

Electronic chart systems - the outcome of the IMO meeting “Nav 44”

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1. Introduction

Electronic chart systems have for the last ten years used a variety of privately produced electronic charts mostly in vector format. Three years ago the UK Hydrographic Office introduced an official and up to date electronic chart in raster format, the ARCS service. The same format was adopted by the Australian HO for their Seafarer service and in the US, NOAA have licensed official raster charts in the BSB format. There then ensued a heated debate - the so-called “raster v vector” debate, which resulted in considerable confusion in the marketplace. Navigators became unsure of which type of chart to select, let alone which type of chart system.

The outlook is now much clearer. In July 1998, the IMO’s navigation sub-committee recommended that the ECDIS performance standard be extended to incorporate official raster charts. This gave raster chart services and the systems which use them an assured future.

Firstly, some background and definitions which you can also find at our website <http://www.pcmaritime.co.uk>

2. Background

SOLAS Chapter V (Safety of Navigation) Regulation 20 defines what is required:

“All ships shall carry adequate and up-to-date charts necessary for the intended voyage”

Although SOLAS may not affect some of you directly, its effect permeates through to all navigational equipment users and it is reassuring if you are able to use equipment which is governed and approved by IMO regulations.

Currently, the only electronic charts which meet the SOLAS regulation must be produced in accordance with IHO Special Publication 57 (S57 ed 3), and used in an ECDIS and the correct term for them is Electronic Nautical Chart (ENC). ENCs are official vector charts.

ECDIS was defined by a performance standard approved by the IMO in November 1995.

However, whilst the chart format and test procedures are all finalised for ECDIS, it is generally acknowledged that it will be several years before sufficient numbers of ENC's are available to provide useful coverage. The considerations include commercial demand and the high investments required to bring surveys and chart data up to the specified standards of quality and accuracy. For example the UK HO is forecasting a commercial service for its area of responsibility by mid 2000. The US is developing ENC's for their 40 largest ports only, leaving remaining areas to be covered by official raster charts until further resources become available. The focus therefore is on primary trading routes and ports; many regions of interest to delegates to this seminar will not be available in official vector format for many years to come.

In the meantime there is a need for high quality, official, legally guaranteed chart services and fortunately this exists in raster format for much of the world.

3. Definitions

3.1 Systems

3.1.1 ECDIS (Electronic Chart Display and Information System)

A navigation system that uses official vector Electronic Navigational Charts (ENC) and meets IMO performance standards. The performance standard states that, "ECDIS with adequate back-up arrangements, may be accepted as complying with the up-to-date charts required by regulation V/20 of the SOLAS convention". Adequate back-up has now been defined by IMO as one of the following options:

3.1.1.1 The carriage of an additional type-approved ECDIS;

3.1.1.2 Reversion to paper charts on failure of the ECDIS;

3.1.1.3 Reversion to a non-ECDIS electronic chart system meeting certain minimum requirements and utilising data issued with the authority of a national hydrographic office.

3.1.2 RCDS (Raster Chart Display System)

A navigation system, that uses official Raster Navigational Charts (RNC).

3.2 Charts

3.2.1 Raster chart

Created by digitally scanning the original film materials used to produce printed paper charts. The resultant image is made up of a very large number of coloured dots or pixels.

3.2.2 Vector chart

Created by the digital capture of individual charted objects and their attributes based on geographical positions. These objects are then stored in a database. This allows the chart display to be interrogated and customised.

3.2.3 Official chart

One which is issued by or on the authority of a national hydrographic office, and for which the relevant government accepts liability.

3.2.4 Non-official chart

Charts produced by commercial companies using data owned by national hydrographic authorities but which are not endorsed or underwritten by them.

4. What happened at NAV 44

Raster charts have been extensively examined and debated over the last three years and in 1997 a draft performance standard for Raster Chart Display Systems was submitted to the IMO's Safety of Navigation Sub-Committee (NAV 43).

One of the significant benefits of this performance standard is that its wording is virtually identical to the ECDIS performance standard so that from the outset it has been possible to develop systems with both ENC (official vector) and RNC (official raster) chart formats in mind.

A core objective for PC Maritime when developing Navmaster Professional has been to ensure that the tools and processes involved in carrying out various navigational functions (position plotting, route planning and monitoring etc) work identically whether the chart in use is vector or raster so that the impact of changing between chart types is minimised.

After heated debate and political lobbying (I was present myself for the entire week of discussions), the final NAV 43 delegate session postponed a decision and called for more trials and feedback from RCDS users.

The results of the trials were presented to the July 98 meeting of the Safety of Navigation sub-committee (known as Nav 44). Responses came from more than 118 officers serving on 61 vessels of a wide range of types operating in many different areas. The trials represented more than 70 ship-years using RCDSs produced by 9 different manufacturers.

PC Maritime's Navmaster Professional was used on Shell International's Euplecta of 31000 dwt, trading in the Caribbean. This was of particular interest because the raster charts for the area tested many fundamental issues including: charts based on old surveys, charts whose datum could not be related to WGS84, and operation in an area where there is little likelihood of ENC becoming available in the near future.

Navmaster Professional was also used by Shell UK's coastal fleet of four tankers of around 3000 dwt whose experience operating in narrow and confined waters in and out of virtually every small port and waterway in UK and Western Europe has also provided valuable feedback.

I will come back to the advantages and limitations identified in the trials reports later but first will highlight the major recommendations of the Nav 44 meeting.

This time the vast majority of the delegations to Nav44 shared the view that RCDS made navigation safer and recommended approval of the RCDS performance standard as an annex to the existing ECDIS performance standard.

This permits ECDIS to operate in two modes:

- 4.1 the ECDIS mode where ENC data is used, and
- 4.2 the RCDS mode where ENC data is not available

When ECDIS is operated in RCDS mode it should be used together with an appropriate folio of up-to-date paper charts. This means, in effect, a reduced folio of paper charts. Hydrographic Offices may produce guidelines for chart folios although national marine administrations will have the final say and will determine appropriate folios on a case-by-case basis.

38 countries were in favour of the recommendation, and five against (Italy, Norway, Russia, Ukraine, Chile). The matter now goes before the December meeting of the parent committee to NAV44, the Marine Safety Committee, to be ratified. Once through, the International Electrotechnical Committee (IEC) will write type certification standards.

The majority accept that the ENC / RNC “dual fuel” concept is the way forward which enables electronic chart navigation relying on official and up-to-date charts to be provided for almost any voyage. The way is now paved for equipment to be type-approved and the market can move ahead with some certainty.

4.3 RNC Product Specification

The RCDS performance standard defines what a system should do. To support this standard the International Hydrographic Organisation (IHO) has drafted a product specification for the raster nautical charts which may be used in a RCDS. This product specification serves the same purpose for raster systems as the IHO standards S-52 and S-57 serve for the ENC of ECDIS.

So not just any raster chart can be used in a RCDS.

The UK HO's ARCS charts format has always met the specification as has the Australian Seafarer chart format which is fundamentally the same as ARCS. It is a testament to the UK HO's technical foresight that virtually no changes have been made to the ARCS format since it was launched nearly three years ago.

Edition 3 of the BSB raster chart format, produced by Maptech under licence from NOAA, will incorporate a chart update service and access to chart notes which are the final two capabilities

required for them to meet the RNC specification. BSB edition 3 is about to go into trials and will be available as a commercial service during 1999.

4.4 Electronic Chart Systems (ECS)

A proposal for guidelines for manufacturers of ECS, which could be defined as any system which does not meet ECDIS or RCDS performance standards and in particular uses charts which do not conform to ENC or RNC product specifications, was also considered at NAV44.

The member states decided that at some point regulation has to stop and guidelines for ECS were unnecessary. The proposal was not accepted and no further work is scheduled for ECS.

5. RCDS Trials feedback

The overwhelming view among seagoing officers was that the official raster chart is easy to understand, easy to use and presents a navigational picture that is the equal of the paper chart. The navigator's workload is reduced and his operating efficiency increased.

5.1 Benefits

The principal benefits highlighted by the trials reports were

5.1.1 Continuous real-time display of own ship's position

This is considered to be the greatest single benefit and it is of course a very obvious one. In addition to plotting position, systems are able to provide strategic information graphically, such as forward looking lines showing where the vessel is heading and where it is going. If a route is displayed then it will be easy to see if the vessel is off track although the system should also give an indication if the vessel moves off track.

5.1.2 Integration with radar information

Positional display is maximised if the system is integrated to radar and ARPA targets are also plotted on the chart display. This enhances the appreciation of the relative position of other vessels and their intended tracks and gives greater insight into the potential for collision avoidance.

5.1.3 Planning and calculation capability

This follows from the provision of automatic calculations such as distance and time to waypoints, cross track error, ease of amendment of plans and the availability of warnings based on user-entered information which were all identified as significant improvements (over paper).

5.1.4 Alarms and indicators

The RCDS performance standard calls for a range of alarms and indicators. These could be divided into two areas: chart-related such as to indicate over or underscale, or that a better scale chart is available for vessel position; and position-related, such as to warn against deviating from the current route, or to alert the navigator that he is approaching a critical point.

5.1.5 Ease of updating official raster nautical charts (RNC)

This was one of the most widely welcomed features. It provides substantial time savings compared to the job of manually updating paper charts and removes the risk of introducing errors via manual correction.

5.1.6 Familiarity

The familiarity of the raster image on the screen, as a direct digital reproduction of the paper chart, and the perception of the reliability of the data from official national sources gave confidence in the charts and associated systems.

5.2 Principal concerns

5.2.1 Look-ahead

On a single chart display, only a portion of a chart is displayed at any one time and because the ability to scale raster charts to facilitate look-ahead is limited, all mariners wanted as large a screen as possible to provide maximum look-ahead.

38% considered their RCDS gave sufficient look-ahead, 42% considered it a minor problem and 20% a significant one. Those who considered their look-ahead capability sufficient pointed out that it was as quick or quicker to change between RNCs than to transfer positions on a paper chart.

However systems can display more than one chart on the screen at a time, and this enables a "largest scale" chart display plus a smaller scale chart to give a look-ahead display.

5.2.2 Viewing off-screen notes

Apparently a few RCDS do not offer an easy method to means of viewing chart notes, although it is called for by the performance standard, and is an easy process with Navmaster Professional.

5.2.3 Chart datums

This item highlights why it is proving so complex to rebuild survey data into ENC's. The problem arises because charts have been produced to so many different local geodetic datums whereas GPS is referenced to one world-wide datum, WGS84. In some cases where charts are based on old surveys, the geographic co-ordinates cannot be reconciled with WGS84. In the worst cases, datum mismatches may run to several miles. It is of course a concern, but the RCDS improves on the paper situation by applying datum shifts where the chart data allows and providing a warning to the navigator where it is not possible.

5.3 RCDS versus paper charts

It is sometimes easy to overlook that the real aim for the technological improvement which has been debated so hotly is to achieve an improvement to the existing paper regime. The UK HO asked mariners to rate the effectiveness of RCDS in relation to paper charts in four key areas and the results clearly indicated that the majority of mariners obtained considerable benefit in the use of RCDS.

Navigational situation	Less effective	Equally effective	More effective
Passage planning	17%	32%	51%
Route monitoring	6%	29%	65%
Navigation in confined waters	13%	18%	69%
Navigation with pilot	5%	22%	73%

5.3.1 Other points

55% of mariners reported that the inability to remove layers of chart information from the RNC was of no significance.

This follows from the fact that paper charts are cartographically designed to provide the information necessary at the scale being viewed. To get more or less information you move up or down a scale rather than take information away, and exactly the same regime is preserved in RCDS.

6. RCDS performance standards

Manufacturers now have a clear standard against which to work (although this has been available in draft form for three years and Navmaster Professional was developed to meet this standard from the outset) and includes standards for:

- display of information
- provision and updating of chart information
- display of radar information
- colours and symbols
- route planning and monitoring
- voyage recording
- alarms and indicators