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Problems with Overlapping ENC Data

Abstract

The number of Electronic Navigational Charts (ENCs) has increased significantly in recent years, and there is now sufficient worldwide coverage of the waters sailed by SOLAS vessels. The total number of ENCs published worldwide is about 15,000 and the number of producer nations is about 80.

Ideally, the entirety of all ENCs should form a consistent, high quality and coherent basis for navigation with ECDIS. In recent years, however, several stakeholders have reported that ENCs from different producer nations do not always form a perfect match. Cases of partially overlapping ENCs have been reported and caused confusion. Is this a real threat to the safety of navigation? This article addresses the reasons, potential implications for the ECDIS systems, and the steps proposed by the IHO to eliminate such overlaps.

The full English version can be downloaded from www.sevencs.com/articles

Introduction

Electronic Navigational Charts (ENCs) are produced for the navigation with ECDIS (Electronic Chart and Display System). Generally the so-called Hydrographic Offices (HOs) of the adjacent states produce ENCs of their own national territories. Some HOs produce electronic navigational charts for international waters and also vicariously for nations which do not have production capacities of their own.

Concerning ENC production there is quite a range of standards and specifications plus various publications with guidelines, recommendations and conventions. These are maintained and published by the IHO (International Hydrographic Organization) or one of its subcommittees. In this context the most important document is the IHO Standard "Special Publication 57" (S-57).

The Usage Principle

The "Use of the Object Catalogue" which belongs to S-57 serves chart producers as instruction and manual which describe in detail the rules of ENC production. Single ENC files cover a specific geographic area. Such files are also called "Cells". According to the size of the covered

area, scale and level of detail ENCs are grouped into different categories which are called “Usage” or “Navigational Purpose”. The following Usage Bands are defined:

Usage Band	Navigational Purpose
1	Overview
2	General
3	Coastal
4	Approach
5	Harbour
6	Berthing

If an ECDIS is set to the smallest possible display scale or the largest presentable area (e.g. Range 2000 nm), respectively, only ENCs of Usage Overview will be presented in the chart display. Now in case the zoom level is increased successively by and by the ENCs of the subsequent Usages will be displayed and superimposed. This is to accomplish that when loading the subsequent Usages the level of detail, the chart scale and the accuracy will be increased.

Each Usage constitutes a seamless chart layer. There is an almost worldwide coverage for the Usage Bands *Overview* and *General*. The coverages of the subsequent Usages roughly adapt to the corresponding Navigational Purpose, i.e. they will superimpose the relevant sea areas (e.g. *Coastal* for zones near the coast and *Approach* for the approach). However, per covered area they also constitute a seamless chart layer.

Usage 2, General

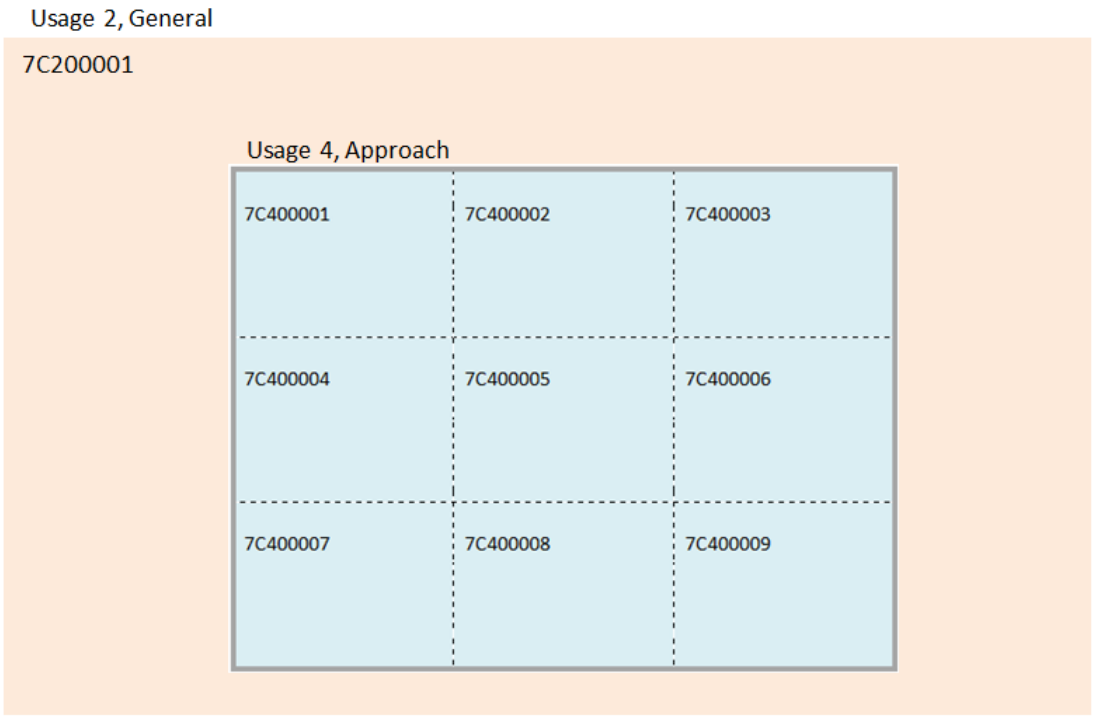

Fig. 1, Usage Principle

Figure 1 illustrates the Usage principle. The Approach layer consists of 9 single cells. They are connected seamlessly. The dashed border lines represent the borders of the single ENC cells. However, they are not depicted in the ECDIS chart display. The Usage border is visible where a higher Usage (e.g. *Approach*) superimposes a subordinate one (e.g. *General*).

The following figure 2 depicts such case. The Usage border is a grey line. In the lower area charts of Usage 4 superimpose charts of Usage 2.

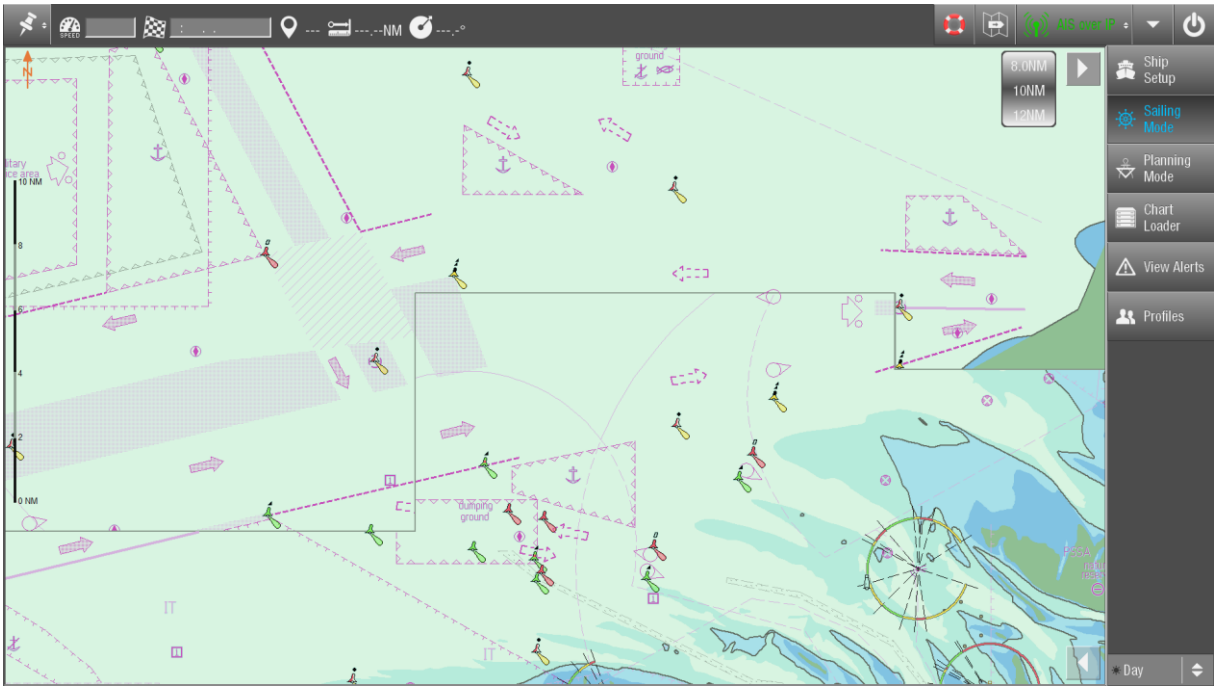

Fig. 2, Usage Border

Seamless ENC Layers

The chart producers must be familiar with the Usage concept described above, as the related aspects of chart production must be considered to ensure the correct display in ECDIS devices. The set of rules *Use of the Object Catalogue* mentioned above stipulates in chapter *2.1.8 Seamless ENC Coverage* that there must be neither gaps nor overlaps when editing adjacent cells of the same usage. In addition, it must be ensured that there is a smooth progression of geometry for chart objects (e.g. depth contours) which cross multiple cells. Only thus a consistent display of seamless chart layers in ECDIs can be guaranteed.

Where ENCs from different states touch it cannot always be assumed that the junctions can be perfectly harmonized. The effort needed for exchanging all required information would be too big. In addition, sometimes there are no consistent source data. The reason is that collecting and processing of source data are from different origin, and the authorities responsible may be different in various nations. That is why the *Use of the Object Catalogue* for such cases recommends to introduce a buffer zone of 5m in which overlaps of the same usage are considered as uncritical.

However, in reality it has to be stated that there is a considerable amount of overlaps of ENCs which do not comply with the standards (i.e. larger than 5m). This applies to data within one organisation as well as overlaps with ENCs of adjacent nations. This could constitute a hazard to navigation in case there are significant overlapping areas with chart inconsistencies. Extreme examples would be cases of discrepancies concerning the existence of dangerous underwater obstructions. ECDIS systems must indicate overlapping ENCs – nevertheless there may be situations when an ECDIS must "randomly" decide which ENC shall be displayed. Thus, there might be the threat that dangerous underwater obstructions are ignored.

IHO Measures for Eliminating Overlaps

Some years ago, the IHO has induced studies to determine whether this might be a merely theoretical danger. Since then the subject of *Overlapping ENCs* has been dealt with repeatedly in various IHO working groups and has been discussed in detail. There is the *Worldwide ENC Database Working Group (WENDWG)* which plays a significant role when it comes to realizing a world-wide, consistent and qualitatively well prepared ENC coverage.

In May 2016 the WENDWG was commissioned by the superior *Inter-Regional Coordination Committee (IRCC)* to create a draft for an IHO resolution concerning the subject of *Overlapping ENC Data*. In preparation of this resolution various members and supporters of WENDWG have conducted investigations concerning the subject of *Overlapping Issues* and have started projects of their own. The results were collected, documented, presented and discussed at the annual WENDWG meetings from 2016 until 2018.

In order to analyse the effects of overlapping ENCs e.g. the *International Centre for ENCs (IC-ENC)* has carried out a project utilizing well-prepared data. Overlaps had been artificially created. Then this data was installed onto five different ECDIS systems and tested. Finally, the results were presented in a report [1] and summarized as follows:

- Overlapping data has erratic effects on then display of ENCs.
- There is huge inconsistency between results in different ECDIS.
- The main negative effects are on panning across the cell and the pick report summary.

For example, it could be observed that it was not possible to foresee which of the two cells would take priority when shifting the chart section. Changing from one cell to the other was carried out at different positions when shifting to and fro. It even happened once that for a short time none of both cells was visible. During zooming it happened that the overlapping cells were displayed alternately for several times. Then there were cases when empty sections of one cell (displayed as greyish filling pattern – "No-Data Pattern") obscured data of the other cells (figure 3).

Fig. 3, Area without data (taken from report [1])

Inconsistencies also occurred when displaying the so-called Pick Report. The Pick Report lists all chart objects which were found during an object retrieval. Such retrieval is started by clicking or tapping at the respective position of the displayed chart section. When tested by the IC-ENC it was noted that there were discrepancies between the objects displayed in the chart and the description in the Pick Report.

In its report IC-ENC draws the conclusion that it would make most sense to deal with the problems described above by harmonization and coordination among the ENC producers. The tests have shown that display rules, object retrievals and other ECDIS functions require that there are no overlaps. These functions have been laid down in the strict standards and regulations valid for ECDIS. Thus, there is hardly a possibility for the ECDIS manufacturers to solve this problem by technical means.

Real Risk or Theoretical Problem

The tests conducted by IC-ENC clearly illustrate the problems which might occur in connection with overlapping ENCs, however, they do not give information on the relevance in practice. That is why IC-ENC have begun to take a closer look at overlapping ENCs and carry out a risk assessment. The survey was limited to data of those producing nations which are members of the IC-ENC. According to the *IC-ENC's Overlapping Data Policy & Reporting* [4] there were 246 cases of overlaps in January 2017. Some of them could be revised, while others were classified as acceptable. This led to a remaining number of 187 overlaps. For 117 the risk level was set to *low*, and for 26 to *medium*. There were no cases of high risk, but 44 cases had not been evaluated yet.

In March 2018 the United Kingdom Hydrographic Office (UKHO) published a report with a historical overview [5] of all ENC overlaps observed from 2012 until 2017. This report does not include e risk assessment. For the named period the number of overlapping ENCs could be reduced to 2.4% (453 out of 18,810). In 2012 the quota had still been 8.4%.

The *Regional ENC Centre Primar* offers the RHCs (Regional Hydrographic Commissions) an online service for checking overlaps of ENC data. RHCs have the task of coordinating and harmonizing cooperation and activities in the realm of hydrography on a regional level. The regional RHC commissions consist of representatives of IHO and non-IHO member states. Checking for overlapping ENCs can be carried out for a region or a nation. The result is then presented in a report with the respective ENCs, the manufacturing nation and the size of the overlap. This information serves the RHCs as a basis for recommendations on how to avoid or eliminate ENC overlaps. These recommendations are passed on to the single hydrographic organizations. In addition, the results are presented at the annual meetings of the WEND working groups.

Another aspect of the difficulties with overlaps is the view of the ENC users. Both aforementioned RENCs, Primar and IC-ENC, have published a paper [6] summarizing the results of a survey. This survey was aimed at ENC distributors and dealt with the frequency of reports concerning ENC overlaps by the ENC users. In summary it was stated in this study that ENC overlaps lead to irritations of the end users on board. However, no cases critical to the safety of navigation were reported. It was viewed negatively that the problems with overlaps might lead to concentrate on criteria other than the safety of navigation, for example costs.

Example from Real Life

ChartWorld International (service provider for ENCs, ECDIS and nautical publications) has kindly provided material for the documentation of a definite example of overlapping ENCs. According to ChartWorld employees there have already been multiple inquiries concerning this matter. In figures 4 and 5 the overlapping ENC 1 and ENC 2 are displayed separately. Figure 6 shows both ENCs and the overlap area.

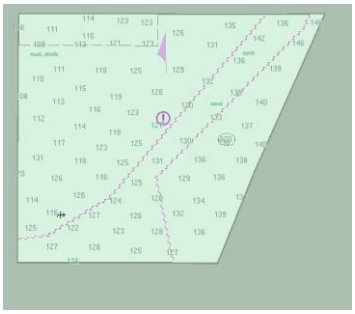

Fig. 4, ENC 1

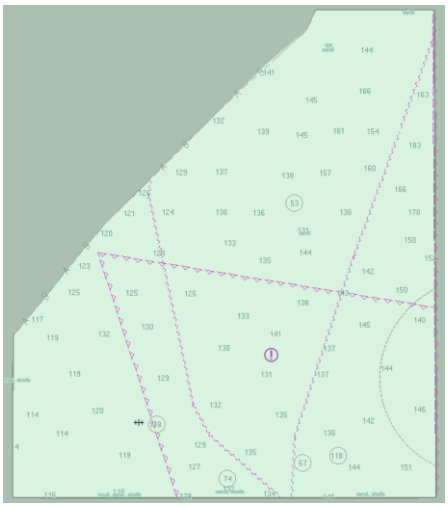

Fig. 5, ENC 2

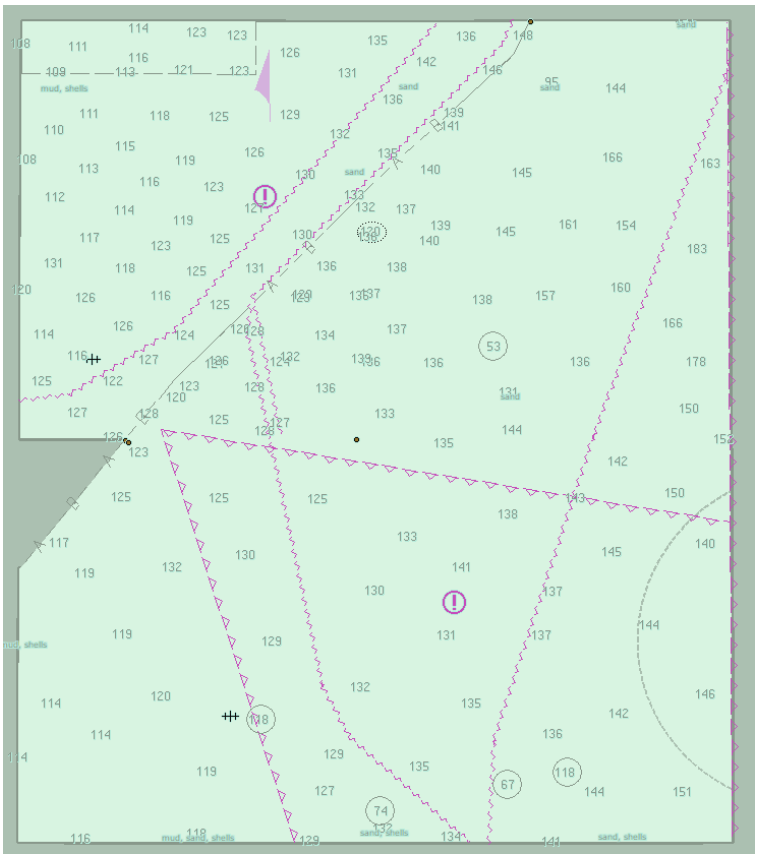

Fig. 6, Overlap area

Closer examination shows that there are slight discrepancies within the overlap area. There is a mismatch between corresponding depth values. From the display of the undersea cable it is not clearly discernible whether there are one or two objects.

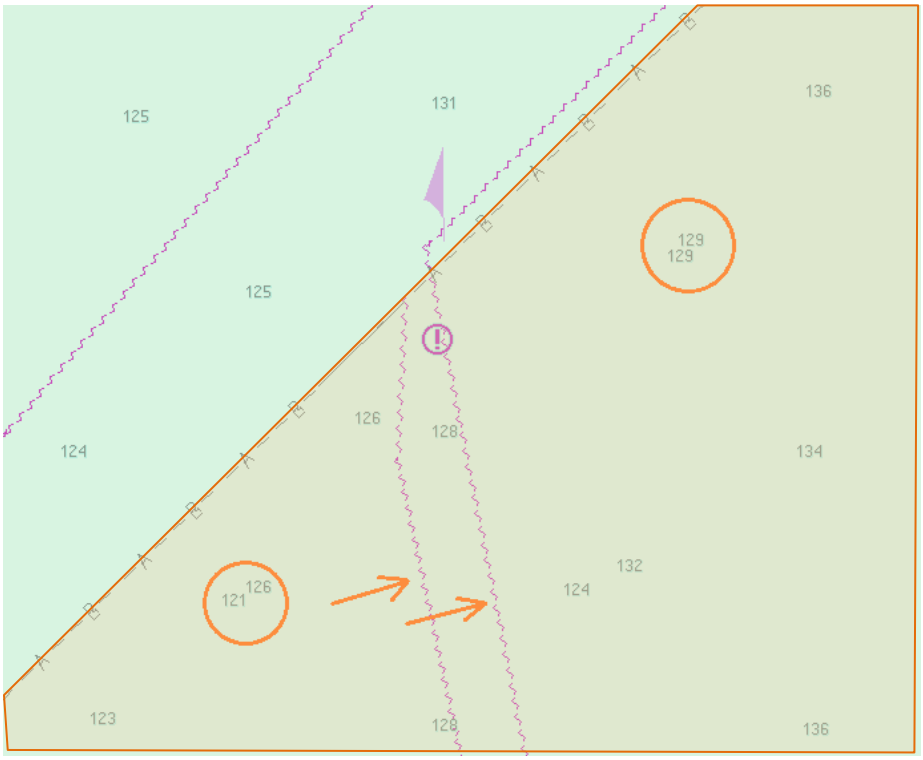

Fig. 7, Discrepancies in the overlap area

There were also differences in the Pick Reports. As one manufacturer warns against military operations and aquaculture the other manufacturer warns against SAR trainings.

So far, ChartWorld has not received any report on overlapping ENCs which from the user's point of view might constitute a hazard to the safety of navigation.

IHO Resolution

On 15 February 2018 the IHO announced that the draft of a resolution [7] concerning the elimination of overlapping ENC data which had been prepared by the WENDWG and was accepted by the IHO member states (with one vote against):

Hydrographic Offices, ENC Producers, and Regional Hydrographic Commissions should seek to:

- *Identify overlapping ENC data in all areas of significance to navigational safety within their areas of production or control;*
- *Prevent the increase of any such cases; and*
- *Resolve all those cases where a demonstrable risk to the safety of navigation exists, through discussion and negotiation between the relevant ENC producers, as soon*

as possible, and at least within one year of any such overlapping ENC data being reported or identified.

According to the resolution the following measures shall be taken: All participating organisations shall identify overlaps, prevent any enlargement and solve cases which evidently constitute a hazard to navigation. This shall be carried out within one year after the detection of the overlap by means of discussions and negotiations between the ENC producers concerned. It is pointed out that the RHCs, being regional coordinators of the associated national ENC producers, shall approach the ENC producers and actively participate in correcting the identified overlaps. In case an agreement cannot be achieved in urgent cases measures are to be taken to inform shipping companies via nautical warning and information services.

Summary

In summary, it can be said that the problems resulting from overlapping ENCs have been thoroughly discussed in various IHO working groups and committees. It has been succeeded in mapping the problems relatively well, both quantitatively and qualitatively. However, when it comes to a solution the IHO has no legal means. That is why it is concentrating on the cooperation of its members – the national hydrographic services. The ECDIS manufacturers also have only limited means to prevent overlapping ENCs from leading to dangerous situations when navigating with ECDIS. At least, ECDIS systems will display a warning whenever there are overlaps.

The reasons why such overlaps cannot be completely eliminated are less of a technical but rather a political nature. This becomes very clear in some of the comments issued by IHO member states in connection with the approval or rejection of the “Resolution on the Elimination of Overlapping ENC Data” [7]. It was criticized that there are nations which violate the following WEND principle: A nation is only responsible for the production of ENCs covering waters within its national territories. Another comment sums up the situation very well: “The existence of overlapping ENC data in areas where the limits of waters of national jurisdiction between neighbouring countries are not established due to varying interests is inevitable in reality for the time being.”

References:

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