

ANOMALOUS ECDIS OPERATIONS

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Abstract

The Electronic Chart Display and Information System (ECDIS), in conjunction with other recent technologies such as Radar and Automatic Information System (AIS) has practical benefits to facilitate safe navigation and bridge watchkeeping. The ECDIS capability however is suffering from ongoing issues including Electronic Navigation Chart (ENC) data encoding inconsistencies, differences between the content shown on paper charts and the corresponding ENC, overlapping and conflicting ENC coverage and the interpretation and application of the IHO's S-52 Presentation Library to display ENC symbols. This paper addresses the International Hydrographic Organization's (IHO) effort to collect, analyze and resolve these problems so that they can be addressed by the appropriate agencies and organizations in order to maintain safety of navigation.



Résumé

Le système de visualisation des cartes électroniques et d'information (ECDIS), conjointement avec d'autres technologies récentes, telles que le radar et les AIS, présente des avantages pratiques qui favorisent la sécurité de la navigation et les pratiques de veille sur la passerelle. La capacité de l'ECDIS souffre toutefois de problèmes récurrents y compris des incohérences dans le codage des données des cartes électroniques de navigation (ENC), des différences entre le contenu qui apparaît sur les cartes papier et les ENC correspondantes, ou de l'existence de chevauchements et de couverture ENC contradictoires et de l'interprétation et de l'application de la Bibliothèque de présentation de la S-52 de l'OHI pour présenter les symboles des ENC. Cet article aborde les efforts de l'Organisation hydrographique internationale pour rassembler, analyser et résoudre ces problèmes afin qu'ils puissent être résolus par les agences et organes appropriés dans le but de maintenir la sécurité de la navigation.



Resumen

El Sistema de Información y de Visualización de la Carta Electrónica (ECDIS), junto con otras tecnologías recientes como el radar y el Sistema de Identificación Automática (AIS), tiene beneficios prácticos para facilitar una navegación segura y para las tareas de guardia en el puente. Sin embargo la capacidad del ECDIS se ve afectada por temas en desarrollo incluyen: incoherencias en la codificación de datos de la Carta Electrónica de Navegación (ENC), diferencias entre el contenido mostrado en las cartas de papel y la ENC correspondiente, el solapamiento y una cobertura discordante de ENCs y la interpretación y aplicación de la Publicación S-52 de la OHI – Biblioteca de Presentación, para representar los símbolos ENC. Este artículo trata sobre el esfuerzo de la Organización Hidrográfica Internacional para reunir, analizar y resolver estos problemas, de modo que puedan ser tratados por las agencias y organizaciones adecuadas para mantener la seguridad de la navegación.

Importance of ECDIS

Numerous studies have been conducted concerning the importance of Electronic Chart Display and Information System (ECDIS). Some of these studies concern the physical state of the mariner whilst other studies related the mental state whilst using the ECDIS technology. A study conducted by the Russian Federation [2], found a reduction in a user's pulse rate by some 10-12% when using ECDIS compared with others who were not using it. The mariner's ability to handle navigationally-challenging areas such as maneuvering to avoid a collision with other vessels in close proximity, is significantly improved when using ECDIS. Another important benefit is the intelligent integration of the radar image and Automatic Identification System (AIS) information with the ECDIS display brings further practical benefits to facilitate safe navigation and bridge watch keeping. ECDIS is also used for pre-sailing activities such as voyage planning, execution and monitoring. [1]

ECDIS Anomalies

Because of the benefits that ECDIS provides, several concerns have been raised about identified ECDIS anomalies. These anomalies could be that ECDIS equipment at sea does not perform optimally or as expected because of shortcomings in the nature of the ENC data, the ECDIS software implementation, the implementation of current IHO ECDIS-related standards, and/or various combinations of these and other factors.

International Efforts

Several efforts have taken place internationally to address these ECDIS anomalies. Examples of these efforts are listed below:

- At the 88th session of the International Maritime Organization (IMO) Maritime Safety Committee (MSC), Japan, Norway, the United Kingdom, the International Chamber of Shipping (ICS), and the International Federation of Shipmasters' Associations (IFSMA) submitted document MSC88/25/6 on "Operating anomalies identified within ECDIS". [3]
- UK made a presentation entitled "ECDIS Anomalies and Safety Implications". [3]
- The UKHO and the UK Maritime and Coastguard Agency co-hosted a technical workshop in London attended by invited experts to review the current situation with reported ECDIS issues. The participants comprised 23 leading ECDIS experts from IHO Member States, ECDIS manu-

facturers, type-approval laboratories, training establishments, professional mariner and industry bodies, and maritime Administrations. [4]

- The International Hydrographic Bureau (IHB) hosted the workshop in Monaco on 15-16 February 2011. The workshop was attended by 37 leading representatives from stakeholder groups including the IMO Secretariat, IHO and IMO Member States, Intergovernmental Organizations, Non-Governmental International Organizations, data service providers, ECDIS manufacturers and type-approval authorities. The Chair and Vice-Chairs of IHO HSSC and TSMAD working groups also attended the workshop. [5]
- UKHO has found over 900 differences between paper charts and their equivalent ENC product that have potential significant implications for navigation safety. These differences cover 400 ENC cells from 30 different producer nations. [6]

IHO Standards for ECDIS

IHO Circular Letter 46/2011 [7] identified the current status of the IHO ECDIS related Standards and these are listed in **Table 1**.

IHO Standard	Name	Effective date of latest edition
S-57 Edition 3.1	IHO Transfer Standard for Digital Hydrographic Data	November 2000
S-52 Presentation Library Edition 3.4	IHO Presentation Library for ECDIS	January 2008
S-63 Edition 1.1	IHO Data Protection Scheme	March 2008

Table 1. IHO ECDIS Standards

Based on the above standards, any ECDIS purchased before 1 January 2008 will not have been built or type-tested in accordance with the latest IHO chart standards. Mariners, whose ECDIS software is not up to date, should contact the manufacturer or the service agent for assistance. [7]

One of the main concerns is that the ECDIS software is not conforming to the latest IHO standards. It should be possible to interrogate the operating software in any ECDIS to determine if the latest standards have been implemented by the manufacturer. However, the method for finding this information differs from system to system and is not always easy to locate. In any case, it does not necessarily guarantee that the latest IHO standards have been comprehensively implemented. For these reasons, the IHO developed a test data set in the

form of three dummy ENC cells that mariners can use to check if the latest IHO Standards have been implemented in their equipment. All together, there are six different tests designed to check the status of the ECDIS [7]. The tests require that you load the three dummy ENC cells. The six tests involve looking carefully at various chart objects contained in the ENC cells.

For this paper, 5 of the 6 tests have been consolidated into 3 Checks as follows:

- Check 1 – Display of navigation areas recently recognized by the IMO.
- Check 2 – Display of complex lights.
- Check 3 – Display of underwater features and isolated dangers.

A final test involving the detection of objects by route checking in voyage planning mode was not included in a Check as the software being tested are not ECDIS equipment but ENC viewing software.

Check Results

Even though these tests are designed to check ECDIS performance, they have been run on two ENC viewers. The ENC viewers are HYPACK ENC Editor 12.0.0.0 and CARIS Easy View 2 (freely available from the CARIS home site). The tests were conducted on 16th June 2012.

Check 1 – Display of navigation areas recently recognized by the IMO

Figure 1 illustrates four symbols that should be displayed to highlight navigation areas that were recently adopted by the IMO and resulted in changes to S-57. These areas include:

- Archipelagic Sea Lane (ASL)
- Environmentally Sensitive Sea Area (ESSA)
- Particularly Sensitive Sea Area (PSSA)
- Also included in this Test is an encoding of a new IHO object called NEWOBJ which will display as a black square and have labeled text “Presentation Library 3.4”. This test is to display a new chart object without any change to the IHO Presentation Library.

Figures 2 and **3** illustrate how the HYPACK ENC Editor 12.0.0.0 and CARIS Easy View 2 display the features.

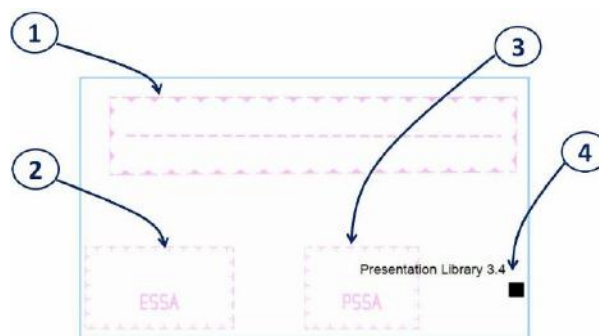


Figure 1. Correct display of 4 objects based on the S-52 Presentation Library edition 3.4

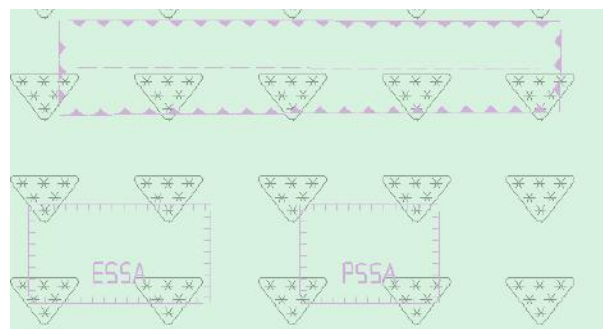


Figure 2. HYPACK ENC Editor 12.0.0.0 depiction of the 4 objects

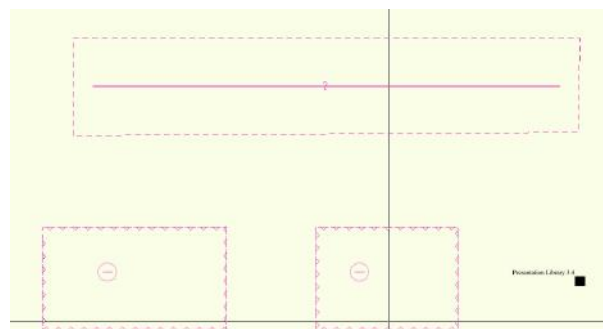


Figure 3. CARIS Easy View 2 depiction of the 4 objects

As shown in Figures 2 and 3, HYPACK ENC Editor 12.0.0.0 managed to show Archipelagic Sea Lane, Environmentally Sensitive Sea Area and Particularly Sensitive Sea Area symbology correctly but CARIS Easy View 2 could not. However, CARIS Easy View 2 shows the Presentation Library 3.4 symbology but HYPACK ENC Editor 12.0.0.0 doesn't show it.

Check 2 – Display of complex lights

Figure 4 shows how complex light should be shown along with light characteristics.

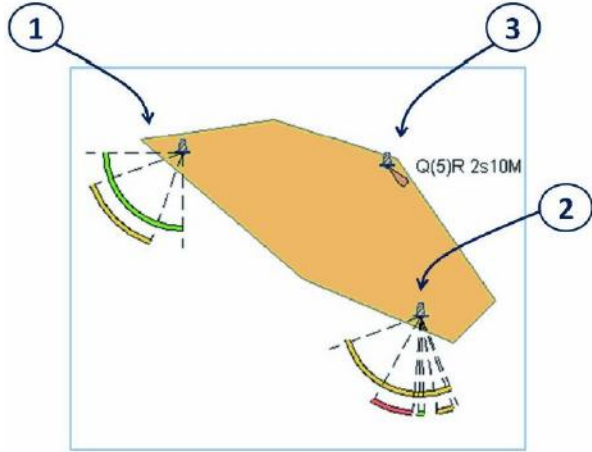


Figure 4. Correct display of complex lights objects.

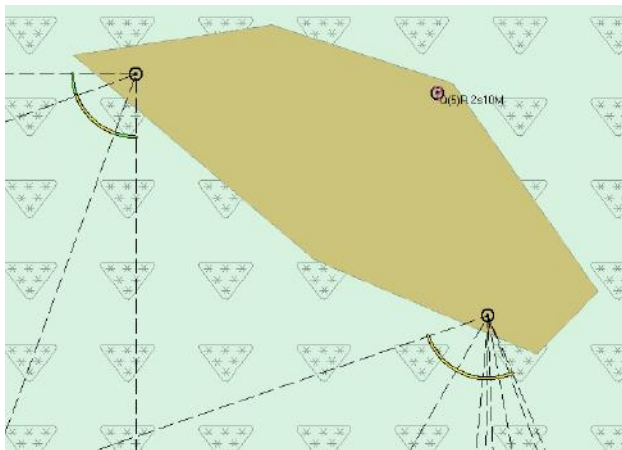


Figure 5. HYPACK ENC Editor 12.0.0.0 depiction of the complex light objects.

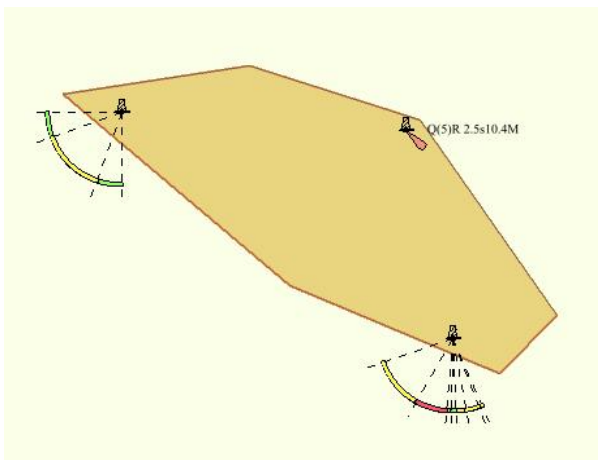


Figure 6. CARIS Easy View 2 depiction of the complex light objects

As shown in **Figures 5** and **6**, both packages fail to depict the correct sector light symbol meanwhile both depict the light characteristics correctly.

Check 3 – Display of underwater features and isolated dangers

The display of obstructions and isolated dangers in ECDIS is complex. Unfortunately, not all ECDIS equipment performs as intended by the IHO Standards. This test is intended to confirm that the more common display issues are not present in the ECDIS display.

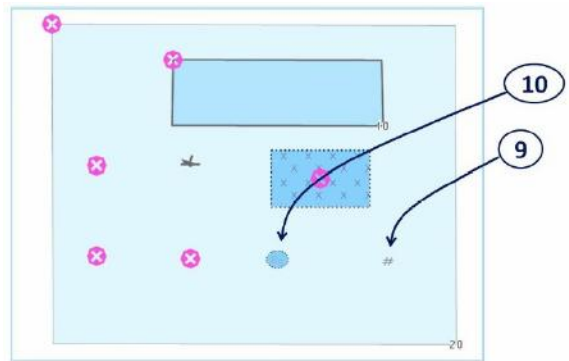


Figure 7. Correct display of isolated dangers in OTHER mode with 10m safety contour/safety depth

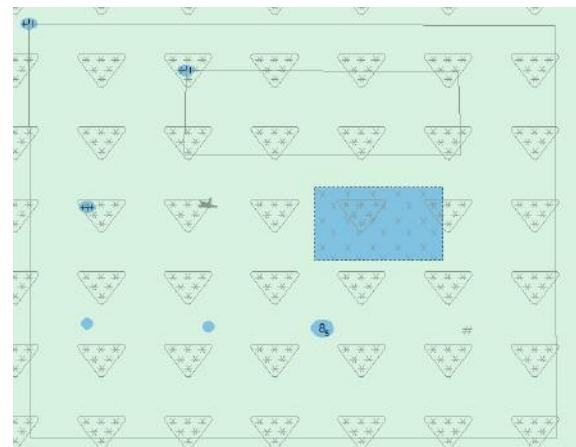


Figure 8. HYPACK ENC Editor 12.0.0.0 depiction of the isolated dangers.

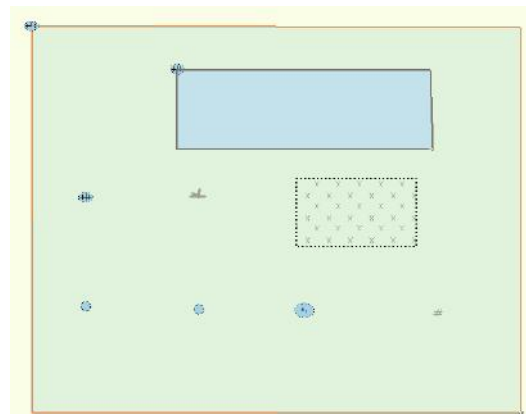


Figure 9. CARIS Easy View 2 depiction of the isolated dangers.

According to **Figures 8** and **9**, both packages depict the isolated dangerous symbols labeled 9 and 10 correctly.

The results of these tests have been sent to both software manufacturers. HYPACK Company upgraded its ENC Editor 12.0.0.0 to comply with IHO standards and will be released in the next version.

ECDIS Validation Test Results

The IHO's ENC Data Presentation and Performance Check was issued in October 2011. By the end of February 2012, 500 reports from testing parties had been received. These reports covered 15 out of approximately 25 recognized and widely used type-approved ECDIS manufacturers.

The results were divided into three major findings;

- One third of the systems fulfill the check and function as expected;
- A further third display all significant underwater features, including underwater obstructions, but the isolated danger symbol required to be shown under certain conditions is not always used; and
- Most of the remaining third failed to display some significant underwater features in the "Standard" display mode. All these features are however displayed in the "Full display" or "All display" modes. [8]

The analysis of results that were received by IHO shows that:

- A significant number of ships reported that they were unable to clearly identify the recently IMO-adopted ASL, PSSA or ESSA objects on the ECDIS display;
- Ships reported that lights with complex characteristics such as multiple colored sectors were not displayed as intended by the IHO standards;
- The display of underwater features and isolated dangers was reported as variable across the different manufacturers' systems. 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 navigational significant objects, such as certain land features, "area to be avoided" and marine aquaculture installations, did not raise an appropriate warning in the route checking mode of ECDIS;
- Few ships in the nearly 500 reports received by the IHB, appear to have an ECDIS that successfully passed all parts of the IHO checks;

- The checks that have produced negative results vary between manufacturers and different software versions from the same manufacturer.
- No check reveals the same failure across all 15 manufacturers' systems reported to the IHB. 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. [9]

ECDIS Non-Conformance – recommended actions

- If after applying the IHO test and finding that the ECDIS is not complying, the mariner should contact the manufacturer to upgrade the ECDIS software. Until ECDIS has been upgraded it is recommended to perform certain actions depending on what test your ECDIS fails to satisfy.
- During the test, the following areas should be displayed - ASL, ESSA, PSSA, as well as the New Object. If these areas are not displayed on the ECDIS screen, and the borders contain "?" marks, interrogate all "?-?-?" type borders or "?" symbols, using the function usually known as Chart Query or Chart Pick. If any symbol could not be seen at all, it is essential to consult other nautical publications during the route planning phase including Sailing Directions and Mariners' Routing Guides, to identify the existence of ESSA, PSSA and ASL and then include them manually as Mariners Objects in the ECDIS.
- Symbols of different sector light and light characteristics should be displayed. If they are not shown at all or not shown correctly, notes should be recorded.
- During the voyage planning phase, cross-check the information about lights shown on ECDIS with the information shown in the relevant List of Lights.
- Among the objects that should be displayed during the test, are underwater and isolated dangers. If any of the objects are not displayed, it is essential to consult other sources of information such as paper charts and publications to ensure that all underwater dangers and isolated dangers are identified.
- The last check on this test is the detection of objects by route checking in voyage planning mode. If hazardous objects don't raise alarms in voyage planning, it is recommended to carry out a visual examination so as to detect them and to highlight them manually in ECDIS as "manual updates".

Conclusions

ECDIS is an important enabling technology to improve navigation safety. ECDIS software, just like any system on the ship's bridge, must be maintained and kept up to date. The mariner's awareness of the need to upgrade ECDIS software should be improved. In using ECDIS systems that fail to adequately show underwater features, the mariner must navigate in conjunction with the paper chart to ensure that all wrecks and underwater obstructions can be properly identified.

References

- [1] DEVELOPMENT OF CARRIAGE REQUIREMENTS FOR ECDIS, Proposal to amend regulation 19 of SOLAS chapter V.
- [2] DEVELOPMENT OF CARRIAGE REQUIREMENTS FOR ECDIS, IMO, NAV 54/14, 2008.
- [3] International Hydrographic Organization, Circular Letter, 83/2010, Monaco, 2010.
- [4] International Hydrographic Organization, Circular Letter, 86/2010, Monaco, 2010.
- [5] International Hydrographic Organization, Circular Letter, 19/2011, Monaco, 2011.
- [6] International Hydrographic Organization, Circular Letter, 40/2012, Monaco, 2012.
- [7] International Hydrographic Organization, Circular Letter, 46/2011, Monaco, 2011.
- [8] International Hydrographic Organization, Circular Letter, 33/2012, Monaco, 2012.
- [9] International Hydrographic Organization, Circular Letter, 18/2012, Monaco, 2012.

Biography

Dr. Mohasseb is currently the head of the Navigation Division in the Egyptian Naval Hydrographic Office and a Hydrographic survey instructor at the Arab Academy for Science and Technology and Maritime Transport (AASTMT), Alexandria, Egypt. He received his CAT B certificate from US Naval Oceanographic Office in 1998, his Master of Science degree from AASTMT in 2001 and a PhD degree from AASTMT in 2006 with the award of best dissertation. He then achieved CAT A certification and his Master of Science with the award of Outstanding Academic and Practical Performance from the University of Southern Mississippi in 2009.
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Note from IHB :

At the time of publication, IHB can report significant progress has been made by ECDIS manufacturers and software producers to address the anomalies identified. As a result of discussions between IHO, IMO and various key stakeholders, considerable efforts have been made by manufacturers to contact system users to provide up-grades which meet the IHO Standards. Performance monitoring remains an ongoing task. For further information see the IHO website: [ENC & ECDIS](#).