



ECDIS issues related to the implementation of the carriage requirements in SOLAS Convention

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ABSTRACT

In the paper the author tries to present the results of monitoring the implementation of the Electronic Chart Display Information System (ECDIS) to ensure that issues identified in regard to the anomalous operation of some ECDIS are collated, analyzed, communicated and resolved as speedily as possible to maintain the safety of navigation and to assist the smooth transition from paper to digital navigation.

Keywords: ECDIS, electronic navigational charts, IMO, marine navigation, ITS, transport telematics, safety of sea transportation, SOLAS Convention

1. Introduction

In accordance with the directive agreed by the 18th International Hydrographic Conference [2], the International Hydrographic Organization (IHO) continues to monitor the implementation of the Electronic Chart Display Information System (ECDIS) to ensure that issues identified in regard to the anomalous operation of some ECDIS are collected, interpreted, analysed, communicated and resolved as fast as possible to maintain the safety of navigation and to assist the smooth transition from paper to digital navigation, from Standard Navigational Charts (SNCs) to Electronic Navigational Charts (ENCs) [10].

IHO endorsed the following resolution [2]:

- Recognizing the IHO's role in the development of ECDIS and its active support to IMO in the endorsement of a carriage requirement for ECDIS that started in 2012;
- Furthermore recognizing the issues with regard to the anomalous behaviour of some ECDIS systems that have come to light through increasing operational experience and the actions already taken by the IHO and the International Hydrographic Bureau to assist in facilitating their resolution;

- The IHO is encouraged to continue to take a leading role within the ECDIS stakeholder community to ensure that issues identified in regard to the anomalous operation of ECDIS are collated, analysed, communicated and resolved to maintain the safety of navigation and to assist the transition to digital navigation.

Unfortunately, there are vessels at sea with a type approved ECDIS that will not pass the recent IHO checks based on the latest IMO safety requirements.

1.1. ECDIS anomalies

A number of ECDIS operating anomalies have been identified on the base of reports from users on board ships.

These anomalies are particularly apparent in ECDIS units that have been built and type-approved to ECDIS Performance Standards (resolution A.817(19) [6]). However, ECDIS units type-approved to the revised ECDIS Performance Standards (resolution MSC.232(82)) [4] are still vulnerable to the limitations in appendix, item 5(a).

An ECDIS anomaly happens when ECDIS behaves in an unexpected or unintended manner that affects the use of the

equipment or navigational decisions. Reported anomalies include, but are not limited to [5], [7], [8]:

- failure to display a navigational feature correctly, such as:
 - navigation areas recently recognized by IMO such as ESSA (Especially Sensitive Sea Area), PSSA (Particularly Sensitive Sea Area) and ASL (Archipelagic Sea Lanes);
 - lights with their complex characteristics; and
 - underwater features and isolated dangers;
- failure to detect objects by “route checking” in voyage planning mode;
- failure to alarm correctly; and
- failure to manage a number of alarms correctly.

Due to the complex nature of ECDIS, and in particular because it involves a mix of hardware, software and data, it is possible that other anomalies may exist without being reported.

The existence of such anomalies highlights the importance of maintaining ECDIS software to ensure that operational capability and reliability are maintained in accordance with SN.1/Circ.266/Rev.1 [7]. It is recommended that appropriate checks are made with the equipment manufacturer. This is of particular importance where ECDIS is the only source of chart information available.

1.2. IHO Test Set of Data

The International Hydrographic Organisation (IHO) has produced an ECDIS Data Presentation and Performance Check (DPPC) dataset that allows mariners to check some important aspects of the operation of their ECDIS. This dataset contains two fictitious ENC cells which navigating officers can load into their ECDIS units to assess operating performance and to determine whether there may be any display anomalies that either need to be remedied or otherwise managed in the way that the ECDIS is operated. If the check highlights a problem, the accompanying guidance notes with the check dataset offer suggested courses of action. The check dataset and accompanying instructions can be obtained from ENC service providers, or can be downloaded from the IHO website at: (www.iho.int) [11].

IHO has identified 19 key anomalies in the way that ECDIS displays data. It believes that there is a real need for live validation of data used in ships’ primary navigation systems. To this end, the IHO have issued a test set of data with two Electronic Navigational Chart (ENC) cells and five tests to allow the Master to see whether software is up to date and if wrecks and shoals are displaying correctly. If any shortcomings are revealed, it is likely that the software will need upgrading. In the meantime, Masters may need to take extra measures, such as employing particular equipment operating procedures.

2. IHO treatments

By the end of January 2012, the IHO had received results of the checks on ECDIS from almost 400 seagoing respondents [3]. There are a number of possible reasons for the limited response rate. Not all mariners may have received the data, others may not have reported their findings if the checks were successful, some

may have been unable to respond easily due to the lack of internet-based communications aboard.

2.1. IHO ECDIS and ENC data check

The IHO ECDIS and ENC Data Check has revealed a number of shortcomings in some manufacturers’ systems being used at sea, particularly in older systems. The results received by the IHO so far cover 15 of the approximately 25 (as known by the IHO [3]) manufacturers of type-approved ECDIS. Whilst the number of responses received so far is relatively low in comparison with the total ECDIS fit throughout the world fleet, there are nevertheless some common issues in the results that merit further consideration.

A significant number of ships reported that they were unable to clearly identify the recently IMO-adopted ASL, PSSA or ESSA on the ECDIS display. Some ships reported that lights with complex characteristics such as multiple coloured sectors were not displayed as intended by the IHO. The display of underwater features and isolated dangers was reported as variable across the different manufacturers’ ECDIS models, however, in most cases the display gave a safe, if not entirely correct, interpretation of the ENC data. A high proportion of ships reported that navigationally significant objects, most importantly, some land features, but also “areas to be avoided” and a marine aquaculture installation, did not raise an appropriate warning in the route checking mode of ECDIS. Operating the ECDIS display in “full” rather than “standard” display mode, will overcome a number of the anomalies – but at the risk of creating a more cluttered display. Few ships in the nearly 400 reports received by the IHO appear to have an ECDIS that successfully passed all parts of the IHO checks.

With regard to anomalies for which the only mitigating action is to refer to paper charts, such as the inability to display certain wrecks and underwater obstructions in any mode of operation, these anomalies appear to apply to one manufacturer only. The IHO has made that manufacturer aware of the situation and has requested information be provided urgently on what remedial action is being taken and how affected vessels are being contacted to alert them to this shortcoming.

The checks that have produced negative results vary both between manufacturers and also between different software versions from the same manufacturer. No check reveals the same failure across all the ECDIS models produced by the 15 manufacturers’ systems reported to the IHO. This appears to confirm that certain parts of the requirements of the ECDIS standards have been interpreted and implemented in different ways by different manufacturers. Several IHO working groups are already reviewing the relevant standards to make them as clear as possible. The results also indicate that as problems become known, continuing improvements have been made to individual manufacturer’s software over time. However, the results also indicate that even when a manufacturer has updated or improved its software, this does not appear to be widely implemented in ECDIS equipment already in use at sea through an appropriate upgrading or software maintenance regime as described in SN.1/Circ.266/Rev.1 [7].

2.2. ENC/ECDIS data presentation and performance check for ships

While between 1 August 2011 and 15 April 2013 1042 reports have been received, one year later between 15 April 2013 and 15 April 2014 already only 76 reports. As of 1 December 2014, 74 additional reports have been received since the previous analysis reported at NCSR 1. Although this number remains small, the outcome seems to indicate a continuing improvement in the updating of ECDIS software, as shown in table 1. Fifty-five per cent of the reports indicate no problems, against 22% and 43% in the previous analyses. Less than 5% of the reports indicate an anomaly in the display of “new objects” against 40% and less than 10% in the previous analyses. No new issue has been identified.

Table 1. Outcome of ENC/ECDIS data presentation and performance checks for ships [5]

Period	1 August 2011 15 April 2013	15 April 2013 15 April 2014	15 April 2014 1 Dec. 2014
Number of reports	1042	76	74
% of reports indicating no problem	22%	43%	55%
% of reports indicating no anomaly in the display of „new objects“	60%	91%	95%

The feedback from the survey confirmed a number of known issues related to:

- the difference between paper chart symbols and those used to display ENCs;
- ECDIS not displaying ENC features as expected or as required;
- inconsistencies between ENCs and paper charts or between ENCs of different scales; and
- the promulgation of temporary and preliminary notices to mariners in ENC updates.

IHO is well aware that there is still scope for improvement in the production and maintenance methods used by Hydrographic Offices to enhance the way ENCs operate in ECDIS as well as to improve ENC consistency. For this reason, ECDIS users are strongly encouraged to continue providing feedback on any issues of concern that they have with IHO is well aware that there is still scope for improvement in the production and maintenance methods used by Hydrographic Offices to enhance the way ENCs operate in ECDIS as well as to improve ENC consistency.

3. Maintenance of IHO standards for ECDIS

As reported to NAV 59, the relevant IHO working groups began a review in 2012 of the IHO standards related to ECDIS. This was as a consequence of the investigations into the anomalous operation of some ECDIS. As reported at NCSR 1, the following new editions of IHO Publications related to ECDIS were published in 2014:

- Edition 6.1.0 of S-52 – *Specifications for Chart Content and Display Aspects of ECDIS*;
- Edition 4.0.0 of S-52 – Annex A – *IHO Presentation Library for ECDIS*; and
- Edition 3.0.0 of S-64 – *IHO Test Data Sets for ECDIS*.

In relation to the revision of IEC Standard 61174 [1] – *Maritime navigation and radiocommunication equipment and systems – Electronic chart display and information system (ECDIS) – Operational and performance requirements, methods of testing and required test results*, the production of a normative reference that supports the requirement for an “ENC Update Status Report” showing the status of ENC data to the end-user (for operational planning) and to the relevant authorities (for such purposes as Port State inspection) appeared necessary. Further consideration led to acknowledging the need to enhance IHO Publication S-63 – *IHO Data Protection Scheme* with a new Annex C describing the functionality required to provide an ENC Update Status Report. Subject to its approval by IHO Member States, a draft revised Edition 1.2.0 of S-63 incorporating the new Annex C should be published in February 2015.

In accordance with the schedule presented at NCSR 1, the date of entry into force of the new editions of S-52 and S-64 will be aligned with the date of publication of the new edition of IEC 61174. From that date, the new editions will be the normative references for the type approval of new ECDIS. The current editions will remain in force for 12 months beyond the date of entry into force of the new editions. This means that if the date of entry into force of the new edition of IEC-61174 is 1 September 2015, then the current editions of S-52 and S-64 will remain valid until 31 August 2016. This transition interval is intended to provide manufacturers and national authorities with an appropriate interval in which to type approve new ECDIS products in accordance with the revised standards, and to enable shipowners and operators to update existing systems to conform with IMO circular SN.1/Circ.266 [7], as amended, concerning the maintenance of ECDIS software.

Compliance with the new annex to S-63 will apply only to those ECDIS systems that will be type-approved in accordance with the new edition of IEC 61174. There will be no retrospective impact on existing ECDIS systems.

The revision of IHO Publication S-66 – *Facts about Electronic Charts and Carriage Requirements* was initiated in 2014. The draft new edition, reflecting the changes that have occurred since the first edition (January 2010), is expected to be available for review by mid-2015.

A new structure of the IHO working groups responsible for the maintenance of IHO standards governing the provision of hydrographic services has been adopted in order to reflect the changing focus from paper to digital data based products and services, the best use of limited resources, improvements in their efficiency and to facilitate inputs from industry and other stakeholders. The maintenance of IHO standards for ECDIS, which was shared between the Transfer Standard Maintenance and Applications Development WG (TSMAD) and the Digital Information Portrayal WG, is now regrouped under the ENC Standards Maintenance Working Group (ENCWG). A separate WG, the S-100WG, will lead the development of IHO standards for IHO e-navigation-based services [9].

4. ENC Coverage

In parallel, IHO continues to monitor the status of ENC coverage. Table 2 summarizes the global availability of ENCs by comparing the availability of paper charts intended for international voyages with the availability of corresponding ENCs. The figures are based on data available as of 1 December 2014.

Table 2. Comparison of ENC coverage with corresponding paper chart coverage [5]

	May 2009	May 2011	May 2013	April 2014	December 2014
Small-scale ENCs (planning charts)	~100%	~100%	~100%	~100%	~100%
Medium-scale ENCs (coastal charts)	77%	88%	90%	90%	91%
Large-scale ENCs (top 800 ports)	84%	94%	96%	97%	97%

Another concern is the existence of some overlaps between adjacent ENCs produced by neighbouring countries, notably in areas where the limits of waters of national jurisdiction between two neighbouring countries are not established. In order to assist in addressing these issues, IHO Member States have been invited to agree on the definition of a “cartographic boundary” (or “cartographic limit”) as the agreed limit to clip overlapping nautical charts or related data between two neighbouring countries. The limit shall not be signified or regarded as a political or jurisdictional boundary. It should be as simple as possible so both data compiler and the data user will be provided with the most coherent service possible.

Noting the inability of some ENC producers to agree on a solution, the IHO is also considering initiating a project, in liaison with ECDIS manufacturers, to investigate technical solutions addressing the display of ENCs where these overlap.

The relevant Regional Hydrographic Commissions have been invited to report on their analysis of any remaining gaps in ENC coverage and to identify possible actions to the next meeting of the IHO Working Group on the World-wide ENC Database (WEND), which will take place in March 2015. It is worth noting that so far, the IHO has received no input from shipping operators which identifies specific areas where there are shortfalls in ENC coverage.

A working group led by Singapore has been formed to carry out a pilot project to explore technical solutions to resolve the unpredictable performance of ECDIS caused by overlapping ENC coverage, notably in areas where the limits of waters of national jurisdiction between two neighbouring countries are not established. ECDIS manufacturers have been invited to take part in the project via the ECDIS Committee of the Comité International Radio-Maritime (CIRM).

4.1. The status of the global ENC production

IHO was set the task of ensuring adequate global ENC coverage, based on the requirements and needs of the IMO, to support the use and implementation of the Electronic Chart Display and Information System (ECDIS). This was a major and far from straightforward task and achievement, considering the financial implications for HOs, the implementation of new technologies and the support and capacity building that some of the HOs required. There is still much work to be done. However, ENCs are now available for most ships sailing in most parts of the world. There are still some gaps, particularly for those areas not in high priority shipping areas. These gaps need to be closed as soon as possible. And as with any new product based on advanced technology, some shortcomings have been identified both with ENCs and with some ECDIS equipment. These various shortcomings have been recognized and the IHO, in close cooperation with all relevant stakeholders, is working to remedy them.

The 5th Extraordinary International Hydrographic Conference (EIHC-5), which met in Monaco from 6 to 10 October 2014, reviewed progress in the global implementation of the IHO worldwide ENC database concept (WEND) and instructed the IHO Inter-Regional Coordination Committee to assess further the situation and perspective in relation to availability, consistency, coverage and quality of ENCs. It was noted that most, but not all States that produce ENCs include their ENCs in the WEND system.

EIHC-5 supported the development of IHO guidelines for an IHO-led crowd-sourced bathymetry programme. This will provide the opportunity for the world’s shipping to contribute directly to obtaining depth data, using mainly existing ship’s equipment while on passage to improve our knowledge of the world’s seas, oceans and navigable waters and thus the improvement of nautical charts.

4.2. The status of Hydrographic Surveying and Nautical Charting Worldwide

The recent focus on ECDIS and ENC coverage by the IMO and by mariners more generally, has drawn particular attention to the state of many charts around the world. They are based, in many cases, on old or inadequate hydrographic information and there are still many areas where there is no data available at all.

Overall hydrographic data acquisition capacity is declining, and coastal States in some of the less well charted parts of the world, do not yet have satisfactory arrangements in place to ensure that surveys are carried out in their waters.

4.3. ENC World Coverage – IHO WEND

Hydrographic data is at the core of ECDIS. The International Hydrographic Organization (IHO) is of the opinion that the quantity and coverage of good hydrographic data around the world is mostly unsatisfactory. Meanwhile, the overall hydrographic data acquisition capacity of its member States is declining. Is there a proper appreciation of the quality and reliability of the data behind the image displayed on the screen? Does the digital presentation of nautical charts give a false sense of security?. The Electronic Navigational Chart (ENC) is a database which enables the navigator to selectively

build a virtual image on a base map to suit the dynamic situation. Uncritical acceptance of the reliability of the core data is potentially problematic.

Status of hydrographic surveying and nautical charting worldwide does not justify unqualified confidence in ECDIS. Mariners need to allow for the limitations of legacy survey data by constantly monitoring their position relative to the uncertainty of the charted information. The IHO has also cautioned that there are anomalies both with ENC data and many ECDIS platforms.

Figures 1 – 3 present overview ENC coverage for global usage, band 1 – 3 [11].

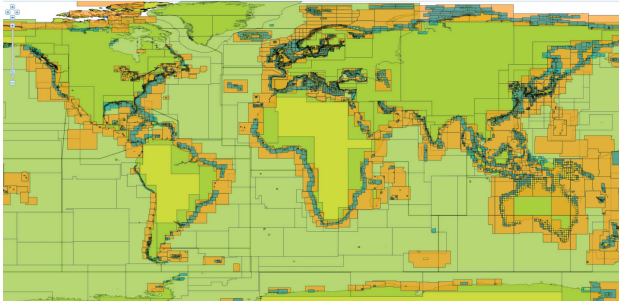


Fig. 1. Global Usage Band 1 – Overview ENC Coverage, December 2014 [11]

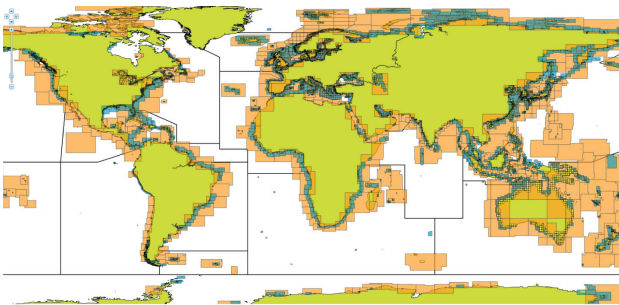


Fig. 2. Global Usage Band 2 – Overview ENC Coverage, December 2014 [11]

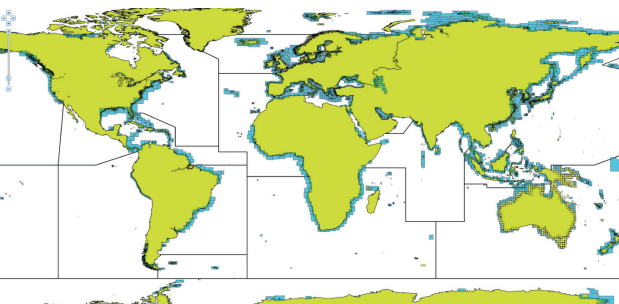


Fig.3. Global Usage Band 3 – Overview ENC Coverage, December 2014 [11]

5. Conclusion

Some ECDIS systems do not correctly display safety critical features. This is due either to anomalies with the ENC data or the ECDIS equipment. With the former, when isolated shoal depths are encoded in a particular way i.e. shoaler than the range of depth of the surrounding depth data, they will not display when operating ECDIS in Base or Standard display mode. Isolated shoal soundings may not trigger anti-grounding alarms in any mode of display. The system may be unable to recognise isolated land areas in sparsely surveyed areas containing little bathymetric information. This led to IHO creating a test dataset to check ECDIS performance. Such checks have revealed shortcomings in some manufacturers' systems being used at sea, particularly in older systems.

Resolving the known issues with ECDIS operating anomalies is progressing normally with the active involvement of all key stakeholders. No major new issue has been identified since 2011.

With the uptake of ECDIS use associated with the entry into force of carriage requirements since 1 July 2012, vigilance and attentiveness are still relevant. The IHO will continue to monitor the evolution of ECDIS and the associated standards, actively pursuing ways to resolve any future issues whenever they arise.

The IHO welcomes further feedback from all stakeholders concerning ECDIS operation and maintenance. The IHO also welcomes feedback from stakeholders about ENC coverage and in particular the identification of specific areas where ENC coverage is still considered to be lacking.

In 2012 IMO published the guidance to mariners on dealing with operating anomalies, which have been identified in some ECDIS systems [8].

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