Paper for Consideration by WENDWG
Mitigating Navigational Risk Involving Overlapping ENCs with Inverse Band-Scale Relationships

Submitted by:	USA (NGA)
Executive Summary:	Feedback to NGA from ECDIS users and systems testers indicate a safety of navigation concern in specific scenarios where two or more overlapping ENCs have an inverse relationship between the navigation purpose and compilation scale of the overlapping cell coverages. This interaction is not prescribed by the IMO ECDIS Performance Standards nor IHO S-52 or S-57 and can lead to unpredictable ECDIS behavior, including failure to provide alarms for or display hazards to navigation. The WENDWG is recommended to engage, through proper protocol, with the ENCWG to fully investigate the level of risk these scenarios present, and to recommend to IRCC that these additional overlap scenarios be tracked and mitigated by RHCs, RENCs, and HOs.
Related Documents:	IMO Resolution MSC.232(82), Adoption of the Revised Performance Standards for Electronic Chart Display and Information Systems (ECDIS)
	IEC 61174, 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
	IHO S-52, Specification for Chart Content and Display Aspects of ECDIS
	IHO S-57 Appendix B.1 – ENC Product Specification
	IHO S-58, ENC Validation Checks
	M-3, Resolutions of the IHO, IHO Programme 2 "Hydrographic Services and Standards", 2.3 – Charts / 2.3.2 – INT, as amended 1/2018
	WEND Principles
Related Projects:	

Introduction / Background

ECDIS user and system tester feedback, provided from users of multiple ECDIS systems to NGA during its transition to ENC, revealed the possibility for certain navigationally-significant ENC objects to fail to trigger alarms or display on certain ECDIS systems.

This scenario presents when an ENC of any navigational purpose and compilation scale overlaps one or more ENCs of a "smaller scale" navigational purpose but larger compilation scale – e.g., a Band 4 cell compiled at 1:80,000 scale overlapped by a Band 3 ENC compiled at 1:50,000 scale. These types of overlaps occur most frequently in areas covered by different producers.

In these scenarios, objects contained in the larger (and often best-available) compilation scale cell may fail to trigger alarms and may not be displayed in certain ECDIS; if the ECDIS logic prioritizes cells by the "largest" navigational purpose, the objects of largest compilation scale are effectively displaced and ignored. A failure to alarm on any hazard, particularly those contained in the largest compilation-scale data, presents a serious risk to navigation safety.

In a review of the pertinent standards produced by IHO and IMO, NGA finds significant ambiguity about how to address this potentiality. That ambiguity yields the possibility for different ECDIS manufactured by different OEMs to handle this scenario in different ways, as was evidenced in testing by NGA's users.

Analysis of Standards

NGA reviewed multiple related documents which may prescribe how to produce, validate, and display ENC, and relevant sections with comments follow.

The IMO Revised Performance Standards for ECDIS state:
> *6.1 ECDIS should provide an indication if:*
> > *.1 the information is displayed at a larger scale than that contained in the ENC; or*
> > *.2 own ship's position is covered by an ENC at a larger scale than that provided by the display.*
> *…*
> *11.2 The largest scale data available in the SENC for the area given should always be used by the ECDIS for all alarms or indications of crossing the ship's safety contour and of entering a prohibited area, and for alarms and indications according to appendix 5.*

Similarly, IEC 61174 – based on MSC.232(82) – states:
> *Section 5.2.1 Scale and Navigational Purpose*
> *(S-52/3.1.7.2) When the display cannot be completely covered with ENC data for the selected navigational purpose, the remaining part of the display shall be filled with data based on a more general navigational purpose (if available).*

Both the IMO and IEC standards describe how to load and prioritize data by scale, but the documents make little (if any) reference to product navigational purpose. It may be reasonably inferred, albeit incorrectly, that a cell having a "larger scale" navigational purpose than other overlapping cells would be of larger compilation scale. After significant discussion with one ECDIS developer, NGA found this false inference was indeed used to dictate the ECDIS logic for at least one system.

S-52 does provide reference to overlapping ENCs, as summarized:
- *ENC scale: The compilation scale of the ENC is the scale at which the ENC was designed to be played… as required by IMO PS 6.1.1, an overscale indication should be shown whenever the mariner selects a display scale that is larger than the compilation scale.*
- *Where ENCs of different navigational purpose overlap, the ECDIS display of the overlap area should show two "chart compilation scale boundaries", at the beginning and end of the overlap. Beyond one boundary the part of the display taken from the smaller scale ENC will often be grossly overscale.*

Quoted sections above do reference compilation scale and boundaries between charts of different compilation scales, but do not provide for a standard default loading behavior nor dictate how ECDIS should display objects impacted by these types of overlaps. Despite indication of overlap areas, if default behavior does not display the largest compilation scale data, it may not be obvious to the mariner whether they need to manually select and prioritize a chart of a "smaller" navigational purpose.

Discussion on Data Findings

After better understanding the causes for the issue at hand, NGA performed a cursory analysis on the IHO ENC Web Catalogue to estimate how many ENCs could present increased risk to navigation when loaded on an ECDIS which prioritizes cells by navigational purpose.

As of 2 December 2022, the IHO catalogue showed over 900 instances of one cell potentially superseding another by having a "larger scale" navigational purpose despite a smaller compilation scale.

It is important to note that NGA's analysis was limited to publicly available information available through the IHO catalogue. While the catalogue does provide cell coverage and compilation scale, that scale only shows the majority scale of ENC coverage (indicated by the DSPM object CSCL value). Cells with larger or smaller scale inset compilation areas, typically included in an M_CSCL object, are not available for analysis. It is likely that additional cells would be affected when considering M_CSCL, but it is difficult to estimate the prevalence.

It is likely the count of 900 would increase if accounting for cases involving M_CSCL areas. For example, a Band 4 cell compiled at 1:80,000 scale and overlapped by a Band 3 ENC compiled at 1:150,000 with a 1:50,000 inset M_CSCL would not be included in this cursory analysis, but would present the same safety of navigation concerns.

While NGA can estimate which cells could lead to unintended ECDIS behavior, at this time, NGA cannot assess the prevalence of ECDIS which include logic to prioritize cells by navigational purpose.

Conclusions

Work by the WEND, IRRC, and RENCs have captured some potentialities which introduce risk to navigation. Resolutions of the IHO under <u>Elimination of Overlapping ENC Data in Areas of Demonstrable Risk to the Safety of Navigation</u> provided recommendations on improving mariner safety by minimizing overlaps:
1. *It has been reported that overlapping ENC data, when used in ECDIS equipment, may lead to unpredictable behavior in at least the following cases:*
   a. *Overlapping data occurring in the same usage band (Navigational Purpose);*
   b. *Overlapping data occurring in ENC cells in different usage bands (Navigational Purposes) but using the same compilation scale.*

The scenario currently in question does not meet either of the above cases. It would fit a third case for overlapping data occurring in ENC cells in different usages bands (Navigational Purposes) where the band and compilation scale have inverse relationships.

Recommending against this overlap similar to other known overlaps types is the most pragmatic approach to mitigating the issue. With the majority of these inverse-relationship overlaps occurring across two different producers, guidance to and through RHCs is key in resolving these issues.

Potential safety implications side, one may also consider the resources Member States spend in maintaining coverage over these areas. It is feasible that producers are currently providing and maintaining redundant coverage when existing coverage exists within an unexpected navigational purpose, or providing and maintaining coverage which is displaced by these overlaps and not displayed for users on some ECDIS.

Recommendations

NGA recommends, as an initial step, the WENDWG engage with the ENCWG and seek to better assess the prevalence of navigational purpose preference logic across ECDIS OEMs and software.

If warranted by that prevalence, NGA recommends the following:
1. That the WENDWG recommend to IRCC amendment to the referenced resolution in M-3, describing a third overlap case that Hydrographic Offices should seek to eliminate.
2. Hydrographic Offices, ENC Producers, and Regional Hydrographic Commissions should take appropriate measures to eliminate all overlapping ENC fitting this new case, particularly in areas of demonstrable risk to the safety of navigation.

Justification and Impacts

The justification for this recommendation is the need for mariners using ECDIS to experience alarms and visualization for all hazards to navigation, particularly those available in the largest-scale ENC products.

Actions to be Considered by the WENDWG

The WENDWG is invited to:
1. Endorse the need for further investigation into risk presented by this new overlap case.
2. Engage, through appropriate channels, with the ENCWG to conduct more detailed investigation and analysis.
3. Pending further analysis, recommend to IRCC that Regional Hydrographic Commissions should track overlaps within their regions, note within the regional reports to the WENDWG and IRCC, and resolve the overlaps to the extent possible.
4. Pending further analysis, provide any guidance possible to Member States for how to best mitigate these overlaps, particularly when occurring across different producers.