessels; test using a PPU on board of a container vessel, functional tests onboard of a Trailer Suction Hopper Dredger (TSHD) and during docking process of a cruise liner.

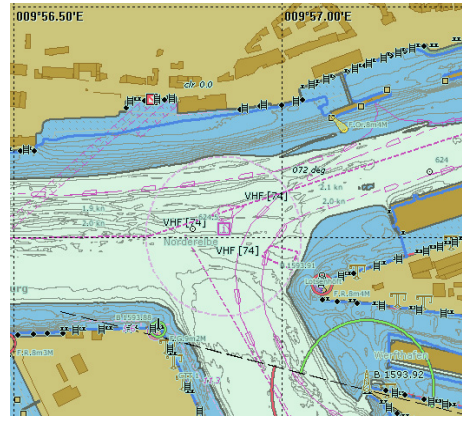


Fig. 4: Port ENC + bENC (Bathymetric ENC)

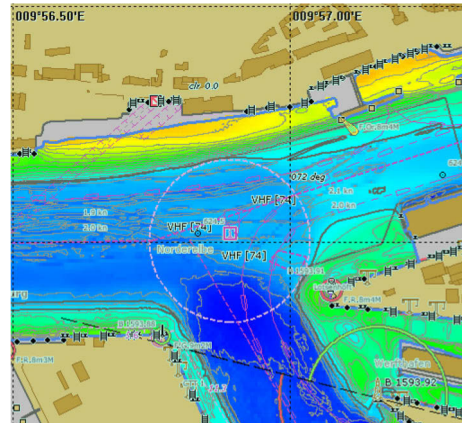


Fig. 5: Port ENC + 3D Gridded Bathymetry

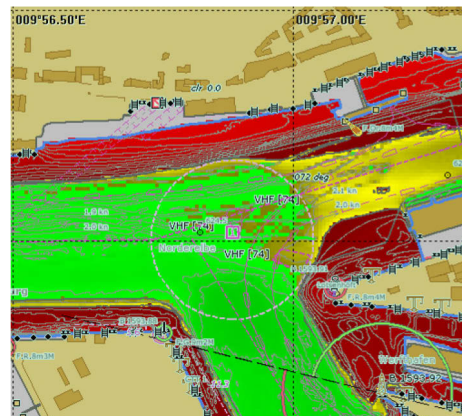


Fig. 6: Port ENC- calculated safety depth

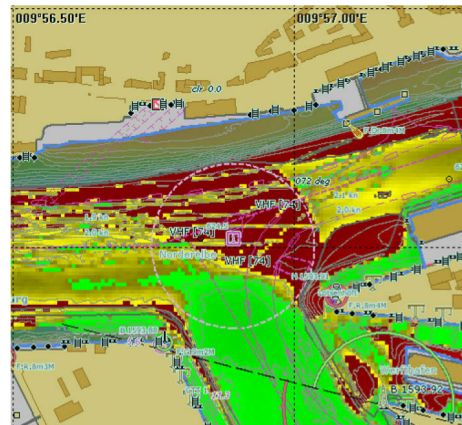


Fig. 7: 3D Gridded bathymetry data versus CRM

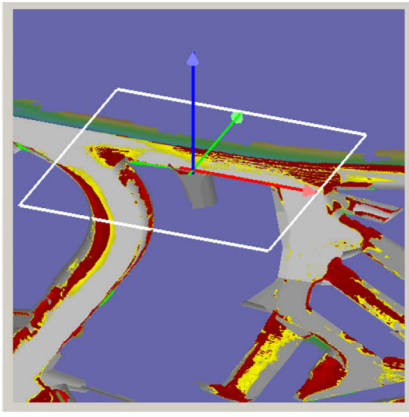


Fig. 8: 3D gridded bathymetry data versus CRM

The figures 4 – 8 giving an overview about the results specified in Task 2 of the Port ECDIS work package.

Task 5 – Defining requirements for follow-up developments and standardization (Port ENC - Roadmap).

- The Port ENC can be used as base information within a PORTIS (Port Information System) which also includes AIS, Radar, VTMIS, Route Planning, dredging information, river and port basin maintenance information, current and velocity, tidal information etc. Follow-up work to enhance the prototype, widen its application and organise standardisation was described.
- Port ENC can also be used in Marine Simulators (ship handling, tug simulator...) et cetera.

3 PORT ECDIS WORK PACKAGE RESULTS - OVERVIEW

- The outcome of the Port ECDIS work package was a proposal and comprehensive concept as basis and input for European / international standardization proved by validation and functional tests in the Port of Hamburg. We produced a paper about the "Definition of present Data Quality in Standards used for ENC data (S57 versus S44 standard) – current situation" and some Port ENC specification documents like a "Port ENC Feature Catalogue", a "Port ENC Encoding guide (representation and symbolisation) and the "Port ENC Product specification". A Port ENC prototype (software and dataset) of the Port of Hamburg including a Port ENC viewer was also developed. We made a lot of very successful tests using the Port ENC prototype (based on basic dataset). All the tests running very successful, delivering very promising results and demonstrating the outstanding quality and accuracy of the developed Port

ENC (report)!! At least we wrote a "Port ENC follow-up requirements document".

- The very successful result of the EFFORTS work package 1.3 - Port ECDIS could be only a proposal and comprehensive concept for a new Port ENC standard. It can be currently only a first step.
- The results were distributed to a lot of official bodies like IHO, IMO, IALA, IHMA, IMPA et cetera and should be discussed also within the global Port and Harbor community and with navigation related organizations (currently started). I think main Ports like Singapore, Rotterdam et cetera and also Hamburg should produce their own precise Port ENCs, because they are responsible for safe and ease of navigation in the port area. The Hamburg Port Authority thinks about how to set it up best.

4 CONCLUSIONS

The outcome of the Port ECDIS work package was a proposal and comprehensive concept as basis for European and international standardization proved by validation and functional tests in the Port of Hamburg.

The Geographic and Hydrographic Department of the Hamburg Port Authority produced a very precise and up to date Port ENC test dataset of the Port of Hamburg area which meets the user requirements of the involved nautical participants like Harbor Masters, Pilots and Port maintenance bodies like dredging, TUG operators, marine simulator and others.

The definition and scope of the IMO draft strategy for the development and implementation of E-Navigation focused on marine information on board and ashore by electronic means to enhance berth to berth navigation and related services. So I think, the Port ENC can play an important role and could/must be a core component for E-Navigation

REFERENCES

- IHO Publications, Standards and Specifications:
S52, S57, INT 1, S100 et cetera.
- SEEFELDT, D., HOFFMANN, R., ROWAN, E.: Port ECDIS – Enhanced ENC Standard for Port Operations, Hydro International, Vol. 14, Sept./Oct. 2010, p. 19-23, 2010.
- Links:
<http://www.hamburg-port-authority.de/presse-und-aktuelles/aktuelle-themen.html>
<http://www.efforts-project.org/index.html>