Paper for Consideration by the NCWG

Improvement of ENCs display on ECDIS

Submitted by:	France
Executive Summary:	This paper points out various current shortcomings of the current display of ENCs on ECDIS and suggests improvements.
Related Documents:	S-52, S-57 UOC, S-101DCEG, S-101 Portrayal Catalogue
Related Projects:	S-101

Introduction / Background

The ENC/ECDIS standards (IHO, IMO and IEC) were elaborated around 1990 and haven't much evolved (mainly due to the hard work and long time that are needed from the decision of a change in the standard and its implementation in the ECDIS, but also to the need of stability to ease the use of ECDIS navigation). On the other hand, during these last 25 years, technology has made progress as regards, amongst others, to computers performances and the quality of the screens (size and definition).

Feedbacks from ECDIS users often point out different issues related with the use of ENCs on ECDIS.

This paper is a review of some of these issues. It is focussed on the display of ENCs on the ECDIS.

Analysis/Discussion

The display of an ENC on ECDIS is a consequence of several inputs:

- S-57 data in the ENC: how much data is encoded and how it is encoded (including SCAMIN rules);
- S-52 (symbols, display priorities, conditional symbology procedures, etc.) and "soon" S-101 portrayal;
- The ECDIS screen (size and resolution);
- The proper ECDIS functionalities (which may vary from one to another);
- SENC loading policy, taking account of the CSCL;
- The proper mariner's global experience (e.g. e-navigation education) and use of his ECDIS (e.g. personal settings).

This paper is only focussed on the display aspect, and especially on screen clutter. The discussion is based on the different parameters that have an influence on the display. It is also based on the principle that the ENC is derived from the paper chart and has about the same content. Some HOs have already started producing ENCs separately from the paper chart (and this is indeed a goal to achieve for all HOs), but it will take long years (if not decades) before having a worldwide "original" ENC portfolio.

1. The scale of the paper chart versus the Compilation scale (CSCL) of the ENC

One first question is: « What is the scale of a paper chart? ».

Let's consider the 2 examples below.

Chart A - 1 : 15 000 paper chart

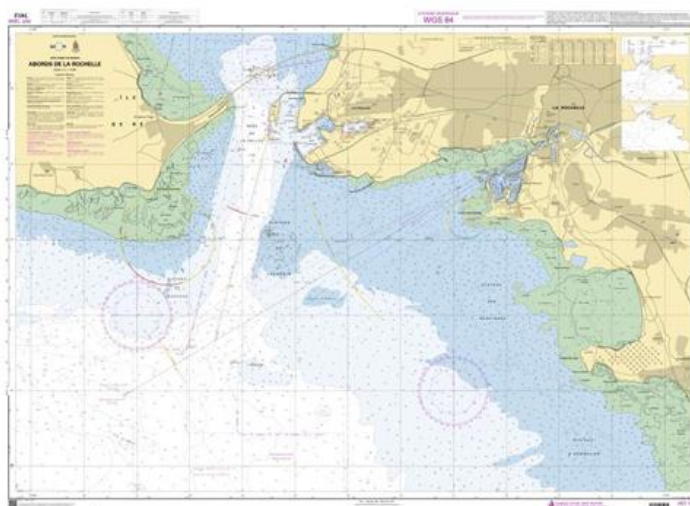(Publication 1889 – Edition 2016)

-Leadline surveys 1883-1924

Chart B - 1 : 15 000 paper chart

(Publication 1998 – Edition 2016)

-Recent multibeam surveys
-High precision coastline

Chart A : **1 : 15 000** - (Publication 1889 – Edition 2016) – *Source: Leadline surveys 1883-1924.*

Chart B : **1 : 15 000** -.(Publication 1998 – Edition 2016) – *Source: Recent multibeam surveys - High precision coastline.*

1 : 15 000 is definitely the scale at which both paper charts are printed but, in terms of accuracy, is there any common point between these charts ? Can we compare a recently published chart, compiled on a modern production system from the most recent and accurate data, with a chart compiled more than 100 years ago? It can be noted that nowhere in S-4 standard there is a mention of a « compilation scale ».
Horizontal precision is probably at least 10 times better for of chart B than for chart A.
In other words: while considering the ENCs that are directly derived from these paper charts, isn't the « real/effective » overscale reached much sooner with chart A than chart B?

CSCL is a mandatory subfield in an ENC. It is defined in the S-57 Use of the Object Catalogue (UOC) as "*the optimum display scale of ENC data*". The UOC gives additional recommendations :
  ✓ *Normally, the nearest larger standard scale should be used, e.g. an ENC produced from a 1:25 000 paper chart should have a compilation scale of 1:22 000;*
  ✓ *Exceptionally, if source material permits, the next larger scale may be used.*

This is a sensible point as CSCL is the starting point for the calculation of:
  ✓ SCAMIN attribute values on individual objects;
  ✓ Overscale indication on the ECDIS;
  ✓ ECDIS "switch" for one chart to a larger scale.

Another aspect is the distance at which the chart is visualized. When a mariner uses a paper chart, he generally looks at it from a short distance (about 30cm). On the other hand, an ECDIS is looked at between 0.5 and 1 metre (1 metre is the distance that was used to decide the size of the S-52 symbols, which are thus larger than those on the paper chart).

It must also be reminded that the effective size of the chart presentation for route monitoring on the ECDIS is at least 270mm by 270mm. This is 0.0729m², about 14 times smaller than a A0 paper chart !
Even showing an ENC on a full 27" ECDIS monitor, the mariner will see less than half of the area covered by the paper chart.

If we add other factors such as the resolution of the ECDIS screen, we get to the conclusion that **using a paper chart of a certain scale is not the same than using the equivalent ENC displayed on the ECDIS at the same scale** and it seems logical to set CSCL to a larger scale than the equivalent paper chart.

2. CSCL and its implications
According to the UOC, CSCL value is normally set at one of the following standard radar ranges:

Selectable Range	Standard scale (rounded)
200 NM	1:3000000
96 NM	1:1500000
48 NM	1:700000
24NM	1:350000
12 NM	1:180000
6 NM	1:90000
3 NM	1:45000
1.5 NM	1:22000
0.75 NM	1:12000
0.5 NM	1:8000
0.25 NM	1:4000

If we consider a 1 : 50 000 scale paper chart, the CSCL of the ENC should normally be set to 45 000.

Paper chart displayed at 1 : 50 000
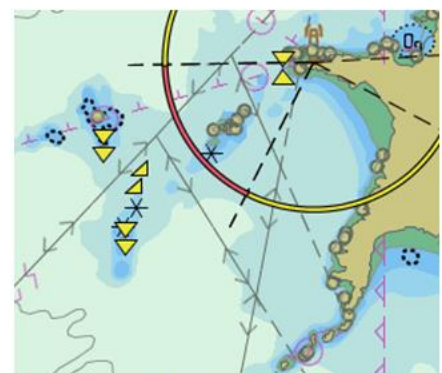No overlap between objects nor between texts and objects.

ENC displayed at 1 : 45 000 - No text displayed
Overlap between objects (LNDARE, UWTROC)

ENC displayed at 1 : 45 000, with texts
When displayed with the texts, the clutter becomes more obvious and makes the chart unreadable in some places.

ENC displayed at 1 : 90 000 - No text displayed
Note the over importance of Point LNDARE

Screen clutter in the above cases are due to:
- ✓ the size of the S-52 symbols,
- ✓ the amount of encoded objects that does not support zooming out,
- ✓ the value of SCAMIN on UWTROC situated within Area OBSTRN,
- ✓ the fact that there is no SCAMIN on point LNDARE (according to UOC, there is no SCAMIN on display base objects).

Focus on LNDARE: when zooming out, Area LNDAREs will progressively disappear as the area becomes smaller. Point LNDAREs will get more and more importance, then overlap and finally mask the Area LNDARE that is close (and which should be more prominent), and possibly other important objects.

To get rid of these overlappings between objects, the ENC must be displayed at a scale of about 1 : 22 000 (Let's remind that the paper chart scale is 1 : 50 000 and "normal" CSCL of the ENC is 45 000), that is the next larger standard CSCL (see image below), but also a scale at which the <u>over scale indication is shown on the ECDIS</u> if CSCL has been set to 45 000.

So, there seems to be 2 options here:
- Option 1: CSCL = 45 000 and the display will only become readable close to the over scale;
- Option 2: CSCL = 22 000 and the over scale indication will appear at 11 000. In other words, the mariner can zoom in 4.5 times as compared to the paper chart.


ENC displayed at 1 : 22 500, with texts
This picture is at the very limit of the overscale.

3. SCAMIN

SCAMIN on an individual object should not have a larger scale value then the compilation scale in the area (UOC + "Error" according to S-58 check 1553). However, we have seen above that <u>screen clutter often exists when the ENC is shown at CSCL</u>.

The UOC defines 11 CSCL and 23 SCAMIN values. Taking the example of a 45000 CSCL ENC based on a 1 : 50 000 paper chart, this means that the objects will start disappearing from the display at 1 : 59 999, then 1 : 89 999.
Hereafter an example of what can be displayed on the ECDIS.
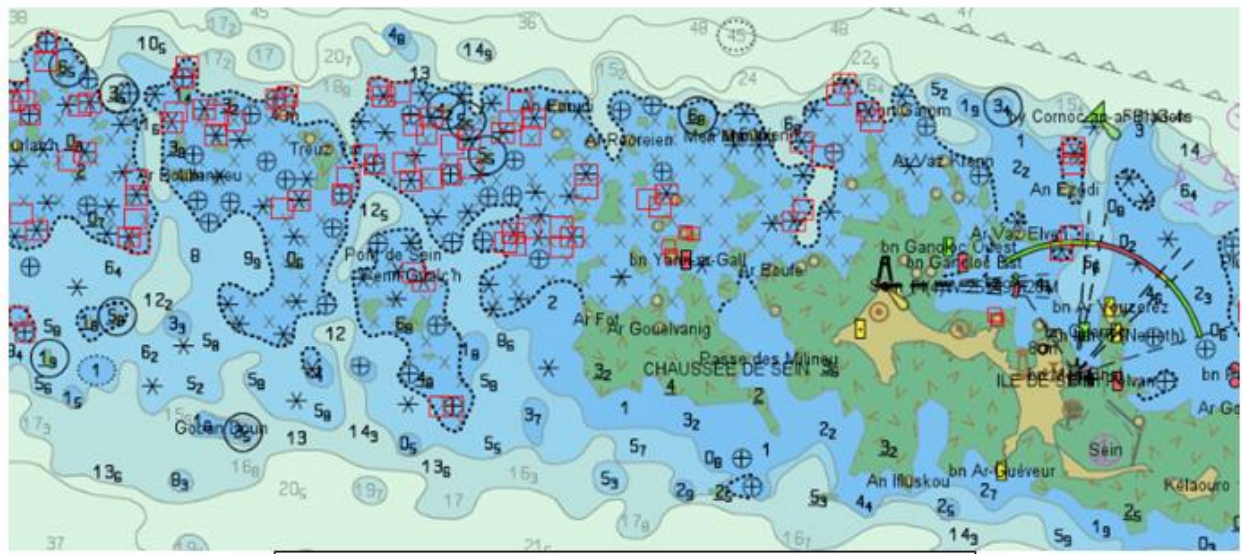
ENC – Display scale = CSCL (45 000)
(Red squares identify overlapping between Point objects)

RESOLUTION MSC.232(82)

10.4   The method of presentation should ensure that the displayed information is clearly visible to more than one observer in the conditions of light normally experienced on the bridge of the ship by day and by night.

The objective being to get a "clear" display of the data whatever the scale of the display (the ENC must be considered as multi-scale data). The current SCAMIN table 2.3 in UOC (§2.2.7) could probably be enhanced. Here are some ideas to refine SCAMIN encoding:
   ✓ Use some existing attributes (CATROD, CATBUA, VALSOU on UWTROC, etc.),
   ✓ Use overlapping between objects* (e.g. SCAMIN on Point LNDARE overlapping Area LNDARE, or on Point OBSTRN within Area OBSTRN),
   ✓ Create new attributes that will help to have a better SCAMIN.

* During the meeting, a tool, developed by Geomod, for the detection of overlappings and possible use for SCAMIN attribution will be presented.

4. Texts

Texts displayed on the ECDIS are also often a cause of clutter. On the one hand, texts can overlap one on the other, but they can also hide important information as shown below.
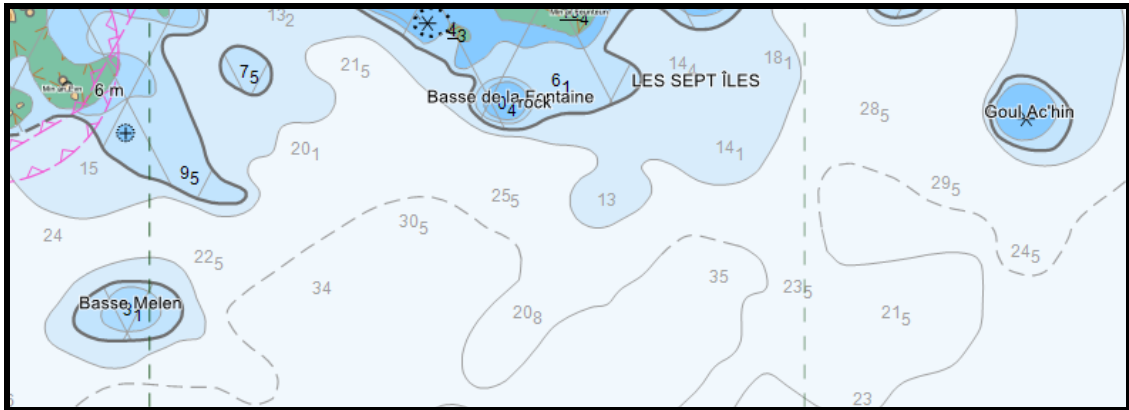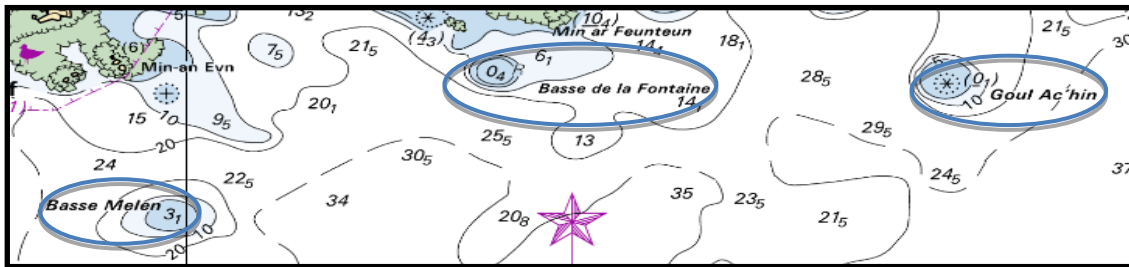
Although it seems logical for the cartographer to encode SEAARE at the "real world" position, this is not satisfying in terms of display, as long as the OBJNAM is displayed in a centred position (S-52). Text placement will be useful in S-101 but the current version of the standard can still be improved. There are probably situations that could be administrated by the proper ECDIS to avoid cases as below.
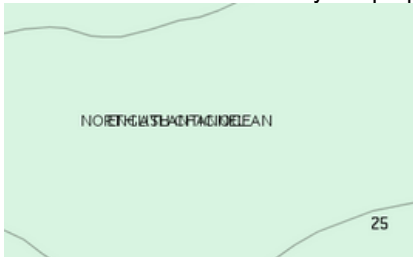
The same applies on how to encode toponyms relating to large areas. The option to encode the real world leads to the encoding of OBJNAM on large Area objects (SEAARE, LNDRGN, LNDARE, etc.) rather than on Point objects, and on successive usage band ENCs. The consequence is the continuous display of the OBJNAM up to a scale and in areas where it is probably no more useful.

Guidance could be added to the UOC/DCEG to minimize such issues (e.g. considering the encoding of Names on Point objects rather than on large Area objects). S-101 portrayal also probably needs further developments to solve such issues.

5. Symbols
As seen earlier in this paper, S-52 symbols were elaborated about 30 years ago. They are larger than paper chart symbols and certainly participate in the screen clutter. IHO workings groups will have to work together with ECDIS OEMs to improve the Presentation Library.

Conclusions
The display of ENCs on the ECDIS as it is today is not satisfying.

ENCs are products elaborated for mariners. While the lack of training of mariners as regards to the use of the ECDIS and the understanding of the ENCs is often mentioned as an issue, cartographers also have little knowledge on how ENCs are displayed and used on the ECDIS. IHO standards such as S-4, S-57 UOC or S-101 DCEG are probably the best mean to "educate" the cartographer.
On the other hand, standards and ECDISs performances (in adding more "intelligence") must now be improved to get a better display.
Shom considers there is an urgent need for member states and expert contributors to work on the ENC display on the ECDIS within the various Working Groups of the IHO. S-57 ENCs will still exist for at least 10 years and the focus cannot only be on S-101.
Can we ask the mariners to wait?

This paper has identified some elements on which we can work: CSCL, SCAMIN, Symbols/Portrayal, Texts, ECDISs performances. There are certainly others.

Recommendations

- Shom recommends setting up sub-groups or teams within the NCWG, ENCWG and S-101WG Project Team, or as a combination of these WGs.
- This or these teams would first be tasked to make an assessment of the current situation as regards to the display of ENCs on the ECDIS (this paper could be one of the inputs). This assessment would have to contain an exhaustive list of "issues to solve".
- Then, the IHO WGs would have to study how they can improve the standards they are in charge of, to solve the issues identified.

Feedback from S-100WG2 and ENCWG2

This paper was presented at S-100WG2 and ENCWG2 (March 2017, Genova, Italy). Both workings groups agreed with the set-up of a joint "ENC Display" sub-working group (see 1st recommendation above).

A draft road map was established (see Annex). In order to be able to come to 2018 WG meetings with proposals, it was decided to start the work immediately.

Members from the NCWG will be welcome and are encouraged to join the sub-WG.

Action Required of NCWG

The NCWG is invited to:

- a. note and discuss on this paper
- b. agree with the recommendations
- c. participate in the "ENC Display" sub-working group

ANNEX: ENC Display sub-WG – Draft road map

- **Participants**
  France (coordinator) , Australia, UK, Norway, Denmark, Estonia, Italy, Brazil, Primar, Furuno, IIC, Transas, IALA, IC-ENC, US (NOAA), Canada (tbc), 7Cs, IHO Sec, Geomod (post-meeting)

- **Tasks**
  - ✓ Work to be done by correspondence.
  - ✓ Collect use cases – different Usage Band ENCs, different areas (or routes), different vessels, different holdings/cargo, different ECDIS systems, different distribution/ENC supply methods. Using new version of S-52 PL (4.0.2).
    - o All members of the group to examine all use cases at first – possibly divide out tasks later on.
  - ✓ Develop list of ECDIS display issues; classify according to the issue.
  - ✓ Analysis.
  - ✓ Encoding practices for ENC (e.g. ENC first – paper chart as derivative).
  - ✓ S-101 portrayal.
  - ✓ Does every member of the group have an ECDIS? (BR and CA do not).
    - o Share the workload.
      - ▪ E.g. Furuno – ECDIS screen shots from 4.0.2 PL ECDIS.
  - ✓ Set up R&D licenses for ECDIS Manufacturers (Tom).
  - ✓ Proposals:
    - o Encoding practices;
    - o ECDIS portrayal.
  - ✓ Actions to be disseminated between WGs.

- **Timeline**
  - ✓ March 2017: Begin.
  - ✓ March 2017: Develop reporting template (France).
  - ✓ April 2017: ECDIS upgrades.
  - ✓ April 2017: Collection of use cases.
  - ✓ End of June 2017: MS to report findings back to the group.
  - ✓ October 2017: Draft proposals to take forward to each of the relevant WGs.
  - ✓ February 2018: Final proposal(s) to take to WG meetings.