INTERNATIONAL HYDROGRAPHIC ORGANIZATION

S-66 - *FACTS ABOUT ELECTRONIC CHARTS AND CARRIAGE REQUIREMENTS*

Edition 1.1.0 – January 2018

S-66

INTERNATIONAL HYDROGRAPHIC ORGANIZATION

Facts about Electronic Charts and Carriage Requirements

IHO Publication S-66 – Edition 1.1.0

January 2018

Page intentionally left blank

Contents

Introduction

The International Convention for the Safety of Life at Sea (SOLAS) includes a requirement for all ships to carry up-to-date nautical charts and publications for the intended voyage. Progressively from 2012, the chart carriage requirement for certain classes of vessels is to be satisfied by electronic means using an Electronic Chart Display and Information System (ECDIS).

Feedback from those involved in the use of charts and electronic charting systems including manufacturers, distributors, users, ship owners, regulatory authorities, pilots, harbour authorities and others indicates a requirement to provide guidance on the regulations and the status of equipment that is available in the market today. In particular the differences between the various types of equipment and the differences between the various types of chart data offered to users are unclear with respect to the regulations in place.

This document has been produced to help clarify some of the uncertainties. It is not intended to replace or amend national or international rules and regulations. Readers should always refer to the relevant national administration or Flag State for the latest detailed information.

This document consists of a number of interrelated sections. This first section contains information on various aspects of electronic charts and electronic chart display systems in the form of questions and answers. The main emphasis is on what can be used to satisfy the SOLAS carriage requirements for charts.

> Section 1: Overview of electronic charting and regulations
>
> Section 2: A list of points of contact for detailed information on Flag State Implementation of ECDIS
>
> Section 3: ECDIS Training
>
> Section 4: Technical aspects of electronic charts
>
> Section 5: Appendix: References, glossary, further reading

This document may be downloaded from the IHO website at *http://www.iho.int*.

Links to pages on the IHO web site containing related documents can be found in the <u>References</u> section.

Edition Feedback

Feedback from readers on any aspect of the document is welcome.

Send feedback to:

> *tsso@iho.int*

or

> Organisation Hydrographique Internationale
> 4b, Quai Antoine 1er
> B.P. 445
> MC 98011 MONACO CEDEX
> PRINCIPAUTE DE MONACO

Document History

This document was originally produced by Hydrographic Offices from the two Regional ENC Coordination Centres (RENCs), PRIMAR and IC-ENC. In 2008 a 2nd edition of the publication, produced by the PRIMAR and IC-ENC Joint Information Working Group (JIWG), was adopted by the IHO. Following further revision it was published in January 2010 as IHO publication S-66. Edition 1.1.0 has been prepared by the IHO ENC Standards Maintenance Working Group (ENCWG) in order to correct and update content that has changed since Edition 1.0.0.

<u>Section 1:</u> <u>Overview of Electronic Charting and Regulations</u>

Regulations

The International Maritime Organization (IMO) is the United Nations organization that is concerned with maritime transportation. The 1974 Convention for the Safety of Life at Sea (SOLAS), together with subsequent amendments, has been adopted by the Member States of the IMO. Chapter V of SOLAS specifies the requirements for the navigational equipment to be used on board ships entitled to fly the flag of a party to the SOLAS Convention.

IMO Member States are obliged to adopt IMO rules and regulations, such as those in SOLAS, into their national legislation. However, only when the requirements of the Convention have been incorporated into national legislation do they take effect for the individual ships registered by that State. This process of incorporation into national legislation may vary from a few months to several years.

The State in which a ship is registered and hence which flag it is flying is known as the Flag State. It is the national maritime administration representing the Flag State that controls the ship's adherence to the SOLAS carriage requirements (Flag State control).

The national maritime administration is also responsible for Port State control. Ships arriving at a port may be subject to Port State control by local officials (Port State Control Officers – PSCO's). Port State control is based on Flag State regulations and international agreements. Port States cooperate within regions to apply consistent standards; for example, the European nations and Canada cooperate under the umbrella of the Paris Memorandum of Understanding (Paris MOU).

What are the IMO requirements that apply to the carriage of nautical charts?

What is a nautical chart?

Nautical charts are special purpose maps specifically designed to meet the requirements of marine navigation, showing amongst other things depths, nature of the seabed, elevations, configuration and characteristics of the coast, dangers, routes, maritime limits, and aids to navigation.

Nautical charts provide a graphical representation of relevant information to mariners for planning and executing safe navigation.

Nautical charts are available in analogue form as paper charts, or digitally as electronic charts.

The requirements for the carriage of nautical charts are laid down in SOLAS Chapter V.

The relevant regulations are:

- Regulation 2, which defines the nautical chart;
- Regulation 19, which specifies the equipment (including charts) to be carried on different types of ships; and
- Regulation 27, which specifies the requirement to keep charts and publications up to date.

IMO SOLAS V/2 1974 (as amended):

2.2 Nautical chart or nautical publication is a special-purpose map or book, or a specially compiled database from which such a map or book is derived, that is issued officially by or on the authority of a Government, authorized Hydrographic Office or other relevant government institution and is designed to meet the requirements of marine navigation.*

> *Footnote to regulation 2.2*
>
> ** Refer to appropriate resolutions and recommendations of the International Hydrographic Organization concerning the authority and responsibilities of coastal States in the provision of charting in accordance with regulation 9.*

IMO SOLAS V/19 1974 (as amended):

19.2.1 All ships irrespective of size shall have:

19.2.1.4 nautical charts and nautical publications to plan and display the ship's route for the intended voyage and to plot and monitor positions throughout the voyage. An electronic chart display and information system (ECDIS) is also accepted as meeting the chart carriage requirements of this subparagraph. Ships to which paragraph [2.10] applies shall comply with the carriage requirements for ECDIS detailed therein;

19.2.1.5 back-up arrangements to meet the functional requirements of subparagraph 2.1.4, if this function is partly or fully fulfilled by electronic means*;

> *Footnote to regulation 19.2.1.5*
>
> ** An appropriate folio of paper nautical charts may be used as a back-up arrangement for ECDIS. Other back-up arrangements for ECDIS are acceptable (see Appendix 6 to resolution A.817(19), as amended).*

IMO SOLAS V/27 *(as amended)*:

Nautical charts and nautical publications, such as sailing directions, lists of lights, notices to mariners, tide tables and all other nautical publications necessary for the intended voyage, shall be adequate and up to date.

The three regulations referred to above show that depending on the class of vessel, the carriage requirement for charts can be fulfilled by:

- Carriage of official and up to date paper charts; or

- Carriage of a type-approved ECDIS (in accordance with the requirements of the IMO ECDIS Performance Standards) supplemented by an appropriate back-up arrangement, and up to date Electronic Navigational Charts (ENC).

What is an electronic chart display system?

An electronic chart display system is a general term for a configuration of electronic equipment, software, and nautical chart data that is capable of displaying a vessel's position superimposed on a chart image.

There are two classes of electronic chart display systems. The first is an ECDIS (Electronic Chart Display and Information System), which can meet IMO/SOLAS chart carriage requirements. The second is an ECS (Electronic Chart System), which can be used to assist navigation, but does not meet IMO/SOLAS chart carriage requirements.

ECDIS

ECDIS equipment is specified in the IMO ECDIS Performance Standard (see Resolution MSC.232(82) as follows:

Electronic Chart Display and Information System (ECDIS) means a navigation information system which, with adequate back up arrangements, can be accepted as complying with the up-to-date chart required by regulation V/19 & V/27 of the 1974 SOLAS Convention as amended ....".

Where the term ECDIS is used in this document, it means those navigational electronic chart systems, that have been tested, approved and certified as compliant with the IMO ECDIS Performance Standard and other relevant IMO Performance Standards and thus are compliant with the ECDIS chart carriage requirements contained in SOLAS Chapter V.

The IMO MSC.1/Circ.1503 (as amended) Circular on "*ECDIS - Guidance for Good Practice*", adopted at MSC 95 in June 2015, provides useful references on ECDIS matters.

ECS

ECS is specified in ISO 19379:2003[1] as follows:

ECS is a navigation information system that electronically displays vessel position and relevant nautical chart data and information from an ECS Database on a display screen, but does not meet all the IMO requirements for ECDIS and is not intended to satisfy the SOLAS Chapter V requirements to carry a navigational chart.

ECS equipment ranges from simple hand held GPS enabled devices to sophisticated stand-alone computer equipment interfaced to ship systems.

What kinds of electronic charts are available?

There are two types of electronic chart – raster charts and vector charts. A raster chart is a scanned and passive image of a paper chart, whereas a vector chart is a digital database of all the objects (points, lines, areas, etc.) represented on a chart. See Section 4 for further technical details.
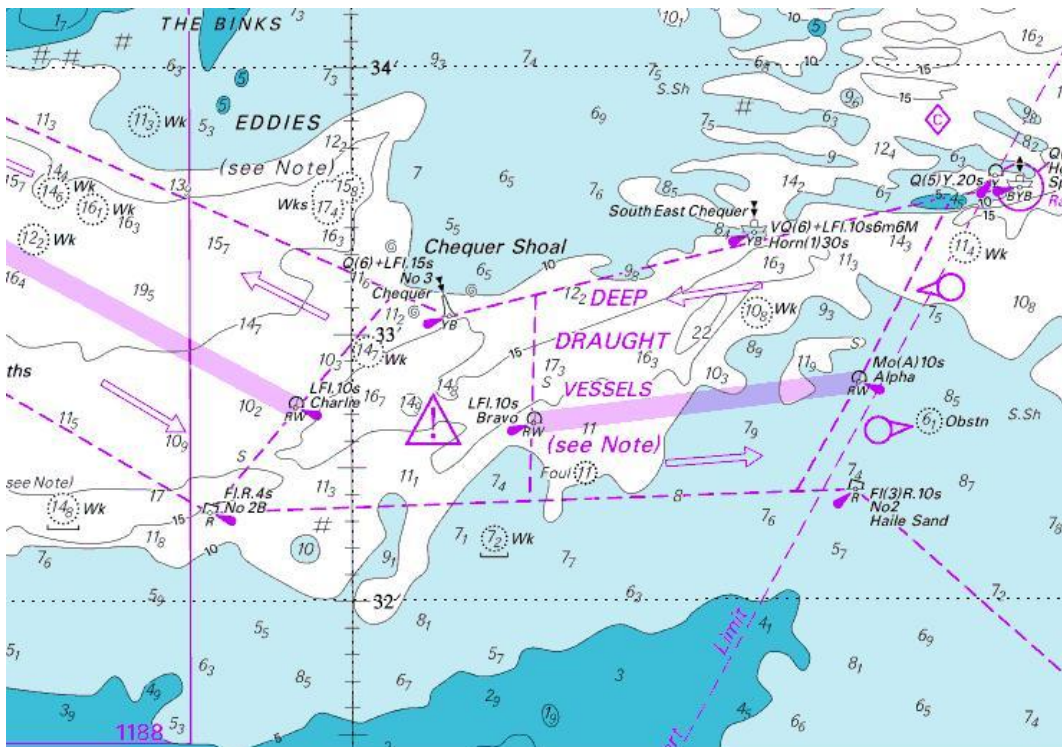
Example of a raster chart

---

[1] See http://www.iso.org/iso/catalogue_detail.htm?csnumber=33801

Example of a vector chart with vessel's position in the centre

What are official charts?

According to SOLAS V (see above), charts issued *by or on the authority of a Government, authorized Hydrographic Office or other relevant government institutions* are official and may be used to fulfil carriage requirements (provided they are kept up to date).

All other nautical charts are by definition not official and are often referred to as unofficial or private charts. These charts are not accepted as the basis for navigation under the SOLAS Convention.

There are two kinds of official digital nautical charts commonly available; Electronic Navigational Charts (ENC) and Raster Navigational Charts (RNC).

What is an ENC?

ENC stands for "Electronic Navigational Chart". An ENC is a vector chart, issued by or on behalf of a Governmental body (see "*official chart*" above) that complies with the relevant IHO standards. Any other vector chart data is unofficial and therefore does not meet the SOLAS chart carriage requirements

ENCs have the following attributes:

- ENC content is based on the latest source data available to the relevant Hydrographic Office;

- ENCs are compiled and encoded according to the international standards set by the IHO;

- Positions on ENCs are referred to the World Geodetic System 1984 Datum (WGS 84). This is directly compatible with GNSS positions;

- ENCs are issued only by or on the authority of a Government, authorized Hydrographic Office or other relevant government institution; and

- ENCs are updated with official update information that is normally distributed digitally.
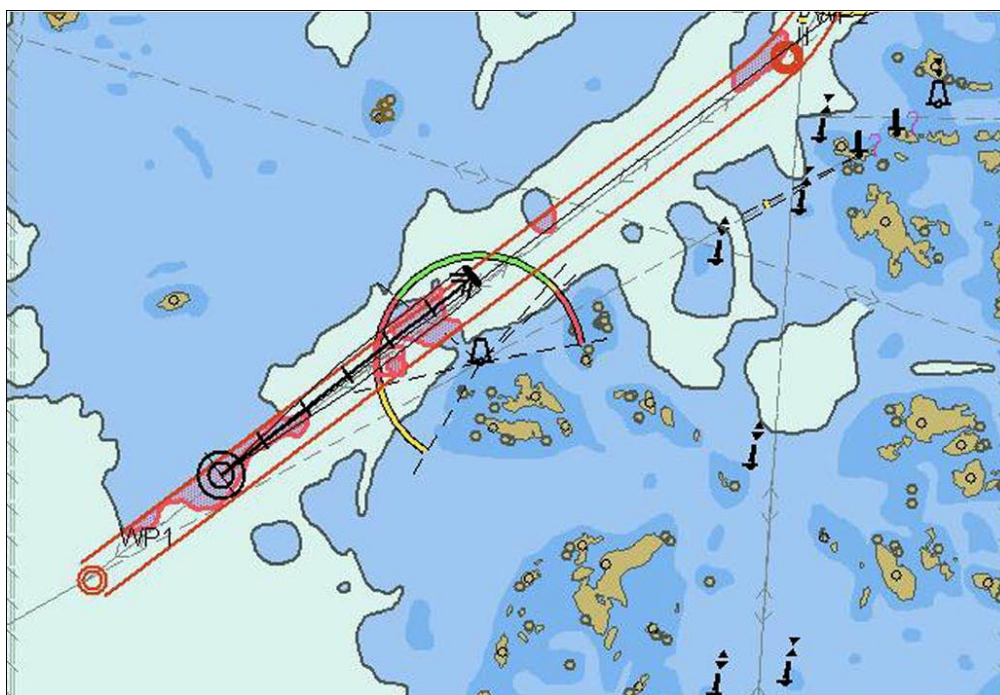
ENC data displayed on an ECDIS

How do I recognise an ENC?

When I am buying

Only authorized user service providers and their distributors sell ENCs, generally under licence agreement; and the delivery of ENC Update information (the equivalent to the Notices to Mariners system for paper charts) is an essential part of their services. These user service providers are appointed either directly by the originating Hydrographic Office or by a Regional ENC Coordinating Centre (RENC) acting on behalf of its participating Hydrographic Offices.

Some national Hydrographic Offices distribute their ENCs directly to end-users. Where this occurs, ENCs (including Updates) must be downloaded from the Hydrographic Office's official website.

When used in an ECDIS

An ECDIS distinguishes ENC data from unofficial data. When unofficial data is used, ECDIS provides mariners with a continuous warning on the screen that they must navigate by means of an official, up to date ENC, RNC or paper chart.

If unofficial data is displayed on ECDIS, its boundaries are identified by a special line style - a "one-sided" RED line with the diagonal stroke on the side of the line containing the unofficial data.
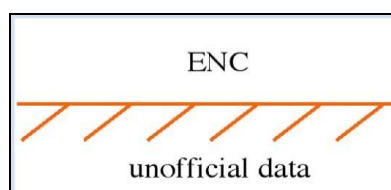
Boundary between ENC and unofficial data

The mariner can also select the appropriate ECDIS function that interrogates the chart display to obtain the chart details, such as information on the data originator, edition number and status of updating.

What ENCs are available?

In addition to RENC and national on-line catalogues, the International Hydrographic Organization (IHO) provides an interactive ENC Coverage Catalogue at *www.iho.int > ENCs & ECDIS > ENC Availability* that shows the availability status of ENCs worldwide.

The illustration below shows the front page of the catalogue.
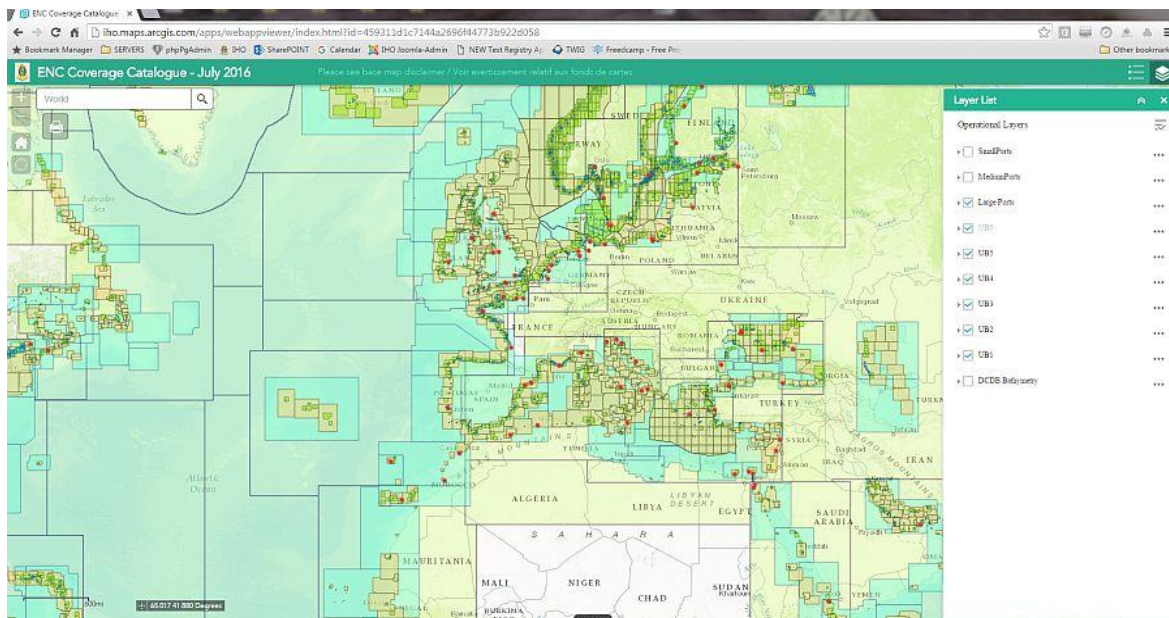
IHO online catalogue for coverage and availability of ENC

How are ENCs protected from Unauthorised Changes?

The majority of ENCs are made available to the end-users in a protected form using the IHO S-63 ENC data protection scheme. S-63 protection ensures the integrity of the ENC data in all transactions between the service provider and the end-user. The protection scheme enables an ECDIS to confirm the authenticity of the supplied information.

S-63 defines the mechanism for encrypting ENC information and applying a digital signature to enable authentication of the chart data by an ECDIS. ECDIS users require an individual decryption key to access and view the ENC data protected by the S-63 scheme. Each ENC cell is encrypted with a different key. The decryption keys are provided to the end-user as 'Cell Permits' by ENC service providers. Decryption keys are unique and apply to specific end-user systems. As a consequence, they cannot be exchanged or shared between different ECDIS installations.

The operation of the ENC protection scheme should not add any operational overhead for ECDIS users. All aspects of ENC decryption and authentication should be handled automatically by the chart system. An ECDIS user will occasionally receive new Cell Permits from their service provider when their ENC subscription is renewed or there are changes to the ENC chart outfit. The updated Cell Permits must be imported into the ECDIS to enable it to automatically process new ENC deliveries and updates.

A few national Hydrographic Offices distribute their ENCs without using encryption. All ECDIS are able to access and display these unencrypted ENCs.

Are there other ways that ENCs can be distributed?

As well as distributing ENCs in the IHO S-57 format, the IHO has approved the distribution of ENCs in the internal "machine-formats" of individual ECDIS manufacturers. The generic name for this form of distribution is SENC distribution (System-ENC distribution). SENC distribution can improve the speed of loading ENC-data in some ECDIS equipment. The IHO requirements are that service providers offering

SENC-distribution must have the agreement of the producer Hydrographic Office of the ENCs, and must also use type approved processes to ensure that the integrity of the S-57 format ENC data is maintained during the conversion to a SENC format.

What is an RNC?

RNC means "Raster Navigational Chart". RNCs are digital raster copies of official paper charts. RNCs conform to IHO Product Specification S-61. In accordance with the SOLAS V definition of a nautical chart, RNCs can only be issued *by, or on the authority of, a Government, authorized Hydrographic Office or other relevant government institution*.

RNCs have the following attributes:

- RNCs are a facsimile of official paper charts;

- RNCs are produced according to the international standards set by the IHO;

- RNCs are regularly updated with official update information. This is distributed digitally.

The IMO ECDIS Performance Standard states that where ENCs are not available, RNCs may be used in ECDIS to meet the chart carriage requirements. However, when an ECDIS is being used with RNCs, the RNCs should be used together with "*an appropriate folio of up to date paper charts*". See section "Meeting carriage requirements with ECDIS".

The option to use RNCs in ECDIS will steadily reduce as more and more ENCs become available.

RNCs, when used in ECDIS do not provide the same level of functionality that is provided by ENCs. The limitations of operating with RNCs are outlined in Appendix 2 of IMO MSC.1/Circ.1503 (as amended) *ECDIS – Guidance for Good Practice*. Guidance on chart datum's and the accuracy of positions is provided in IMO SN.1/Circ 255.

How are ENCs and RNCs kept up to date?

In order to meet the requirements of SOLAS V/27, nautical charts must be kept up to date by incorporating Notices to Mariners and other chart updates issued by Hydrographic Offices. (See Stage 9 in IHO S-65 - *ENCs: Production, Maintenance and Distribution Guidance*).

ENCs and RNCs are normally kept up to date by applying regular update information to the chart data via a digital data file. The update file may be transferred by wireless transmission, or on a suitable media, such as a CD-ROM. In these cases the updating of the chart database is done automatically by the ECDIS. Another standard function of ECDIS is the capability to update the ENC manually. This may be required when a digital update is not available or a hydrographic office has issued update information in a non-digital form.

ENC and RNC updates are generally supplied to ships on CD-ROM but 'remote updating' using satellite (or, when in port, shore based) telecommunications is becoming more and more common. Most ENC service providers now also provide updating services using e-mail, the worldwide web and other remote means. Details may be obtained from ENC distributors.

Is it possible to check that all updates have been applied to an ENC?

Updates to ENCs are sequential. The sequence is unique to each ENC. During the updating process ECDIS always checks that all updates in the sequence have been applied. If an update is missing then the ECDIS will indicate this. It is not possible to load later updates until any earlier updates have been applied.

An ECDIS maintains an internal list of the updates that have been applied and the date of their application. The format and content of an "ENC Update Status Report" is specified in Annex C of IHO standard S-63 "*IHO Data Protection Scheme*". Such a status report is designed to demonstrate the revision status of ENCs within the ECDIS SENC, and can be generated by the ECDIS user. Some ENC service providers

(for example RENCs) also provide additional tools to generate reports on the "up-to-datedness" of the ENCs in the SENC. If ECDIS is not able to generate such a report, ECDIS users should create and maintain a list of updates manually. ENC distributors should be able to provide mariners with details of the latest ENC edition and update numbers in force. It is also possible to refer to traditional sources of update information, such as Notices to Mariners for paper charts, to cross-check and verify that corresponding ENC updates have been applied.

Port State Control officers are likely to refer to the update status report function of ECDIS to verify that ENCs are being kept up to date in accordance with SOLAS V Regulation 27.

A closer look at ECDIS

ECDIS equipment is specified in the IMO ECDIS Performance Standards (IMO Resolution MSC.232 (82) as follows:

> *Electronic Chart Display and Information System (ECDIS) means a navigation information system which, with adequate back up arrangements, can be accepted as complying with the up-to-date chart required by regulation V/19 & V/27 of the 1974 SOLAS Convention, as amended, by displaying selected information from a system electronic navigational chart (SENC) with positional information from navigation sensors to assist the mariner in route planning and route monitoring, and if required display additional navigation-related information.*

ECDIS is a ship borne navigational device and as such the rules governing its use come under the jurisdiction of the IMO through SOLAS. The IMO has adopted performance standards for ECDIS (IMO Resolution MSC.232 (82) and subsequent amendments). ECDIS equipment must be certified as meeting these performance standards if it is to be used to meet the chart carriage requirements of SOLAS V/19. Certification of ECDIS equipment is achieved through type-testing and certification.

Within an ECDIS, the ENC database contains chart information in the form of geographic objects represented by point, line and area shapes, carrying individual attributes. Appropriate mechanisms are built into the ECDIS to query the data, and then to use the information to perform various navigational and monitoring functions (such as, anti-grounding surveillance) and to generate a chart-like display.

The presentation of ENC data on a screen display is specified in IHO standard S-52 "*Specification for Chart Content and Display Aspects of ECDIS*". The style of presentation defined in S-52 is mandatory.

How is an ECDIS approved and by whom?

To meet SOLAS requirements an ECDIS must be certified to show it conforms to the IMO Performance Standard for ECDIS. This is achieved through the type approval and certification processes recognised by the relevant Flag State.

Type approval is normally conducted by recognized technical organizations or by marine classification societies approved by Flag States. However in some countries the maritime administration conducts type approval themselves. Many European governments have agreed to mutual recognition of their ECDIS type approval certificates – indicated by the so-called "Wheel Mark" sign which indicates conformity with the Maritime Equipment Directive of the European Union (MED).

ECDIS type approval testing is conducted using test standards and procedures developed by the International Electro-technical Commission (IEC). These are based on the IMO Performance Standard for ECDIS and the supporting IHO standards (IHO S-52, S-57, S-63, S-64). The S-64 "*IHO Test Data Sets for ECDIS*" is used for type approval testing (not for mariners), and the IEC testing standard for ECDIS is IEC 61174 *(See: www.iho.int > ENCs & ECDIS > Information on IHO Standards related to ENC and ECDIS)*.

Is there a need to keep ECDIS software updated?

If ECDIS software is not upgraded to read ENCs based on the latest version of the S-57 ENC Product Specification or to use the latest version of the S-52 Presentation Library then the ECDIS may be unable to

correctly display the latest approved chart symbols. If an ECDIS is unable to interpret and draw any newly introduced chart symbol it will display a question mark (?) instead. Additionally there will be a possibility that alarms and indications for any newly introduced features may not be activated even though they have been included in the ENC. Because of this, the IMO have issued guidance on the maintenance of ECDIS software in IMO MSC.1/Circ.1503 (as amended) *ECDIS – Guidance for Good Practice*.

ECDIS users should ensure that their ECDIS software always conforms to the latest IHO standards. This should be available from the "*about*" function in the software or from the ECDIS manufacturer. A list of the current IHO standards relevant to ECDIS software is maintained in the ENC/ECDIS section of the IHO website *(See www.iho.int > ENCs & ECDIS > Current ENC and ECDIS Standards).*

Is there a mandatory requirement to carry ECDIS?

In July 2002 an amendment to Chapter V of SOLAS came into force. This amendment included a specific reference to ECDIS and stated that it

... may be used to fulfil the chart carriage requirements of Regulation 19.

A further amendment to Regulation 19 adopted in June 2009 requires that certain classes of vessel use ECDIS to meet the SOLAS V chart carriage requirements as follows:

Ship type	Size	New ships	Existing ships
Passenger ships	>= 500 GT	constructed on or after 1 July 2012	constructed before 1 July 2012: not later than the first survey* on or after 1 July 2014
Tankers	>= 3000 GT	constructed on or after 1 July 2012	constructed before 1 July 2012: not later than the first survey* on or after 1 July 2015
Cargo ships, other than tankers	>= 10 000 GT	constructed on or after 1 July 2013	see below
	>= 3000 < 10 000 GT	constructed on or after 1 July 2014	-
	>= 50 000 GT	-	constructed before 1 July 2013: not later than the first survey* on or after 1 July 2016
	>= 20 000 < 50 000 GT	-	constructed before 1 July 2013: not later than the first survey* on or after 1 July 2017
	>= 10 000 < 20 000 GT	-	constructed before 1 July 2013: not later than the first survey* on or after 1 July 2018
*Refer to the Unified interpretation of the term "first survey" referred to in SOLAS regulations (MSC.1/Circ.1290).			

Flag State authorities may exempt ships from the requirements shown above if those ships will be taken permanently out of service within two years after the implementation dates shown for other ships of the same class.

In addition to SOLAS V/19, ECDIS has already been fixed as the chart carriage requirement in the High Speed Craft Code of IMO (HSC). In December 2006 the 82nd session of the Marine Safety Committee (MSC82) agreed amendments to 1994 and 2000 HSC Code with regard to ECDIS:

... High-speed craft shall be fitted with an ECDIS as follows:

New vessels	Existing vessels
craft constructed on or after 1 July 2008	craft constructed before 1 July 2008, not later than 1 July 2010.

Meeting Carriage Requirements with ECDIS

Only a type-approved ECDIS operating with up to date ENCs and with appropriate back-up arrangements may be used to replace paper chart navigation. Where ENCs are not available, the SOLAS regulations allow Flag States to authorise the use of RNCs (together with an appropriate folio of paper charts) - see below. In all other cases the vessel must carry all the paper charts necessary for its intended voyage.

Back-up Requirements

No electronic system can be completely failsafe. The IMO Performance Standard for ECDIS therefore requires that the "overall system" includes both a primary ECDIS and an adequate, independent back-up arrangement that provides:

- *Independent facilities enabling a safe take over of the ECDIS functions in order to ensure that a system failure does not result in a critical situation*; and

- *A means to provide for safe navigation for the remaining part of the voyage in case of ECDIS failure*.

However, these rather basic statements allow for considerable flexibility. This means that there can be various interpretations as to what are the minimum functional requirements, or what constitutes "adequate" back-up arrangements.

There are two commonly accepted options:

- A second ECDIS, connected to an independent power supply and a separate GNSS position input;

- Up to date paper nautical charts sufficient for the intended voyage

Some Flag States may, however, permit other options (for example: radar-based systems such as "Chart-Radar"). Ship owners should consult their national maritime administration for specific guidance.

At the request of the IMO, the IHO has sought information from its member states on which paper charts covering their territorial waters would be considered as *appropriate* to serve as a back-up to ECDIS. This information is presented on the IHO web site as part of the ENC coverage catalogue *(See www.iho.int > ENCs & ECDIS > ENC Availability > Backup Paper Charts)*.

What to do in areas without ENC coverage?

In 1998 the IMO recognised that it would take some years to complete global coverage of ENCs. As a consequence, the IMO ECDIS Performance Standard was amended by adding a new optional mode of operation for ECDIS - the Raster Chart Display System (RCDS) mode. In this mode Raster Navigational Charts (RNCs) can be used in ECDIS to meet the SOLAS carriage requirements for nautical charts. However, this is only allowed if approved by the Flag State of the ship concerned. The intention of the change was to provide the widest possible coverage of official electronic chart data for ECDIS in advance of complete global coverage with ENCs alone.

IMO took note of the limitations of RNCs as compared to ENCs (see Section D "*Differences Between Raster Chart Display (RDCS) and ECDIS*" of IMO MSC.1/Circ.1503 (as amended)). As a consequence, the revised ECDIS Performance Standard requires that when the RCDS mode is employed an ECDIS must be used together with "*an appropriate folio of up to date paper charts*".

The following definition of *an appropriate folio of up to date paper charts* (APC) was established by MSC within appendix 7 of Resolution MSC.232(82):

Appropriate Portfolio of up to date paper Charts (APC) means a suite of paper charts of a scale to show sufficient detail of topography, depths, navigational hazards, aids to navigation, charted routes, and routeing measures to provide the mariner with information on the overall navigational environment. The APC should provide adequate look-ahead capability. Coastal States will provide details of the charts which meet the requirement of this portfolio, and these details are included in a worldwide database maintained by the IHO.

Consideration should be given to the details contained in this database when determining the content of the APC.

While paper charts are to be used with RNCs, the underlying intention was, nevertheless, to minimise the number of paper charts carried by a vessel when the RCDS mode was employed, but only to a level compatible with safe navigation. As stated by the IMO, ship owners should consult their Flag State regarding whether RCDS mode is allowed and under what conditions.

A web-based catalogue showing world coverage of all ENCs and RNCs is available on the IHO website (*http://www.iho.int > ENCs & ECDIS > ENC Availability*).

In any areas where both ENCs and RNCs are unavailable vessels must carry all the paper charts necessary for the intended voyage.

Does your ECDIS system meet IMO chart carriage requirements?

ECDIS Carriage Requirements – a summary:

Are ENCs available for area of operation?	YES	NO	YES	NO
What Digital Charts are being used in the ECDIS by the mariner?	ENC (coverage at an appropriate scale for navigation)	RNC (coverage at an appropriate scale for navigation)	RNC	Private charts (6)
What back-up system is required?	Independent ECDIS or other back-up solution required	Independent ECDIS or other back-up solution required	None required (3)	None required (3)
What are the requirements for the carriage of Official paper charts?	None needed (1) (except if back-up is a folio of paper charts)	An "*appropriate*" folio of up to date paper charts to be used in conjunction with the ECDIS in RCDS mode	All up to date paper charts required for safe navigation in areas where ENCs are available	All up to date paper charts required for safe navigation for the intended voyage
How is the ECDIS operating?	As an ECDIS	As an ECDIS in RCDS mode	As an ECDIS in RCDS mode	As an ECS
Does the ECDIS fulfil Chart Carriage Requirements?	YES (1)	YES (2)	NO (4)	NO(5)

Notes:

1) Some Flag States may require specific documentation to allow this.
2) Requires approval of vessel's Flag State – Flag State defines meaning of 'appropriate'.
3) Back-up system is only required if ECDIS is intended to meet carriage requirements.
4) For ECDIS to fulfil Carriage requirements vessels must use ENCs where these are available.
5) Paper charts (not the ECDIS) must remain the primary means of navigation.
6) If private charts are used in an ECDIS the system is regarded as operating as an ECS. ECDIS operating as ECS; ECS systems meeting RTCM or IEC standards; or Private charts meeting ISO standards being used in ECDIS, do not meet IMO chart carriage requirements.

It should be noted that interpretations between Flag State administrations may vary. Additionally in some countries Flag State administrations will require to check the equipment on board before issuing any certificates. Prospective ECDIS users should consult the vessel's Flag State administration for detailed information.

Can chart format names indicate carriage compliance?

There has been much confusion regarding the names used to describe electronic chart distribution formats. The diagram below is intended to clarify this. From the diagram it can be seen that the same distribution format can be used for the delivery of both "private" (<u>not</u> produced officially by or on the authority of a Government, authorized Hydrographic Office or other relevant government institution) and official chart data. For example, 'BSB' is the term used for the distribution format of US and Canadian RNCs. The same term is also used for the distribution of private raster chart data in other areas (for example, in European waters).

There can also be confusion with ENCs and End-User Service Providers packages. Private vector chart data delivered in S-57 format does not meet IMO requirements and should never be described as an ENC. Similarly private vector data delivered in a SENC format can be mistaken as being ENCs delivered in the same SENC format.

The most important factor to consider in determining whether data is official is the electronic chart producer rather than the format. The electronic chart producing authority determines the status and the purpose for which the chart data may be used. The combination of the status of the chart data and the functionality of the particular device finally determines whether an electronic chart navigation "system" is operating as an ECDIS or as an ECS.
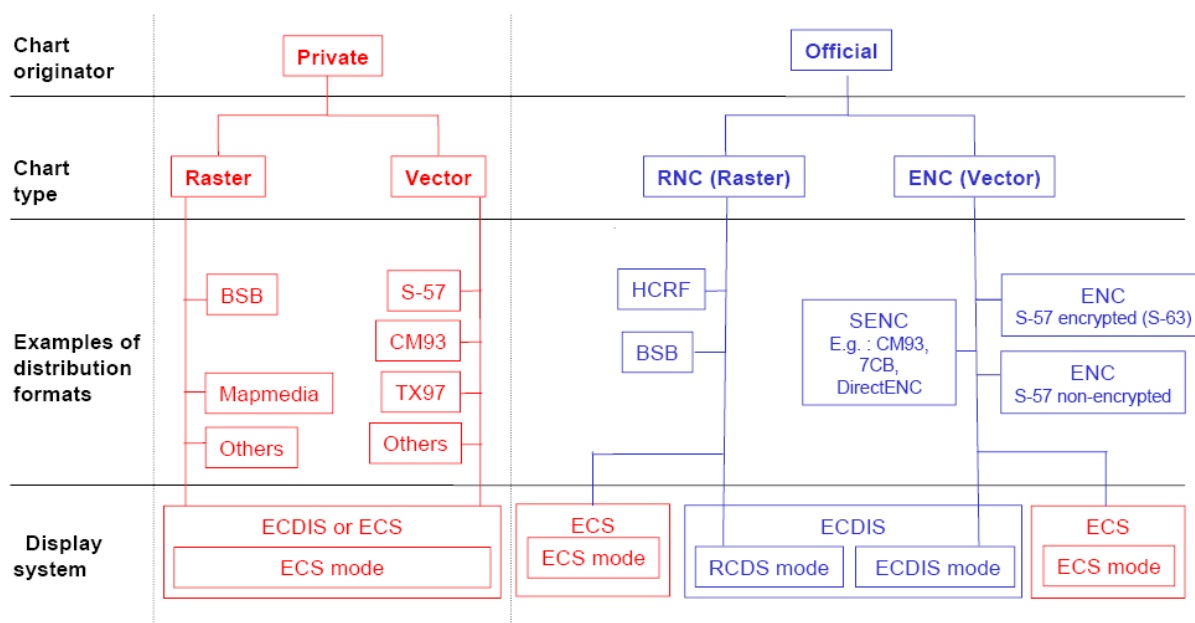
Examples of Electronic Chart Formats. Many ECS systems are able to use ENC or RNC data, however even when using official charts they may not be used to fulfil ECDIS carriage requirements in accordance with SOLAS chapter V

Examples of format names used by private data producers:

- o CM93 chart data produced by C-Map.
- o TX90 vector chart data produced by Transas.

Acceptance of ECDIS by Port State Control Authorities

Ships arriving at a port are normally subject to Port State control. This is enforced by local officials (Port State Control Officers (PSCO's)) who refer to the relevant Flag State regulations and international agreements. Nations have formed a number of regional groups to ensure consistent application of Port State control.

In Europe, Port State control follows the guidance set out in the "*Guidelines for Port State Control on Electronic Charts (Paris Memorandum of Understanding)*". Its ECDIS guidelines explain how a PSCO

should assess whether a ship is using electronic charts in accordance with SOLAS requirements. Checks may include whether:

- The ship has documentation indicating that the ECDIS complies with the IMO ECDIS Performance Standards. In the absence of such documentation, the PSCO should seek confirmation from the Flag State that the ECDIS does meet the statutory requirements;

- The ECDIS is being used for primary navigation. It should be established if the ECDIS is used in ECDIS mode or RCDS mode or in both modes;

- There are written procedures onboard the vessel for using ECDIS;

- The master and watch-keeping officers are able to produce appropriate documentation that basic ECDIS familiarization has been completed and demonstrate familiarization with the ECDIS equipment installed on board;

- The ENCs (and any RNCs) used for the intended voyage are up to date; and

- There are approved back-up arrangements available to ensure a safe transfer of the ECDIS functions in the event of an ECDIS failure and to provide safe navigation for the remaining part of the voyage.

Is there a need for ECDIS training?

ECDIS is far more than the image of a chart displayed on an electronic screen. ECDIS is a highly sophisticated system which, besides the navigational functions, includes components of a complex, computer-based information system. In total, the system includes hardware, operating system, ECDIS software (kernel and user interface), sensor input interfacing, electronic chart data, rules for presentation and display, status and parameters of alarms and indications, etc. All these items are accessed through an appropriate human-machine interface. As such, care must be taken when navigating with ECDIS to avoid:

- Incorrect operation;

- Misinterpretation;

- Malfunction; or, even worse,

- Over-reliance on this highly-automated navigation system.

With any type of shipboard navigation equipment, it can only be as good as those who use it and what it is being used for. In the case of ECDIS and ENCs, if the mariner is well trained then the system will provide the relevant information that the mariner needs in order to make good decisions and thereby contributes significantly to safe and efficient navigation. Stated another way, an ECDIS is another tool to enable mariners to perform their job better. However, just having some "knowledge" about "functions" and "operational controls" is insufficient to maximise the benefits of ECDIS; proper training is absolutely necessary.

What are the requirements for ECDIS training?

ECDIS and other electronic charting systems have become increasingly important in ship navigation and are widely used either as a primary navigation tool or as an aid to navigation. The systems are complex, and require adequate and appropriate training in order to be operated correctly and safely. Without proper training, these systems will not be used to their full potential and could under some circumstances increase the hazard to navigation. The IMO STCW (Standards of Training, Certification and Watch-keeping) and ISM (International Safety Management) codes put the responsibility firmly on the ship-owner to ensure that mariners on their vessels are competent to carry out the duties that they are expected to perform. If a ship is fitted with ECDIS, the ship-owner has a duty to ensure that users of such a system are properly trained in its operation and use before using it operationally at sea.

On the 1st of January 2012, the "2010 Manila Amendments" to the STCW Convention entered into force. The amendments include binding minimum ECDIS standards for the training and advanced training of masters and navigating officers. They include:

- Basic training intended to convey a basic level of competency. This is mandatory for masters and navigating officers, and require certification for the corresponding levels of competence. (Chapter II of the Annex to the STCW Convention); and

- Type-Specific Training which should provide appropriate training on ship-specific ECDIS equipment. Companies are responsible for ensuring that seafarers employed on their ships are familiarized with the installed ECDIS, but seafarers are not required to provide documentation (certificates) of having completed this training. (Regulation I/14 of the Annex to the STCW Convention and IMO STCW.7 Circ.24 (as amended)).

The provisions were implemented gradually during an interim period until 1 January 2017, and are now in place.

To encourage effective ECDIS education, the IMO has approved a syllabus for a standardised model course for the general operation and use of ECDIS (IMO Model Course 1.27). In May 2012 (at the 43rd STCW meeting), the Model Course was revised and updated (annex to STW 43/3/1) in order to make provision for the generic use of ECDIS.

Courses based on this syllabus are offered by approved training institutions and maritime academies. Maritime administrations can provide information on approved institutions. Some Flag States have developed their own training courses in ECDIS in order to be able to recognise the training certificates.

Type-specific ECDIS training is normally available from the ECDIS equipment manufacturer.

Further information on ECDIS training can be found in Section 3 of this document.

What are the operational considerations when using ECDIS?

The IMO has recognised that the adoption of a carriage requirement for ECDIS from 2012 is a very significant change for the shipping industry and that there will need to be a careful transition both within the ship operating companies, and onboard the ships of their fleet. In 2008 the IMO issued a Safety of Navigation Circular (IMO SN/ Circ. 276) on *"Transitioning from paper chart to ECDIS navigation"*, which has been superseded and is now included at Section F of IMO MSC.1/Circ.1503 (as amended) *ECDIS – Guidance for Good Practice*.

Navigating with ECDIS is fundamentally different from navigating with paper charts. Important bridge work-processes are significantly affected, in particular, the voyage planning and voyage execution tasks. These differences require careful analysis and consideration.

Voyage Planning

ECDIS provides a number of additional planning functions and features such as the use of safety contours, various alarms and indications, and click-and-drop facilities for designating waypoints and markers. Whilst in many ways ECDIS makes voyage planning easier, it is still possible to make errors. However these errors are likely to be of a different type to those encountered when using paper charts.

Even though world-wide ENC coverage has almost been achieved, many vessels may, to some degree, have to operate a dual, or even triple, system with a voyage covered by various combinations of ENCs, paper and raster charts. The planning and validation of an intended voyage has therefore to consider issues such as which chart types are available for the various segments of that voyage. The format of the voyage plan is likely to differ from the traditional alphanumeric lists of waypoints used with paper charts and should include information on the usability of connected electronic navigational devices such as GPS and AIS and their actual alarm settings.

It is essential to make use of the in-built automatic checking functions provided by ECDIS when validating and approving the voyage plan. Thought also needs to be given to ensuring that a backup to the voyage plan on the ECDIS is available in case of equipment failure of the ECDIS or the connected sensors.

It is important that there is a good understanding of the voyage plan by all bridge officers so that they are prepared for the intended voyage. This should include information on equipment status and backup procedures.

Voyage execution

At the beginning of a voyage, as well as at any change of watch, officers should review the voyage plan and agree the selected pre-settings of functions, alarms and indicators to be used on the ECDIS.

Where vessels carry paper charts as well as an ECDIS, the role of the ECDIS and the paper charts should be considered. If the ECDIS is used for real time navigation, the statutory requirements regarding monitoring of the progress of the voyage and marking of positions will need to be considered:

   o   Are positions marked on paper charts solely for record keeping purposes?

   o   What steps are being taken to ensure that intended tracks marked on the paper charts correspond with the ECDIS information?

   o   Have the bridge procedures set in place by the shipping company been adapted for the use of ECDIS and are all persons concerned with the navigation of the vessel familiar with these adjustments?

Over reliance on ECDIS

There is a tendency to put too much trust in computer-based systems and, in the case of ECDIS, to believe implicitly in whatever is shown on the chart display. It is essential that officers remember to cross check the displayed information by all means available; especially by visual observation and comparison from the bridge window and by watching the radar. Bridge-procedures must be adapted appropriately and ENC training must be carried out to minimise the potentially adverse consequences.

More on ECS

All electronic charting systems, which are not tested and certified as meeting the IMO ECDIS Performance Standards, are generically designated as "Electronic Chart Systems" (ECS). An ECS may be able to use ENCs, RNCs or other chart data produced privately and could have functionality similar to ECDIS.

Some ECDIS and ECS equipment manufacturers also produce private vector and raster data to use in their products. These private charts are usually derived from Hydrographic Office paper charts or Hydrographic Office digital data but these derived charts have no official status.

Hydrographic Offices do not take any responsibility for the accuracy or reliability of privately produced charts. Where a SOLAS vessel operates with ECS, the paper chart remains the only officially recognised basis for navigation onboard. In these circumstances a vessel must retain and use a full folio of up to date paper charts onboard, regardless of the type of electronic charts used.

Because ECS is not intended to meet SOLAS chart carriage requirements, there is no IMO Performance Standard for ECS.

The STCW and ISM codes place the responsibility firmly on the ship-owner to ensure that mariners on their vessels are competent to carry out the duties that they are expected to perform. If a ship has an ECS fitted for use and it is being used as an aid to navigation, the ship-owner has a duty to ensure that users of such a system are properly trained in its use before employing it operationally at sea, are aware of its

limitations compared to ECDIS and the need to use paper charts to fulfil the SOLAS chart carriage requirements.

<u>Section 2:   List of Flag State Authorities</u>

Note: This list as of June 2017 is not exhaustive and is not kept up-to-date.

Nation	Website
Antigua & Barbuda	http://www.antiguamarine.com/
Australia	http://www.amsa.gov.au/
Bahamas	http://www.bahamasmaritime.com/
Barbados	http://www.barbadosmaritime.com/
Belgium	http://mobilit.belgium.be/en
Bermuda	www.bermudashipping.bm
Canada	http://www.tc.gc.ca/eng/marine-menu.htm
Cayman Islands	www.cishipping.com
China	http://en.msa.gov.cn/
Cyprus	http://www.shipping.gov.cy/
Denmark	http://www.dma.dk
Estonia	http://www.vta.ee/?lang=en
Finland	http://www.liikennevirasto.fi/web/en
France	http://www.ecologique-solidaire.gouv.fr
Germany	http://www.bsh.de/en/index.jsp
Gibraltar	http://www.gibmaritime.com/
Greece	http://www.hrs.gr/
Hong Kong (China)	http://www.mardep.gov.hk/en/pub_services/home.html
India	http://shipping.gov.in/
Ireland	http://www.transport.ie/
Isle of Man	http://www.gov.im
Italy	http://www.mit.gov.it/mit/site.php?p=cm&o=vd&f=cl&id_cat_org=34&id=218
Japan	http://www.mlit.go.jp/index_e.html
Korea, Republic	http://www.krs.co.kr/eng/main/main.aspx
Liberia	http://www.liscr.com/liscr/
Malaysia	http://www.marine.gov.my
Malta	http://www.transport.gov.mt/
Marshall Islands	http://www.register-iri.com/
Netherlands	https://www.ilent.nl/
New Zealand	http://www.maritimenz.govt.nz/default.asp
Norway	http://www.nis-nor.no/
Panama	http://www.segumar.com/
Philippines	http://www.prc.gov.ph
Poland	http://emsa.europa.eu/

Russian Federation	http://www.rs-head.spb.ru/en/index.php
Singapore	http://www.mpa.gov.sg/sites/utility_navigation/Contact_info.page
South Africa	http://www.samsa.org.za
St Kitts & Nevis	http://www.stkittsnevisregistry.net/
St Vincent & Grenadines	http://www.svg-marad.com/home.asp
Sweden	https://transportstyrelsen.se/en/shipping/
Thailand	http://www.mot.go.th/about.html?dsfm_lang=EN&id=7
United Kingdom	http://www.mcga.gov.uk
USA	http://www.marad.dot.gov/
Vanuatu	http://vanuatuships.com/content/view/107/43/
Vietnam	http://www.vr.org.vn/VRE/homeNE.aspx

<u>Section 3:</u> ECDIS Training

See also Appendix 3 of IMO MSC.1/Circ.1503 (as amended) *ECDIS – Guidance for Good Practice*.

Training Objectives

The overall objective of ECDIS training is to enhance navigation safety. In rather general terms, this includes

- Safe operation of the ECDIS equipment
    - o Use of the functions for route planning and monitoring
    - o Proper action in case of any malfunction
- Proper use of ECDIS-related information
    - o Selection, display, and interpretation of relevant information
    - o Ambiguities of data management (such as "datum")
    - o Assessment of ENC data quality indicators (for example CATZOC)
    - o Assessment of alarms and indications
- Awareness of ECDIS-related limitations
    - o Errors of displayed data and their interpretation
    - o Real and potential limitations
    - o Over-reliance on ECDIS
- Knowledge of legal aspects and responsibilities related to electronic charts
    - o Awareness of the status of ECDIS and ECS; of official and non-official data
    - o Limitations of RCDS mode

In order to achieve these objectives, the mariner must acquire a thorough knowledge and functional understanding of the basic principles governing ENC data, its proper display in ECDIS and its use with navigation sensors and their respective limits. For example, the Mariner must be familiar with the object-attribute structure and the feature-space relationship of ENC data as well as charted information; and the impact of such things as "SCAMIN", "overscale", "update history", "CATZOC", "safety values" and "chart usage".

ECDIS training must have an appropriate depth in theoretical aspects (ECDIS data and their presentation) as well as dealing with the proper use of ECDIS (functions and limitations). It should cover all safety-relevant aspects and go far beyond type-specific "button pressing" or basic operations. ECDIS training should be both generic and type-specific.

Ideally, training should cover the full extent of functions and procedures necessary to deal with a wide range of possible navigational problems. It should cover thorough route planning and both visual and automatic route monitoring in typical navigational situations and sea areas. To prepare a user for practical operations, decision-making and alarm handling, real-time complex ECDIS simulator exercises should be conducted.

IMO Model Training Course - *Operational Use of ECDIS*

The IMO Committee on Standards for Training and Watch-keeping (STW) approved a standardised IMO "Model Training Course on the Operational Use of ECDIS" (Model Course 1.27). The primary objective

of the Model Course is to ensure proper use and operation of ECDIS in terms of a thorough understanding and appreciation of its capabilities and limitations. The IMO Model Course contains four main parts

- Part A: Course framework;
- Part B: Course outline and time table;
- Part C: Detailed teaching syllabus;
- Part D: Instructor manual; and
- Part E: Evaluation and assessment.

There are also annexes dealing with proposals and examples of situations for the development of scenarios and of "errors of interpretation".

In May 2012 (at the 43rd Standards of Training, Certification and Watch-keeping (STCW) meeting), the Model Course was revised and updated (annex to STW 43/3/1) in order to make provision for the generic use of ECDIS in addition to type-specific ("familiarization") training.

The contents (syllabus) of ECDIS training are listed below. They are based on the analysis of onboard navigational activities and include learning objectives at the operational as well as the management level (for example STCW Convention). In addition to providing specific learning objectives and detailed guidance on a range of subject areas, the Model Course also contains recommendations for facility and staffing requirements, entry standards, lesson plans, teaching aids, examples of ship-simulator training exercises that can be conducted, and certificates.

- Legal aspects and requirements
- Main types of electronic charts and their differences
- ECDIS data
- Presentation of data
- Sensors
- Basic navigational functions
- Special functions for route planning
- Special functions for route monitoring
- Updating
- Additional navigational functions and indications
- Errors in displayed data
- Errors of interpretation
- Status information, warnings and alarms
- Voyage documentation
- System integrity monitoring
- ECDIS back-up
- Risks of over-reliance on ECDIS

The IMO Model Course 1.27 - *The Operational Use of Electronic Chart Display and Information System (ECDIS)* together with its annex and attachment is regarded as the minimum requirements a candidate should have gone through to receive an ECDIS certificate. It covers all relevant safety aspects and overall system knowledge. Governments are strongly recommended to ensure that every officer in charge of a navigational watch is trained and certified in accordance with the objectives of the course.

Certification of ECDIS Education

The certificate should document that:

- The candidate has completed a course in the operational use of ECDIS (Electronic Chart Display and Information Systems), based upon the IMO Model Course 1.27 - *The Operational Use of Electronic chart Display and Information systems (ECDIS).*

- The course fulfils the requirements of IMO STCW-95.

The certificate should be issued by a government authority or a relevant body that is government approved.

Section 4:   Technical Details of Electronic Charts

Official Electronic Chart Data

The term "Official", indicates chart data that has been produced under the authority of a government organization – in contrast to private, or non-official, electronic chart data which might be technically of the same type but has not been endorsed by a government authority. By definition, the terms ENC(s) and RNC(s) only refer to officially endorsed electronic charts.

Types of Official Chart Data

Electronic chart data is of two general types:

- Electronic Navigational Charts (ENC), and

- Raster Navigational Charts (RNC).

The inner construction of ENCs and RNCs is fundamentally different:

- ENCs are *vector* charts, and

- RNCs are *raster* charts.

Electronic Navigational Charts (ENCs)

General Principles

IMO's definition for the Electronic Navigational Chart – ENC:

Electronic Navigational Chart (ENC) means the database, standardized as to content, structure and format, issued for use with ECDIS by or on the authority of a Government, authorized Hydrographic Office or other relevant government institution, and conform to IHO standards. The ENC contains all the chart information useful for safe navigation and may contain supplementary information in addition to that contained in the paper chart (e.g. sailing directions), which may be considered necessary for safe navigation.

ENCs are vector charts comprising a database of individual geo-referenced objects extracted from a Hydrographic Office's records including existing paper charts. When used in an ECDIS, the ENCs content can be displayed as a seamless chart-like display at user selected scales. Due to the limited size and resolution of electronic displays the chart image generated from ENCs may not fully replicate the traditional appearance of a paper chart. This apparent shortcoming is more than compensated for by the special operational functions of ECDIS which continuously monitors the ENC data content (rather than the display) to provide warnings of impending dangers in relation to a vessel's position and its movement.

ENC Data Format

ENCs are formatted in accordance with the latest version of ENC Product Specifications as published by the IHO *(See www.iho.int > ENCs & ECDIS > Current ENC and ECDIS Standards)*. These Product Specifications describe the standards to be used for the exchange of digital hydrographic data between national Hydrographic Offices and for the distribution of digital data and products to manufacturers, mariners, and other data users. The current ENC Product Specification is based on the IHO S-57 data format which is the IHO Transfer Standard for Digital Hydrographic Data. The current version of S-57 is Edition 3.1. A new ENC Product Specification S-101 is currently (2017) under development, based on the IHO S-100 Universal Hydrographic Data Model.

ENCs use the World Geodetic System 1984 (WGS 84) as the horizontal datum reference. This makes most ENCs directly compatible with GNSS. However, a few ENCs have been compiled from older non-WGS 84 paper charts and a close match with GNSS positions cannot be assured. These ENCs carry an extra warning that will be displayed in the ECDIS, such as "This chart cannot be accurately referenced to WGS

84 Datum; see caution message". A typical caution message would be: "Positions in this region lie within ± nn metres of WGS 84 Datum".

See also IMO SN.1/Circ.213 *Guidance on Chart Datums and the Accuracy of Positions on Charts*; and IMO SN.1/Circ.255 *Additional Guidance on Chart Datums and the Accuracy of Positions on Charts* for additional information on horizontal datum reference.

ENC Display

An ENC is a database of geographic entities. It currently does not contain any presentation rules.

Both the geo-referenced data objects contained in the ENC and the appropriate symbolisation contained in the S-52 ECDIS Presentation Library are linked to each other in the ECDIS only when called up for display. The resulting image will change depending on the sea area selected, the intended display scale and the mariner's pre-settings, such as the display mode best suited to the ambient light conditions, and other operational conditions.

The presentation rules for ENCs are contained in a separate ECDIS software module - the "Presentation Library". The definition of the Presentation Library for ENCs is contained in Annex A of the IHO Publication S-52 – *Specifications for Chart Content and Display Aspects of ECDIS*. The use of the S-52 symbology and presentation rules is mandatory in all ECDIS.

The ECDIS Presentation Library follows, as much as possible the presentation and symbology used on a paper chart. This will avoid confusion during the extended period when paper charts, RNCs and ENCs will co-exist. However, the ECDIS display provides a much increased level of flexibility compared to a paper chart. This includes:

- Displaying/removing various types of chart and non-chart information;
- Selecting standard chart display or a thinned out display, and full or simplified symbols;
- Using cursor interrogation to obtain further detail not shown on the continuous display;
- Overlaying/removing radar video or radar target information (in order to: confirm ship's positioning; aid radar interpretation; show the entire navigation situation on one screen);
- Overlaying/removing various other sensor information, or information transmitted from shore;
- Changing the scale or orientation of the display;
- Selecting true motion or relative motion;
- Changing screen layout with windowed displays, providing text information in the margins, etc.;
- Possibility of pull-down menus and other operator interaction devices being alongside the operational navigation display and so interacting with it;
- Giving navigation and chart warnings, such as: "*too close approach to safety contour*"; "*about to enter prohibited area*"; "*over-scale display*"; "*more detailed (larger scale) data available*" etc.;
- Possibly, a diagrammatic representation of a computer evaluation of grounding danger;
- Possibly, a diagrammatic representation of the immediate vicinity of the ship to aid in close quarters manoeuvring;

The ambient lighting on the bridge varies between the extremes of bright sunlight, which can wash out information on the ECDIS display, and night, when the light emitted by the display has to be low enough that it does not affect the mariner's night vision. The colours and symbols specifications of S-52 have been designed to meet these more difficult requirements. ECDIS provides a negative image of the chart at night, using a dark background in place of the white background of the paper chart, in order not to impair night vision.

Three predefined colour schemes are provided:

- Day (white background)
- Dusk (black background)
- Night (black background)

The following illustrations show two of the colour schemes and the three standard selections of content; that is Standard Display, Base Display and Full Display.

Standard Display, day
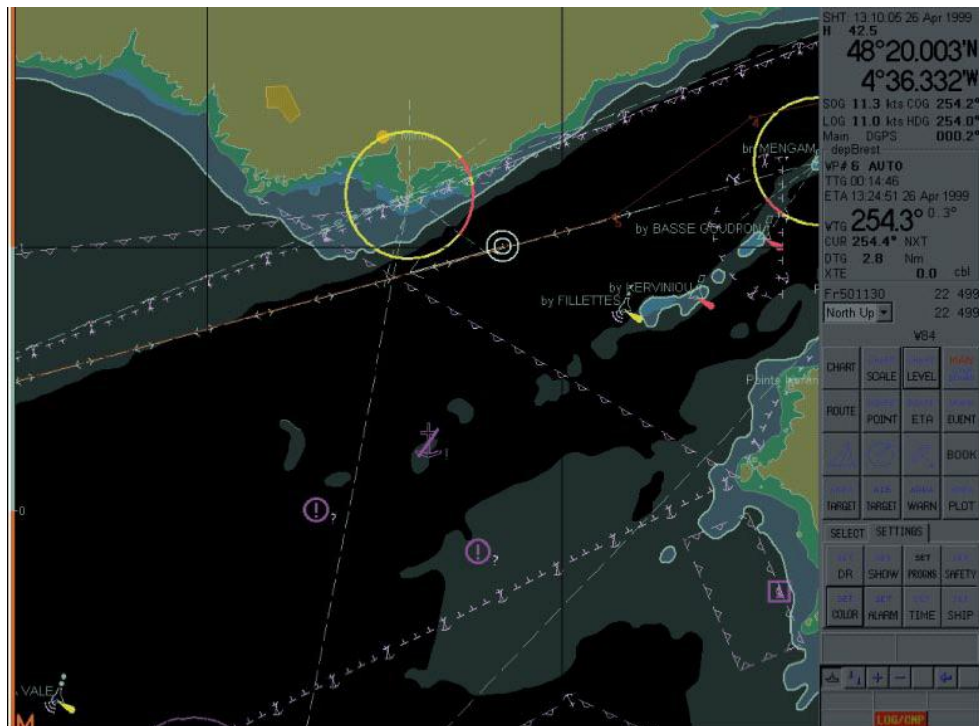
Standard Display, night

Base Display, day

Full Display, day

Use of ENCs in ECS

Many ECS are able to use ENCs. However, because an ECS, by definition, is not type-approved as meeting the ECDIS performance standards, the use of ENCs in an ECS does not satisfy the ECDIS carriage requirements of SOLAS.

ENC Distribution

The provision of a timely, reliable, worldwide and uniform ENC data distribution service is a major organizational challenge and the IHO developed the WEND (World-wide ENC Database) concept to meet these requirements. The p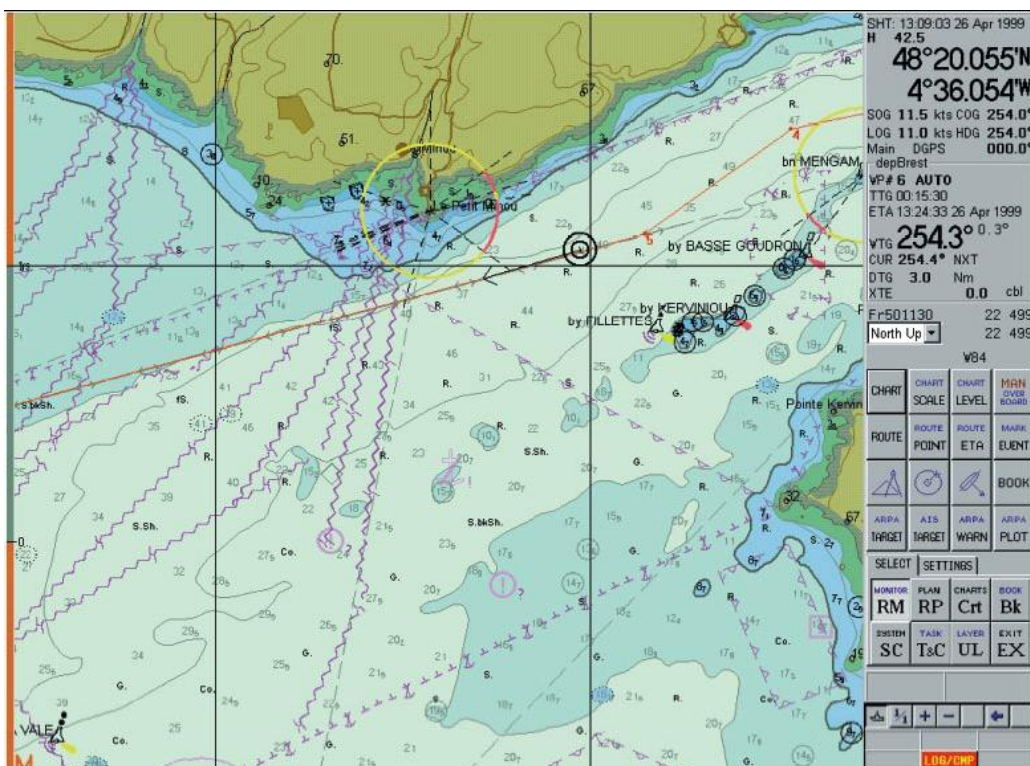urpose of WEND is to ensure a world-wide consistent level of high-quality, updated official ENCs through integrated services that support chart carriage requirements of SOLAS Chapter V, and the requirements of the IMO Performance Standards for ECDIS. The WEND Principles are included as Resolution 1/1997 (as amended) in IHO publication M-3 (*www.iho.int* > *Standards & Publications* > *M-3*). The WEND Working Group (WENDWG) has also produced "Guidelines for the Implementation of the WEND Principles" which are available from the WENDWG document page (*www.iho.int* > *Committees & Working Groups* > *WEND*). WEND consists of two components:

- A charter that describes the principles governing cooperation between the worlds Hydrographic Offices producing ENCs. Principles include:
    - The organization responsible for the primary charting of an area is responsible for ENC production in that area;
    - The relevant IHO standards, especially S-57 must be followed; and
    - The rules of a recognised work quality assurance system (such as ISO 9000) should be applied to ENC production.

- A conceptual schema describing a network of Regional Electronic Chart Co-ordinating Centres (RENCs), where:
    - Each RENC takes responsibility in its area for the collation of ENCs and updates for the region;
    - Each RENC can offer an identical global dataset for ECDIS through the exchange of the regional datasets and their updates between all the RENCs, and
    - RENCs act as a wholesale outlet for ENCs. RENCs supply ENCs to commercial user service providers who - rather like paper chart distribution - tailor individual sets of chart data for the special needs of a shipping company or a particular ship.

Producer Member States are encouraged to distribute their ENCs through a RENC. Those not opting to join a RENC should make appropriate arrangements to ensure that their ENCs meet WEND requirements for consistency and quality and are widely distributed.

To date, two RENCs – PRIMAR, based in Norway; and IC-ENC, based in the United Kingdom, Australia and the Americas, are in operation. The RENC model has yet to be fully adopted by all ENC producing nations. A number of nations still distribute their ENCs individually either through individually appointed chart data suppliers or directly rather than through RENCs.

Because ENCs might be subject to unauthorised amendment or illegal copying, the IHO has adopted S-63 – "*The IHO Data Protection Scheme*". This provides a standard authentication and encryption for ENCs. S-63 defines the technical details of the encryption method and the operating procedures for the RENC and ENC distributors. It also provides specifications that allow ECDIS manufacturers (OEMs) to build systems that can authenticate and decrypt S-63 ENCs.

What is a SENC?

In order to get efficient data structures that facilitate the rapid display of ENC data, most ECDIS convert each ENC dataset from S-57 into an internal machine-language format called SENC or System ENC – which is optimised for chart image creating routines. Most ECDIS software manufacturers have their own SENC format.

SENC Delivery

In order to take advantage of the efficiencies of delivering ENC data in a SENC format, the IHO has authorised an optional distribution mechanism called SENC delivery. This is in addition to the standard distribution of ENC in S-57 format. In this case, a RENC delivers the S-57 based ENCs to an authorized chart data distributor who then performs an ENC-to-SENC conversion (that otherwise would take place inside the ECDIS), and delivers the resultant SENC to the end user.

However, it is up to individual Hydrographic Offices to decide whether they wish to allow the ENCs for their waters to be distributed in SENC format in addition to S-57. Not all Hydrographic Offices allow their ENCs to be delivered by distributors as SENCs.

Official and Unofficial Data

An ECDIS can determine if data is from either an ENC or a private source by interrogating the Agency Code (a two character combination which is unique for any data producer) embedded in the data.

Using this code an ECDIS will warn mariners that they must navigate with an official up to date paper chart if data from a private source is in use. The ECDIS will show a warning on the ECDIS screen:

> *«No Official Data -Refer to paper chart »*

What scale should an ENC be displayed at?

During production, ENCs are assigned a compilation scale based on the nature of the source data upon which they are based and their intended usage. They are also allocated to a Navigational Purpose related to this. This is analogous to a series of paper charts covering the same area, ranging from "small scale charts" to "large scale plans". As shown in the table below there are six Navigational Purposes (NOTE: scale ranges are indicative only).

Suggested assignment of Navigational Purposes to scale ranges

Navigational Purpose	Name	Scale Range
1	Overview	<1:1 499 999
2	General	1:350 000 – 1:1 499 999
3	Coastal	1:90 000 – 1:349 999
4	Approach	1:22 000 – 1:89 999
5	Harbour	1:4 000 – 1:21 999
6	Berthing	> 1:4 000

To facilitate the display of a radar overlay on ENCs, the IHO specifications recommend that hydrographic offices set the compilation scales of their ENCs to be consistent with the standard radar range scales as shown in the following table:

Radar range / standard scale

Selectable Range	Standard scale (rounded)
200 NM	1:3 000 000
96 NM	1:1 500 000
48 NM	1:700 000
24NM	1:350 000
12 NM	1:180 000
6 NM	1:90 000
3 NM	1:45 000
1.5 NM	1:22 000
0.75NM	1:12 000

0.5 NM	1:8 000
0.25 NM	1:4 000

How are ENCs named?

Each ENC is identified by an 8-character identifier, for example FR501050. The first two characters indicate the producer; for example FR for France, GB for United Kingdom of Great Britain and Northern Island. A complete list of producer codes is included in the IHO standard S-62 – "*List of Data Producer Codes*". The third character (a number from 1 to 6) indicates the Navigational Purpose (as shown in the table above). The last five characters are alpha- numeric free text and provide a unique identifier.

Updating ENCs

In principle the generation and distribution of regular updates for ENCs follows a similar organizational structure to the production and distribution of ENCs. The frequency of updates (including permanent updates and updates equivalent to the content of Temporary (T) and Preliminary (P) paper chart Notices to Mariners) is normally synchronised with the chart corrections promulgated by national Notice to Mariners for the affected sea areas.

Updates may reach a ship via different ways depending upon the capabilities of the ENC service provider and the communication facilities onboard:

- o On data distribution media, for example CD;

- o As an e-mail attachment via SATCOM; and

- o As a broadcast message via SATCOM plus additional communication hardware.

Raster Navigational Charts (RNCs)

General principles

RNCs are digital copies of paper charts conforming to IHO publication S-61 - *Product Specifications for Raster Navigational Chart (RNC)*. RNCs are issued by, or on the authority of a national Hydrographic Office.

When displayed on an ECDIS screen RNCs appear as a facsimile of the paper chart however, they contain significant metadata to ensure that they have a certain minimum functionality; such as a geo-referencing mechanism that allows geographic positions to be applied to and extracted from the chart, automatic updating of the RNC from digital files (and the ability to show the state of correction), and the display of the RNC in day or night colours.

An RNC is a digital copy of the current paper chart. As such the chart content cannot be analysed by a computer program to trigger alarms and warnings automatically as is the case with a vector chart; however, some alarm and warning functions can be achieved by manual user input to the ECDIS.

RNC data format and production

RNCs are normally produced by digitally scanning the stable repromat used to make a paper chart, or direct conversion of a completed compilation of a paper chart in a digital chart production system to a raster format. Unlike ENCs there can be more than one format for RNCs. The main RNC formats are:

- o BSB (used by USA, Canada, Cuba and Argentina); and

- o HCRF (used by UK and New Zealand).

RNC Display

- The display of RNCs is limited by the resolution at which they were scanned. Excessive zooming in or out of the image seriously degrades the clarity of the image (see figure below). When the user wants to see a representation of a geographic area in greater detail, then just like a paper chart, a larger scale RNC should be selected (if it exists);

- Orientation of the Raster Chart Display System (RCDS) display to other than north-up (for example course-up or route-up), may affect the readability of chart text and symbols;

- RNCs incorporate very similar colour palettes to the day/night colours used by ENCs. It is mandatory for ECDIS with an RCDS capability to provide the appropriate colour palettes for RNCs;

- RNCs are treated as individual charts (not seamless like ENCs). However, it is possible for ECDIS to automatically load an adjoining chart, based on the meta data provided;

- ARPA radar targets can be overlaid onto an RNC. It is also possible for a radar video image to be scaled to fit an RNC. Scaling an RNC to fit a radar video image is inappropriate as this is likely to result in a degraded chart image; and

- RNCs include significant meta data to allow an ECDIS to make maximum use of the image. For example chart notes and tide panels may be accessed directly in RCDS mode rather than the user having to scroll to the appropriate area of the chart.
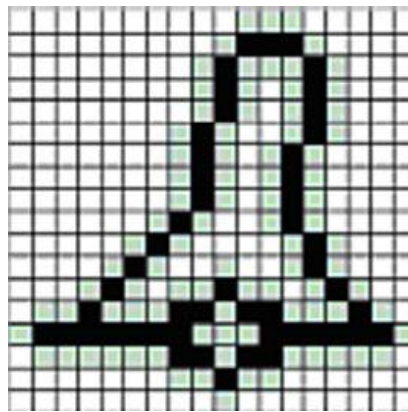
"Over-zoomed" symbol on a raster chart

The image of an RNC retains the horizontal datum of the paper chart from which the RNC has been derived. However, the geo-referencing of the RNC can include an adjustment to account for the use of GNSS and the WGS 84 datum. Mariners should understand how the horizontal datum of the original chart relates to the datum used by the ships position fixing system. In some instances, this will appear as an apparent shift in geographical position. (Any differences will be most noticeable at grid intersections and during route monitoring). Where the difference between the local horizontal datum and WGS 84 is known, the adjustment should be automatically applied by the ECDIS. If the horizontal datum of the paper chart from which the RNC is produced is not known then it is not possible to relate GNSS positions accurately to the RNC; IMO SN/Circ.255 has been issued to alert users to this problem.

Below are illustrated Day and Night colour schemes of a RNC:
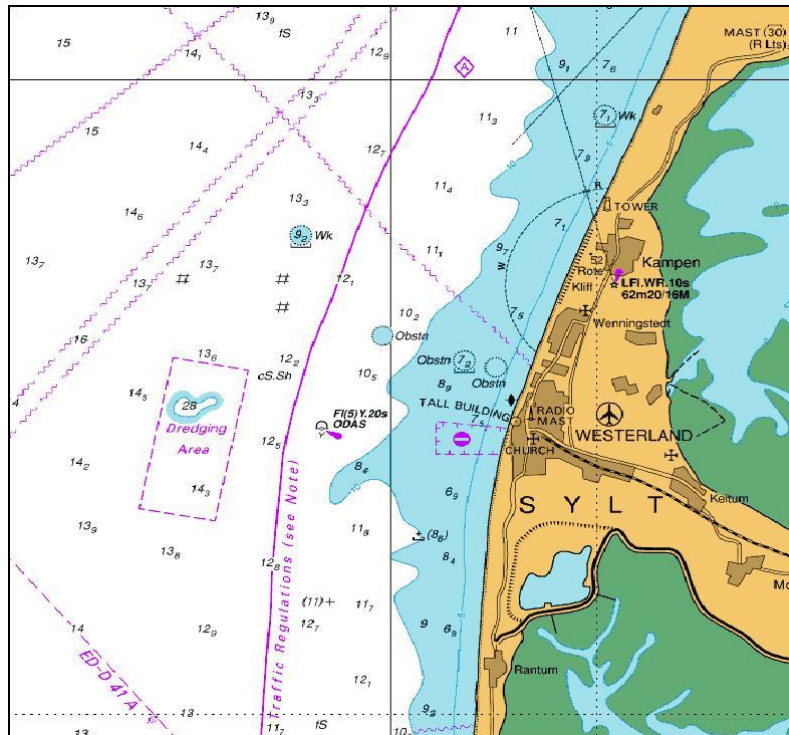
RNC Display, day

RNC Display, night

RNC updating

- RNC updates can be supplied as complete refreshed images or as patches (tiles or areas) that the ECDIS can superimpose on the original RNC. The latter method is normally used as this minimises the amount of data to be provided;

- Updates are provided in line with those made available via the Notices to Mariners system for the equivalent paper chart; and

- Most RNC services currently rely on CD as the transfer media; however electronic courier services are now being established to allow mariners to download selected chart updates.

Private Chart Data

Privately produced chart data may be provided in either vector or raster formats and superficially might seem similar to official chart data. However there are important differences in the type and quality of data being sold and while many companies take care in the production of electronic chart data to ensure both completeness and accuracy, this cannot be assumed for all.

Private chart data cannot be updated with the same regularity as official data. The private chart data suppliers normally base their products on official charts and data (supplied by HOs under licence). This means that the updating of their charts depends on the availability of the updated official chart product. Consequently there is a delay, sometimes considerable, between the promulgation of the updates for the official charts and the release of updates for private chart data.

Chart data published by private companies is not quality controlled or assured by a Government organization; therefore the product liability is entirely the responsibility of the producing company.

In 2003 ISO published a specific standard (ISO 19379:2003) for the compilation of private chart data for use in Electronic Chart System (ECS); this standard was produced on the initiative of the private chart data industry. ISO 19379 applies to both private vector charts and to private raster charts. It includes test methods for the production of an ECS database and addresses the elements of the database relevant to safety of navigation including content, quality and updating. It also provides guidance on the production and testing of an ECS database. It does not cover the methods and techniques required for database design and development, nor does it address specific quality management procedures. Private chart data, regardless of the format in which it is supplied to the market or any ISO certification, does not meet the requirements specified by the IMO Performance Standards for ECDIS and thus does not meet the chart carriage requirements.

In contrast to ENCs and RNCs many proprietary formats are used. Consequently, chart data from different manufacturers are often incompatible with each other – and so are the ECS which make use of them.

Section 5:   References and Glossary

References

- International Convention for the Safety of Life at Sea (SOLAS)

- International Convention for Standards for Training, Certification and Watchkeeping (STCW)

- IMO Resolution MSC.232 (82): Revised Performance Standards for ECDIS

- IEC 61174: Electronic chart display and information system (ECDIS) - Operational and performance requirements, methods of testing and required test results

- IEC 62288: Maritime navigation and radiocommunication equipment and systems - Presentation of navigation-related information on shipborne navigational displays – General requirements, methods of testing and required test results

The latest versions of the following IHO ECDIS and ENC Standards can be accessed from *www.iho.int > ENCs & ECDIS > Current ENC and ECDIS Standards*.

- IHO S-52: Specifications for Chart Content and Display Aspects of ECDIS;

- IHO S-57: IHO Transfer Standard for Digital Hydrographic Data
    - Appendix B.1 – ENC Product Specification

- IHO S-61: IHO Product Specification for Raster Navigational Charts

- IHO S-62: IHO List of Data Producer Codes

- IHO S-63: IHO Data Protection Scheme.

ENC related IHO S-100 based Specification under development:

- IHO S-101: ENC Product Specification

For information on the latest versions of documents mentioned above, consult the web site of the issuing Organization:

International Maritime Organization	*www.imo.org*
International Hydrographic Organization	*www.iho.int*
International Electrotechnical Commission	*http://www.iec.ch*

Links to the following IMO Circulars may be found on the IHO web site *http://iho.int/iho_pubs/IHO_Download.htm*, under the table entry for S-66, as supplementary reference documents to S-66:

- IMO MSC.1/Circ.1503 (as amended) *ECDIS – Guidance for Good Practice*;

- IMO STCW.7/Circ.24 (as amended) *INTERNATIONAL CONVENTION ON STANDARDS OF TRAINING, CERTIFICATION AND WATCHKEEPING FOR SEAFARERS (STCW), 1978, AS AMENDED - Guidance for Parties, Administrations, port State control authorities, recognized organizations and other relevant parties on the requirements of the STCW Convention, 1978, as amended*;

- IMO SN.1/Circ.213 *Guidance on Chart Datums and the Accuracy of Positions on Charts*;

- IMO SN.1/Circ.255 *Additional Guidance on Chart Datums and the Accuracy of Positions on Charts*.

Glossary/List of Abbreviations

Abbreviation	Explanation
AIS	Automatic Identification System
ARPA	Automatic Radar Plotting Aid
BIMCO	The world's largest Association of ship-owners and others representing more than 65% of the world's tonnage
BSB	Raster data format used by USA and Canada and others (BSB comes from the first letter of the companies that joined together with NOAA to make the first NOAA raster charts: Better Boating Association, Sewall Company and Blue Marble Geographics)
ECDIS	Electronic Chart Display and Information System
ECS	Electronic Chart System (does not meet SOLAS requirements)
ECS charts	Non official (private) chart data (vector or raster)
ENC	Electronic Navigational Chart
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HCRF	Hydrographic Chart Raster Format
Hydrographic Office (HO)	National Hydrographic Office
IC-ENC	International Centre for ENC's - a RENC operated by UK Hydrographic Office and in collaboration with the Australian Hydrographic Service, Brazil Directorate of Hydrography and Navigation and NOAA
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISM	International Safety Management code
ISO	International Organization for Standardization
MED	Maritime Equipment Directive of the European Union
PRIMAR	a RENC operated by the Norwegian Hydrographic Service
PSC	Port State Control
PSCO	Port State Control Officer
RCDS	Raster Chart Display System
RENC	Regional ENC Coordination Centre
RNC	Raster Navigational Chart
RTCM	Radio Technical Commission for Maritime Services
SATCOM	Satellite Communications
SENC	System ENC
SOLAS	International Convention for the Safety of Life at Sea
WEND	World-wide ENC Database
WGS 84	World Geodetic System 1984

Further Reading:

The Electronic Chart – Fundamentals, Functions, Data and Other Essentials – A Textbook by H.Hecht, B. Berking, G. Büttgenbach, M. Jonas, L. Alexander; 3rd revised edition; 2011; Publisher: Geomares Publishing; ISBN: 978-90-806205-8-2

From Paper Charts to ECDIS – A Practical Voyage Plan; by Harry Gale; February 2009; Publisher: The Nautical Institute; ISBN 978 1 870077 98 9

ECDIS and Positioning, Vol 2 of Integrated Bridge Series; by Dr Andy Norris; January 2010; Publisher: The Nautical Institute; ISBN 978-1-906915-11-7

The Electronic Chart Display and Information System - An operational handbook by Adam Weintrit, Navigational Department, Gdynia Maritime University, Poland.; 1st edition; 2009; Publisher: CRC Press; ISBN: 978-0-415-48246-2

Page intentionally left blank