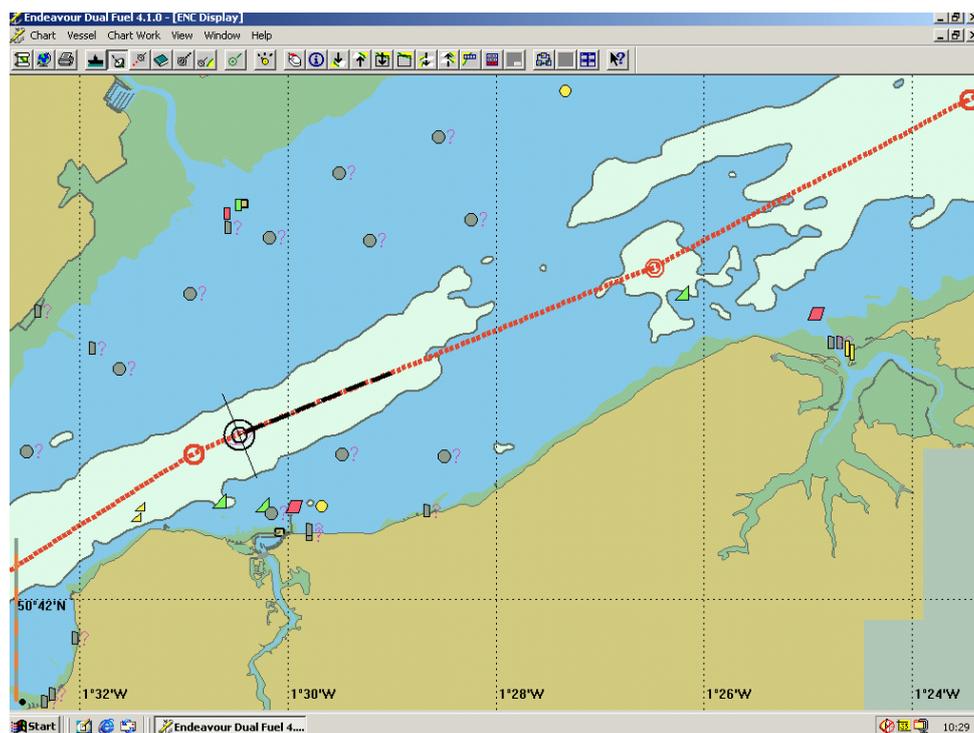


INTERNATIONAL HYDROGRAPHIC ORGANIZATION



ELECTRONIC NAVIGATIONAL CHARTS (ENCs)

“PRODUCTION, MAINTENANCE AND DISTRIBUTION GUIDANCE”



**A guide to the requirements and processes necessary
to produce, maintain and distribute ENCs**

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Introduction

Purpose and Scope

This document provides a high level guide to the production, maintenance and distribution of Electronic Navigational Charts (ENCs).

It offers a framework to inform hydrographic offices of the processes and requirements necessary to produce, maintain and distribute ENCs.

It provides references to documentation which can support each stage of the process. It is not intended to serve as a technical reference manual but to enable hydrographic offices to gain an overview of ENC production processes, and the requirements and procedures that need to be in place to set up an ENC production facility.

References

Standards and Conventions

- A IHO S-52, "Specifications for Chart Content and Display Aspects of ECDIS"
- B IHO S-57, "IHO Transfer Standard for Digital Hydrographic Data"
- C IHO S-58, "Recommended ENC Validation Checks"
- D IHO S-62, "ENC Producer Codes"
- E IHO S-63, "IHO Data Protection Scheme"
- F IHO M-3, "Resolutions of the IHO", Resolution 1/1997, Principles of the Worldwide Electronic Navigational Chart Database (WEND).
- G IHO S-4, "Regulations of the IHO for International (INT) Charts and Chart Specifications of the IHO"
- H IHO S-8, FIG/IHO/ICA 'Standards of Competence for Nautical Cartographers'
- I IMO Resolutions MSC.232 (82) and A.817 (19), as amended by MSC.64 (67) and MSC.86 (70), "Performance Standards for Electronic Chart Display and Information Systems (ECDIS)"
- J IMO Convention on the Safety of Life at Sea (SOLAS), 2009
- K IHO S-66, "Facts about electronic charts and carriage requirements"

Indicative Documentation

- L UKHO ENC Product Specification
- M UKHO ENC Data Capture Specification
- N UKHO ENC Training Documentation and Job Descriptions
- O UKHO Quality Procedures for the production of ENCs
- P Guidelines for the Implementation of the WEND Principles

The UKHO can make References L & M and the overview elements of References N & O available on request; due to their complexity more detailed elements of the latter pair would typically form part of the documentation provided as part of an overall training/support package and would be considered on an individual basis.

In addition, various HOs have established their own specifications; certain of them are available.



Abbreviations

ENC	Electronic Navigational Chart
ECDIS	Electronic Chart Display and Information System
HO	Hydrographic Office
IHO	International Hydrographic Organization
IMO	International Maritime Organization
QMS	Quality Management System
RENC	Regional ENC Coordinating Centre
SOLAS	Convention on the Safety of Life at Sea
WEND	Worldwide ENC Database



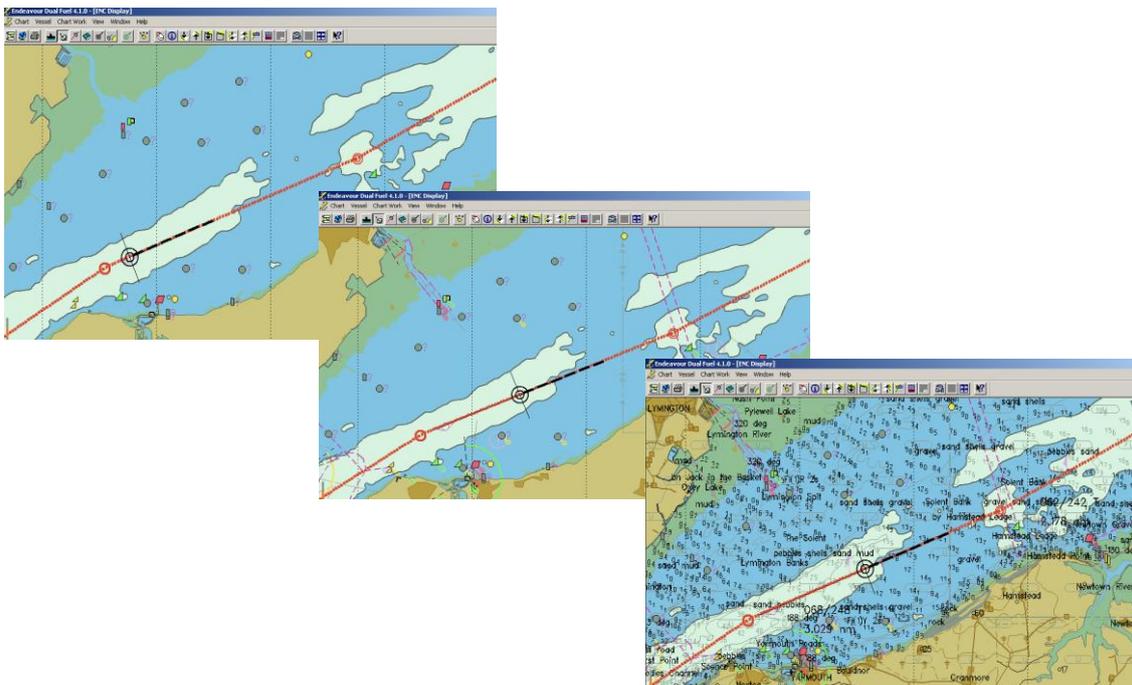
What is an ENC?

Digitised Data

Electronic Navigational Charts (ENCs) consist of digitised data conforming to the IHO's S-57 ENC Product Specification that records all the relevant charted features necessary for safe navigation, such as coastlines, bathymetry, buoys, lights, etc. The basic unit of geographic coverage (analogous to a paper chart) is termed a cell.

An Electronic Chart Display and Information System (ECDIS) will convert the ENC and its updates into its own native System ENC (SENC) format. The SENC format is optimised by the ECDIS manufacture for the correct and efficient display of the ENC information.

Within the ECDIS, the features and their attributes (e.g. position, colour, shape) can be selectively displayed and queried, creating the potential to manipulate the chart image displayed on screen. The figures below show



various levels of detail displayed from the same cell:

This not only provides ENC users with control over what level and type of detail they wish to see, but can also be linked to other onboard systems to provide additional features such as automatic warning alarms and indications.

S-52 Display Standard

While S-57 defines what information can be encoded and how it is to be structured, it says nothing about how that data can be displayed. When ENC data is used in an ECDIS, this is defined within S-52. This specifies not only the symbology to be used but also the full range of conditional rules that govern their use.



Official Vector Charts

ENCs are official vector-based electronic charts designed to meet the relevant chart carriage requirements of the Safety of Life At Sea (SOLAS) convention.

When displayed within certain parameters, and using a type approved ECDIS, ENCs fully satisfy SOLAS chart carriage requirements, and so can be used as the primary means of navigation.

Relevant Regulations

The SOLAS convention of the International Maritime Organization (IMO) includes a number of pertinent requirements:

- ❑ That nations publish nautical information necessary for safe navigation; this includes systematic updating with all necessary safety-critical information
- ❑ That ships shall carry nautical charts and that use of an ECDIS meets this requirement. It also notes that such charts (paper or electronic) shall be “issued by or on behalf of a Government authorized hydrographic office or other relevant government institution”; in other words they must be ‘official charts’.

The IMO’s ECDIS Performance Standard further mandates that “The chart information to be used in ECDIS should be the latest edition of that originated by a government authorized hydrographic office, and conform to IHO standards.”

In order to be a legal equivalent of paper charts, the ECDIS must be type-approved in accordance with Standard 61174 of the International Electrotechnical Commission (IEC).

Hydrographic Office Responsibilities For Producing ENCs

The responsibilities of Hydrographic Offices (HOs) for the production and distribution of ENCs are defined in the WEND (Worldwide Electronic Navigational Chart Database) principles. (M-3, Resolutions of the IHO). These note that :

“The purpose 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.”

HOs are responsible for:

- ❑ The preparation and provision of digital data and its subsequent updating for waters of national jurisdiction.
- ❑ Ensuring that, mariners, anywhere in the world, can obtain fully updated ENCs for all shipping routes and ports across the world and that their ENC data are available to users through integrated services.
- ❑ Assuring the high quality of its ENC services through the use of a Quality Management System that is certified by a relevant body as conforming to a suitable recognised standard; typically this will be ISO 9001:2000.



- ❑ Ensuring compliance with all relevant IHO and IMO standards and criteria (including IHO S-57, IHO S-52, or their replacements).
- ❑ Providing timely updates to the ENC for the mariner; these should be at least as frequent as those provided by the nation for correction of paper charting.

Reference is made throughout this document to the relevant WEND principles that support some of the stages of the ENC production processes.

For full details of the WEND principles refer to M-3 - Resolutions of the IHO, Resolution 1/1997, Principles of the Worldwide Electronic Navigational Chart Database (WEND).

Note should also be taken of the 'Guidelines for the Implementation of the WEND Principles'¹ agreed by the WEND Committee in 2008 and available on the IHO Website.

Useful References: S-66 - Facts about electronic charts and carriage requirements²; (Plus those documents listed above).

Flow Chart

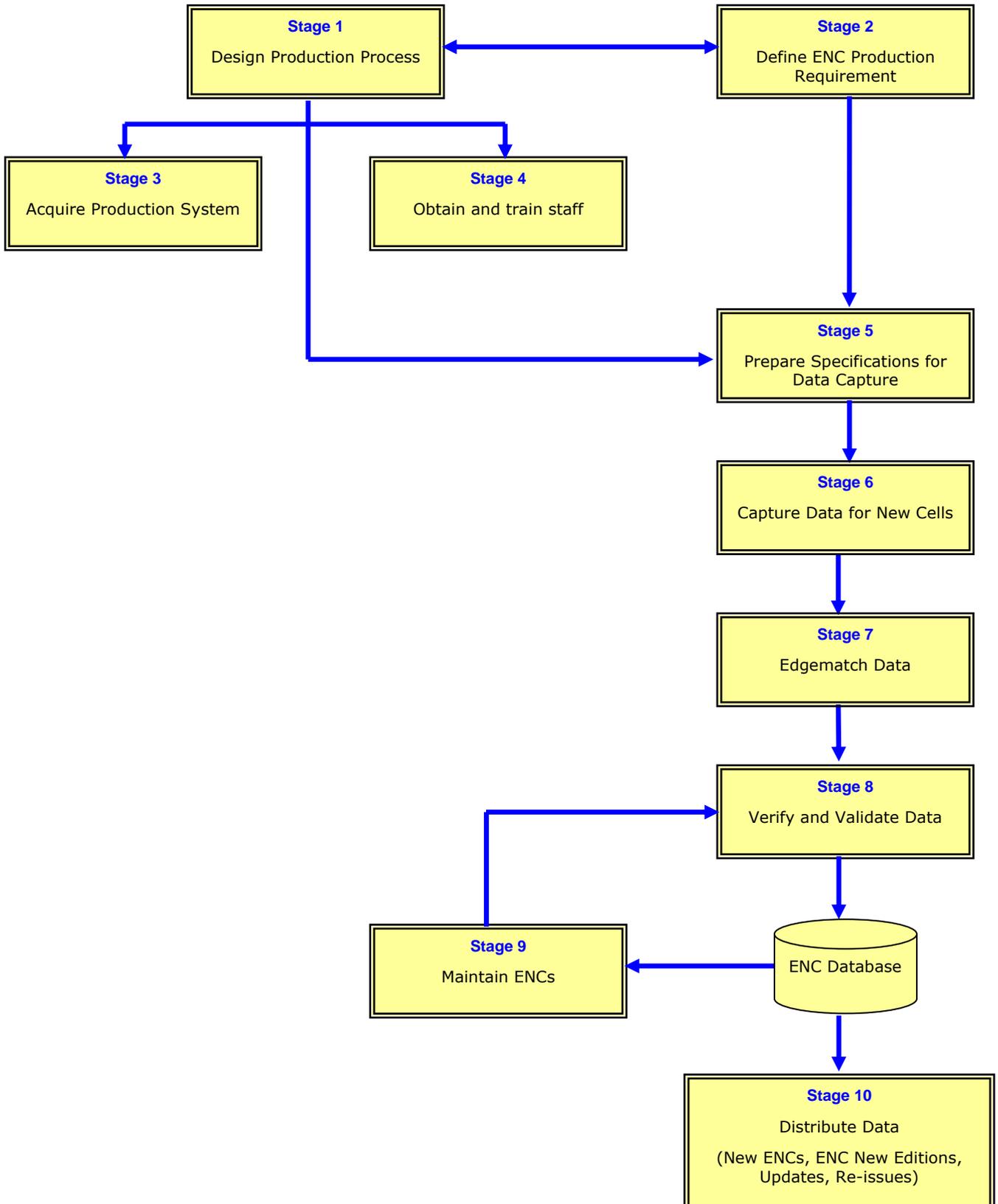
A flow chart detailing each stage of the process is shown overleaf.

¹ Reference P

² Reference K



Key Stages in the Production of ENC





ENC PRODUCTION AND DISTRIBUTION GUIDANCE

STAGE 1 – Design Production Process

STEP 1 – Production Method

- Before the production process can be designed, it has to be decided which source material will be used for the ENCs.

ENCs can be encoded directly from original survey material, databased information, from existing paper charts or a combination of each.

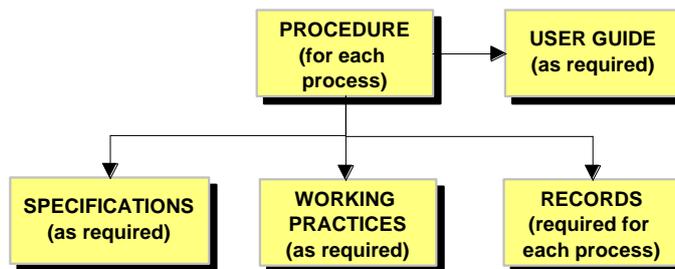
The decision as to which source material will be used will depend on several factors:

- The quality and format (i.e. digital or analogue) of existing survey data. For example it may be more efficient and prudent to produce ENCs only from surveys completed to modern surveying standards.
 - The availability of accurate transformations for existing information to WGS-84 where required.
 - The existence of, or facilities to produce, rectified raster images of existing charts.
- Once it has been decided which source material will be used, a production process needs to be designed and a Quality Management System (QMS) for ENC developed to interface with existing production processes.
 - Any production process will be dependent on whether the Data Capture is to be carried out 'in house' or under contract – see Stages 5 & 6. This decision must be based on the in house production capacity, number of cells to be captured, required timescales, available staff and IT resources, and funding. Each has its own advantages and disadvantages. These include:
 - In house capture should provide a more flexible solution but may require a longer lead time for staff training and may have resourcing issues where a large team is needed for initial capture and a much smaller team to maintain the service thereafter.
 - Contracting out the work should reduce the costs of basic capture, however the time necessary to put the contract in place should not be underestimated nor the effort required to support it; also final validation needs to be carried out by the HO taking responsibility for the product.
 - Options such as using external resources to provide an initial 'bulk load' - see Stage 2 - with all further capture and maintenance carried out in-house should be considered.
 - Consideration should be given to ensure that the publication of ENCs and updates is co-incident with the publication of the equivalent paper chart information.



STEP 2 – A Quality System

- Procedures should be put in place to ensure that each stage of the production process is carried out correctly and consistently. These should be approved by a relevant body as conforming to a suitable recognised standard; typically this will be ISO 9001:2000.



ENC PROCESS DOCUMENTATION

- The production of ENCs demands a high level of quality control and quality assurance. It is important to bear in mind the difference between these two concepts:
 - Quality Control – those checks made on a product after production;
 - Quality Assurance – the overall set of processes, of which Quality Control forms a part, designed to ensure that a product is produced correctly and without errors.

The IHO WEND principles state the following with reference to Standards and Quality Management:

- ❖ A Quality Management System should be considered to assure high quality of ENC services. When implemented, this should be certified by a relevant body as conforming to a suitable recognised standard; typically this will be ISO 9001:2000.
- ❖ There must be conformance with all relevant IHO and IMO standards.

Useful References: UKHO Quality Procedures



STAGE 2 – Define ENC Production Requirement

STEP 1 – Identify Requirements

■ While each nation has the responsibility for ENCs in its own waters, many aspects of the overall service to the mariner will be improved through their working within the relevant Regional Hydrographic Commission (RHC). This will expedite the completion of small scale coverage and the agreement of cell boundaries between nations. The WEND Task Group recommended that RHCs should:

- Identify key shipping routes and ports within their regions
- Identify charts covering these routes and ports to be captured as ENCs
- Identify producer nations for the ENCs
- Arrange for their production

Wherever possible ENCs should be based on INT charts and the producer nations for the ENCs should be the same as the producer nations for the corresponding INT charts.

If ENCs are to display correctly in an ECDIS it is especially important that there is no overlap of data within the same navigational purpose band. The ENC Product Specification³ makes it clear that such overlap must not occur. See also S-57 Appendix B.1, Annex A – Use of the Object Catalogue for ENC, clause 2.1.8.

In addition to the agreement of boundaries, it is important that neighbouring countries agree, where possible, factors contributing to consistent ENC data encoding such as assignment of ENCs to navigational purpose, use of SCAMIN, and contour interval to provide a seamless depiction (see Stage 7, Step 2). The final assignment of ENCs to navigational purposes and the values used for individual SCAMIN attribution should preferably be done through consultation with all ENC Producer States within a Regional Hydrographic Commission as appropriate, in order to maintain consistency across national or regional boundaries.

STEP 2 – Produce Production Plan

- A national production plan then needs to be compiled to define:
 - which geographic areas are to be captured – note that this relates to actual areas of data coverage rather than the rectangular cell limits.
 - which navigational purposes are to be populated for each area
 - how the areas are to be divided into cells for each navigational purpose
 - the order of capture; e.g. larger scale cells first
- The production plan will be dependent on some of the following factors:

³ Reference B, Appendix B.1



- The reason for the requirement – Defence / SOLAS
- Priority given to major ports and traffic routes, based on volumes of goods and number of passengers
- Liaison with bordering countries to maximise production, improve efficiency and coverage, and to ensure cross-border consistency
- Design considerations outlined below.



The IHO WEND principles also state the following with reference to responsibility and ownership.

- ❖ SOLAS Chapter V, Regulation 9, requires Contracting Governments to ensure that hydrographic data are available in a suitable manner in order to satisfy the needs of safe navigation. Once the carriage of ECDIS becomes mandatory, there will be a consequential requirement to ensure that such data, as agreed by IMO, are available in a form suitable for use in ECDIS.
 - ❖ It is expected that Member States, for waters of national jurisdiction, will have mature supply systems for ENC's and their subsequent updating in place by the earliest date for mandatory carriage of ECDIS.
 - ❖ By the dates established by IMO, Member States will strive to either:
 - a Provide the necessary ENC coverage, or
 - b Agree with other States to produce the necessary ENC coverage on their behalf.
- IHO will address overall coverage on a regional basis through Regional Hydrographic Commissions.
- ❖ The INT chart system is a useful basis for initial area selection for producing ENC's.
 - ❖ Responsibilities for providing digital data outside areas of national jurisdictions must be established.
 - ❖ In producing ENC's, Member States are to take due account of the rights of the owners of source data and if paper chart coverage has been published by another Member State, the rights of that State.
 - ❖ Responsibility for the production of ENC's can be delegated in whole or in part by a country to another country, which then becomes the producing country in the considered area.
 - ❖ When the limits of waters of national jurisdiction between two neighbouring countries are not established, or it is more convenient to establish boundaries other than established national boundaries, producing countries are to define the boundaries for ENC production within a technical arrangement. These limits would be for cartographic convenience only and shall not be construed as having any significance or status regarding political or other jurisdictional boundaries.
 - ❖ In international waters, the INT chart producer nation shall be assumed to be the producer of the corresponding ENC. Where the offshore limits of waters under national jurisdiction have not yet been established, the clause above should apply.
 - ❖ In areas where the paper INT charts overlap, neighbouring producer nations should agree a common limit of ENC production in the overlapping areas. Cartographic boundaries should be as simple as possible, for example: a succession of straight segments and turning points corresponding to such things as meridians, parallels, or chart limits. Where different producer nations are responsible for INT coverage of the same area at different scales, those nations should agree on a suitable set of boundaries so as to provide the user with the most coherent service possible.

Useful Reference: Guidelines for the Implementation of the WEND Principles



Cell Schema Design Considerations

Limits of ENC Cells

- The HO has to decide how the limits of the planned ENC cells should be defined. The limits can be based on the existing limits of paper charts, or be defined by a rectangular grid.
- The ENC Production Specification, S-57 Appendix B.1, states that *"the geographic extent of the cell must be chosen by the ENC producer to ensure that the resulting dataset file contains no more than 5 megabytes of data. Subject to this consideration, the cell size must not be too small in order to avoid the creation of an excessive number of cells."*

It also states that "cells must be rectangular". Within this, the actual data coverage can be any shape.

Compilation Scales

It is recommended that the compilation scales for ENCs are based upon standard radar ranges as described in the Use of the Object Catalogue for ENC, S-57 Appendix B.1, Annex A, clause 2.2.6.

Navigational Purposes

- Dependent on its intended navigational purpose an ENC is assigned to one of the 6 navigational purposes defined in S-57:
 - Overview
 - General
 - Coastal
 - Approach
 - Harbour
 - Berthing
- S-57 Edition 3.1 does not define minimum and maximum compilation scales for each navigational purpose.



STAGE 3 – Acquire Production System

STEP 1 – Identify Requirement

- The capacity and capability of the production system required will depend on the production plan (see Stage 2) and on the extent to which data capture will be contracted out.
- In the broadest terms there are two types of production software:
 - Those which populate and maintain a database of ENC objects, attributes and attribute values in a format which is compatible with IHO Transfer Standard for Digital Hydrographic Data, S-57 (ENC Product Specification);
 - Those which create individual flat files each forming a single ENC cell.
- A Statement of Requirement (SOR) should be written to set out clearly the requirements of any contract. The SOR should include Key User Requirements, capability of the system, the number of workstations required, any support requirements, and any interfaces with other existing production systems. The contract could include hardware as well as software or just the latter for installation on existing infrastructure. See also Stage 4 regarding the potential for including training provision as part of this contract

STEP 2 – Invitation to Tender

- Once the required production capacity is known (see Stage 2) then an invitation to tender should be sent out to those companies identified as being capable of supplying a suitable system.
- The tenders rendered can then be evaluated against the criteria defined in the initial invitation.
- The contract can then be awarded to the selected company following the evaluation.

STEP 3 – System Installation and Testing

- Before acceptance, the system needs to be installed and tested to ensure that all contractual requirements have been met.

STEP 4 – Live Running

- When the supplier has demonstrated that the system performs in accordance with the specifications it can be contractually accepted and transferred to live running.



STAGE 4 – Obtain and Train Staff

STEP 1 – Staffing Levels

- Staffing levels need to be defined for the production of new ENC cells and the maintenance of existing cells. The staff requirement will be based on whether the decision is to contract out the data capture or capture data in-house, on the number of cells planned, and the proposed targets to achieve those plans.
- To assist with this planning the following provide some guidelines on the approximate timescales (based on UKHO ENC production) for the production and maintenance of cells, from initial preparation to final publication. These are based on production of ENC from paper charts with updates matching the paper chart Notice to Mariners service:
 - Production of New Cells = approximately 5 weeks of an operator's time for a full paper chart equivalent.
 - Production of New Editions = approximately 5 weeks.
 - Production of Updates = approximately 1 hour per update.

Information from other HOs indicates that these figures may vary considerably depending on the complexity of the area, the verification and validation processes adopted and the experience of the staff involved.

Australia's experience is that if highly detailed ENCs are compiled from source material such as hydrographic data, rather than from existing paper charts, substantial additional time will need to be allowed. This will depend on the extents of the cells, area of data coverage, depth contour interval adopted and how complex the source data is. As an example, one degree square ENC cells in the Great Barrier Reef where the seabed is quite complex, compiled from source surveys showing **one** metre depth contours and depth areas, with a navigational purpose of 4, took about 26 weeks to produce, including checking and validation. Such cells often approach the maximum size of 5 MB after optimisation and grouping of soundings has been carried out.

STEP 2 – Determine Skill Levels

- The training needs depend on whether existing staff are to be re-trained or new staff recruited for ENC production.
- A Skills Analysis and Training Needs Analysis should be employed to determine the skills required for the job and the skill levels of the staff. Commercial companies can assist with this task. Where appropriate, reference should be made to Publication S-8; FIG/IHO/ICA 'Standards of Competence for Nautical Cartographers'.

The following training may be required:

- Chart Awareness Training, especially regarding navigational marks
- ENC/S-57 Awareness training
- Quality Assurance training, including quality control aspects



- Production System Training
- ECDIS training – for displaying ENCs to assess portrayal

STEP 3 – Identify Training Provider

- Once the requirement for training has been identified, the training provider needs to be determined. For Production System training, the system provider in most cases will provide the initial training and this needs to be specified within that contract. For Chart Awareness, QA and ENC/S-57 training, this could be provided internally by existing staff, or externally. Courses that are available internationally are listed in IHO Publication C-47, “Training Courses in Hydrography and Nautical Cartography”.

The IHO WEND principles state that:

- ❖ Member States’ HOs are strongly recommended to provide, upon request, training and advice to HOs that require it to develop their own national ENC provision.

Useful References: S-8 FIG/IHO/ICA ‘Standards of Competence for Nautical Cartographers’
UKHO ENC Training Documentation;
UKHO Job Descriptions;
C-47 IHO Training Courses;
Guidelines for the Implementation of the WEND Principles



STAGE 5 – Prepare Specifications for Data Capture

STEP 1 – Published Specifications

- The IHO Transfer Standard for Digital Hydrographic Data, S-57, defines the content, structure and format of the data for ENC. Appendix B1 of the standard contains the Product Specification for ENC.
- Reference should be made to Appendix A (Object Catalogue) and Annex A to Appendix B1 (Use of the Object Catalogue for ENC), of S-57, which define how charted objects should be encoded for ENCs.
- It should also be noted that S-57 is maintained by Maintenance Documents and any clarifications within these documents apply to ENCs complying with S-57 Edition 3.1 together with any Supplements that are extant. TSMAD, the IHO group responsible for maintaining and developing S-57, also produces ENC Encoding Bulletins and Frequently Asked Questions (FAQ) about ENC encoding issues. These are all available on the IHO website. TSMAD welcomes additional queries from member states or HOs about ENC encoding issues.

All of these sources need to be searched when collating specifications relating to ENC data capture.

STEP 2 – Data Capture and Product Specifications

- The S-57 standard, although comprehensive, leaves it to HOs to decide what should be the content of the ENCs, what the limits of the cells should be, and which navigational purposes the cells should belong to.
- Supplementary Data Capture and Product Specifications should be produced to clarify the content and construction of ENC cells and the capture of ENC data, in addition to the recommended and mandatory requirements of S-57. As well as clarifications regarding content, these should include elements such as accuracy requirements and file naming conventions for cells and associated text and picture files.
- Size of data sets should be optimized and only necessary data should be included. This will facilitate remote distribution services.
- Ensure consistency with neighbours wherever possible.

The IHO WEND Principles state that:

- ❖ There must be conformance with all relevant IHO and IMO standards.

Useful References: UKHO Data Capture Specification;
UKHO ENC Product Specification;
(Plus those documents listed above).



STAGE 6 – Capture Data for New Cells

STEP 1 – Optionally, place external capture contract

- If it has been decided that new cells are to be captured externally, a suitable contract needs to be agreed. This requires:
 - Definition of a suitable Statement of Requirements.
 - Identification of companies able to carry out the work; this can include a requirement that they be ISO9001:2000 certified.
 - Issuing of Invitations to Tender, including possible production of sample cell.
 - Evaluation of Tenders.
 - Selection of the contractor.
- Alternatively, other Hydrographic Offices may be able to offer production capacity, either on a commercial basis or as part of a wider bilateral agreement.

STEP 2 – Capture data

- In order to facilitate capture, a 'package' should be created for each cell containing all the necessary source information (For example, where capture is from paper charts: Raster Files; List of Lights; Overlays for clarification etc) for populating the cell.
- Depending on form of data capture used:
 - The package will be sent (via a secure route) to external contractor or HO; for facilitating this aspect, consideration should be given to sending such data in batches.
 - A suitably trained in-house operator will be tasked.
- The data must be captured in compliance with the recommended and mandatory requirements of S-57 and in accordance with any HO clarification or Data Capture Specifications.

Useful References: UKHO Data Capture Specifications;
UKHO Quality Procedures



STAGE 7 – Edge Match Data

STEP 1 –National data

- Once a New Cell has been captured, or a New Edition of an ENC produced, it is important that the data on the cell border is aligned and matched with the corresponding data in any adjoining cells particularly of the same navigational purpose.
- When editing data on the border of cells to match adjoining data, it is important that the data is edited so that depth contours, depth areas etc. are adjusted on the side of safety.
- Editing should also only be done within a specific tolerance so that the accuracy of the data is not impaired to too great a degree.

STEP 2 – Between Nations

- In areas which include neighbouring producer nations, HO's should co-operate to agree on cell boundaries. It is recommended that where advantageous, nations agree data boundaries within a technical arrangement based on cartographic convenience and benefit to the mariner.
- Suitable communications with neighbouring nations should be put in place to ensure data consistency across cell boundaries. These will include exchange mechanisms to allow access to each other's ENCs. Issues of ENC consistency across cell boundaries that should be addressed include:
 - ENC cell compilation scales and application of the SCAMIN attribute.
 - COMF value used.
 - Overlaps and gaps between data limits (buffer zone).
 - Data content (including depth contour interval) and alignment.
 - Truncated areas and boundary limits.

For further information, refer to S-57 Appendix B.1, Annex A – Use of the Object Catalogue for ENC.

The IHO WEND principles state:

- ❖ Member States are encouraged to work together on data capture and data management.
- ❖ ENC duplication should be avoided. A single ENC producing country should exist in any given area.
- ❖ Responsibility for the production of ENC can be delegated in whole or in part by a country to another country, which then becomes the producing country in the considered area.
- ❖ When the limits of waters of national jurisdiction between two neighbouring countries are not established, or it is more convenient to establish boundaries other than established national boundaries, producing countries are to define the boundaries for ENC production within a technical arrangement. These limits would be for cartographic convenience only and shall not be construed as having any significance or status regarding political or other jurisdictional boundaries.



- ❖ In areas where the paper INT charts overlap, neighbouring producer nations should agree a common limit of ENC production in the overlapping areas. Cartographic boundaries should be as simple as possible, for example: a succession of straight segments and turning points corresponding to such things as meridians, parallels, or chart limits. Where different producer nations are responsible for INT coverage of the same area at different scales, those nations should agree on a suitable set of boundaries so as to provide the user with the most coherent service possible.

Useful Reference:

Guidelines for the Implementation of the WEND Principles



STAGE 8 – Verify and Validate Data

STEP 1 – Production Systems and Procedures

- Thorough verification and validation procedures need to be in place to verify and validate ENC cells for content and accuracy, ensuring consistency with the IHO Data Transfer Standard S-57 Edition 3.1 together with any Supplements that are extant.

STEP 2 – Verification

- Cells need to be checked for content and capture accuracy. Typically this will take the form of a 100% check of the vector data against the source information so as to ensure that no charted objects or attributes have been omitted from the cell or captured in an incorrect position.

STEP 3 – Validation

- Validation software should be used to perform checks on the completed ENC cell. This is to ensure that an ENC is compliant with the S-57 ENC Product Specification. The minimum checks are defined within S-58.
- The validation process used should include software provided by a different supplier to that used for production. Some HOs use more than one validation software package as each tends to pick up different warnings and errors.

The IHO WEND principles state:

- ❖ The Member State responsible for originating the data is also responsible for its validation in terms of content, conformance to standards and consistency across cell boundaries.
- ❖ Member States should recognize their potential exposure to legal liability for ENCs.

A list of companies supplying ENC Validation Tools is maintained on the IHO website (www.iho.int > External Stakeholders Liaison > List of External Stakeholders > External Stakeholders' contact list > Search on 'ENC Compilation Checking Software').

Useful Reference: Guidelines for the Implementation of the WEND Principles



STAGE 9 – Maintain ENC

STEP 1 – Establish mechanism for ENC updating

- Once an ENC cell has been produced and made available to the end user, then that data has to be maintained.
- The overall Quality Management System must include mechanisms for ENC updating designed to meet the needs of the mariner regarding safety of navigation.
- The processes for updating the paper chart are described in Part B-600 of S-4. The general principles of these processes apply equally to paper and electronic charts. The processes for updating the paper chart will need to have its equivalent in any updating process for the ENC.
- The processes for updating the paper chart and its equivalent for the ENC should be synchronised; however, if paper chart production cycles are lengthy, the option of issuing ENC Updates and New Editions earlier should be considered together with any wider implications.

The IHO WEND principles state:

- ❖ It is expected that Member States, for waters of national jurisdiction, will have mature supply systems for ENCs and their subsequent updating in place by the earliest date for mandatory carriage of ECDIS.

STEP 2 – Notice to Mariners (Updates)

- ENC Cells require updating to include details published in paper chart Notices to Mariners. These are in two forms: Chart Correcting Notice to Mariners (NM), and Temporary and Preliminary Notice to Mariners (T&P NM – see S-4, clauses B-631, B-633 and B-634; and S-57 Appendix B.1, Annex A – Use of the Object Catalogue for ENC, clause 2.6). Updating must be completed within a rigid timescale for ENC cells that have been issued to customers.
- ENC Updates must be produced to provide the ECDIS user with an updated SENC. As a guide, an ENC Update should not exceed 50 Kilobytes in size as legacy ECDIS have issues with loading larger update files.
- ENC Updates must be produced which fully replicate the corrections to the equivalent paper chart(s), and distributed at the same frequency, e.g. weekly.

STEP 3 – New Editions or Notice to Mariners (NM) Blocks

- New Editions of the equivalent paper charts or paper chart NM blocks will require an ENC New Edition or an ENC Update. To optimize data transmission, updates are preferred where practical. Note: If it is reported from users that it is not possible to load an ENC Update properly, a New Edition should be created.



STEP 4 – ENC Re-issues

- Where it is considered that the number of updates to be applied to a base cell becomes too large, it is recommended that a Re-issue of the ENC be produced. A Re-issue of an ENC will optimise data transmission and avoid the machine intensive task of installing an overly large number of updates for new users of ENC services. It is at the data producer's discretion as to what constitutes a large number of updates, but as a guide this may be considered to be between 20 and 50 , and other factors, e.g. the size of the updates, should also be considered. Existing users will not be effected by the publication of a Re-issue (i.e. will not be required to load the Re-issue), and both new and existing users will update their SENC from the time of the Re-issue through subsequent updates or New Editions.

STEP 5 – Distribution of ENC Data

- The timely distribution of ENC data can be on CD-ROM, through the Internet, over SATCOM, or by landline communication. However, see Stage 10 regarding wider distribution principles.

The IHO WEND principles also state the following with reference to Updating of ENCs:

- ❖ Technically and economically effective solutions for updating are to be established conforming to the relevant IHO standards. The updating of ENCs should be at least as frequent as that provided by the nation for correction of paper charting.
- ❖ National HOs providing source data are responsible for advising the issuing HO of update information in a timely manner.



STAGE 10 – Distribute ENC Data

STEP 1 – Identify Distribution Mechanism

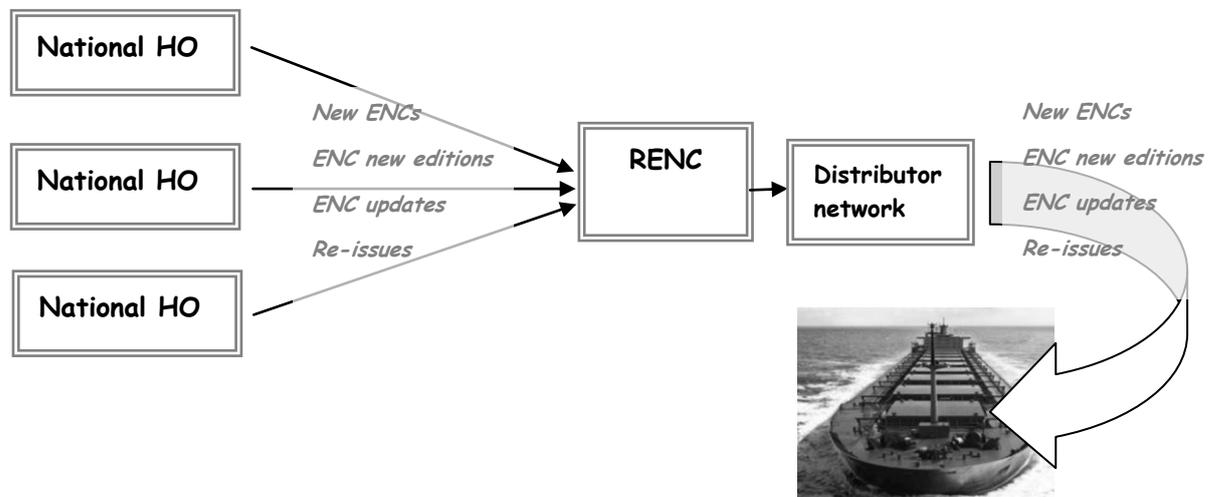
- The distribution mechanism must provide the user with up to date ENC data, from the issuing HO to the user, in a timely manner to support safe navigation. A considerable reduction of time should be possible by taking advantage of digital and telecommunication technologies. These technologies must not compromise the service continuity and the data integrity.
- The distribution mechanism must ensure data integrity and data protection. IHO S-57 Appendix B.1 (ENC Product Specification) identifies the file integrity checks that must be carried with the exchange of unencrypted ENCs. The IHO Data Protection Scheme (S-63) should be used for ENC distribution to end users. See also step 3 Distribution Format.
- A Quality Management System should be established for the overall distribution process.
- The distribution mechanism must provide new users with the latest ENC base cells (New Cell, New Edition or Re-issue) together with all updates applying to them.
- The distribution mechanism must provide existing users with regular updates, e.g. ENC New Editions, Re-issues or Updates, to ensure that the ECDIS SENC is maintained up to date. In the case of remote supply, data transmission can be optimized by sending only the additional ENC data necessary to bring the SENC up to date.
- The distribution mechanism should issue information about the current status of all ENCs in service (latest edition and update number), cancelled ENCs, and where appropriate, replaced ENCs.
- The distribution mechanism may use various methods of delivering ENC data, depending on the media and channels as well as validation procedures required to secure correctness. The methods should provide the update information to the SENC in the most effective way.
- Methods of delivery may include the use of physical media or remotely using telecom (on line), on land or at sea.
- The distribution mechanism must make Updates available to users at regular intervals adequate to support safe navigation and known in advance by end users, e.g. Thursday every week.
- As a minimum, all ENC data must be made available on CDROM. On-demand and remote services via telecom should also be made available and a nil message should be supplied if no additional update information is available. These services should ensure that service continuity and data integrity is not in conflict with data installed using conventional methods, e.g. CDROM.
- Fully-automatic updating (i.e. the update data reaches the EDCIS directly without any human intervention) may exist. To ensure the integrity of the broadcast update, effective safe transmission mechanisms and/or error detection methods should be employed.



- Updating of the ENC should be accomplished in a user-friendly way by the mariner without the need for assistance of the distributor or manufacturer.
- It is recommended that all ENC data (New ENCs, New Editions, Updates and Re-issues) is distributed through a Regional ENC Co-ordinating Centre (RENC).
- It is the responsibility of the RENC to establish a distribution network for ENC data. The RENC and its distributors are entities of the distribution process.

The IHO WEND principles state:

- ❖ Member States are encouraged to distribute their ENCs through a RENC in order to share in common experience and reduce expenditure, and to ensure the greatest possible standardization, consistency, reliability and availability of ENCs.
- ❖ Member States should strive for harmonization between RENCs in respect of data standards and service practices in order to ensure the provision of integrated ENC services to users.



- The supply of data through RENCs reduces the overall cost of ENCs by centralising the distribution of the data, thus avoiding the need for each individual HO to invest in developing their own service and distribution network, thus simplifying the purchasing of ENC data. RENCs also act as 'one stop shops'.
- RENCs can also ensure that data is of uniform quality (in terms of its validation against S-58) and that there are no gaps, or overlaps or inconsistencies between adjacent cells.
- RENCs help promote the production of ENCs around the world, and thus help to ensure that developments in electronic charting are coordinated and meet the requirements of the market.



STEP 2 – Sign Agreement

- Whatever distribution mechanism is adopted, where an outside organisation such as a RENC is involved, the rights and responsibilities of each partner should be detailed in a signed agreement.

STEP 3 – Distribution Format

- Distribution through a RENC is not mandatory. If data is not distributed through a RENC, a security system should be applied to protect the integrity of the data, prove authenticity, and prevent unauthorised copying. Reference should be made to S-63 (IHO Data Protection Scheme).
- In addition to standard S-57 (either S-63 encrypted or unencrypted) ENC data can also be distributed directly in the SENC format proprietary to an ECDIS manufacturer. The SENC update mechanism should not be inferior to the ENC - ECDIS update mechanism.

The IHO WEND principles also state that:

- ❖ Member States will strive to ensure that, mariners, anywhere in the world, can obtain fully updated ENC data for all shipping routes and ports across the world.
- ❖ Member States will strive to ensure that their ENC data are available to users through integrated services, each accessible to any ECDIS user (i.e., providing data in S-57 form), in addition to any national distribution or system-specific SENC delivery.
- ❖ A Member State responsible for any subsequent integration of a country's data into a wider service is responsible for validating the results of that integration.
- ❖ Methods to be adopted should ensure that data bear a stamp or seal of approval of the issuing HO.
- ❖ Member States should work together so that the IHO Data Protection Scheme (S-63) is used for ENC distribution to end users, to ensure data integrity, to safeguard national copyright in ENC data, to protect the mariner from falsified products, and to ensure traceability.
- ❖ When an encryption mechanism is employed to protect data, a failure of contractual obligations by the user should not result in a complete termination of the service. This is to assure that the safety of the vessel is not compromised.
- ❖ In order to promote the use of ENC data in ECDIS, Member States are to strive for the greatest possible user-friendliness of their services, and facilitate integrated services to the mariner.

In addition, the **WEND Committee** endorsed the following definition of integrated services:

- ❖ “A variety of end-user services where each service is selling all its ENC data, regardless of source, to the end user within a single service proposition embracing format, data protection scheme and updating mechanism, packaged in a single exchange set.”

Useful Reference: Guidelines for the Implementation of the WEND Principles



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Glossary of Terms

Terms and Abbreviations relating to ENC/ECDIS

The following definitions have been principally taken from the Glossary of ECDIS related terms (IHO S-32, Appendix 1, 2007). Reference has also been made to 'The Electronic Chart', Chapter 16, Glossary (Hecht, Berking, Büttgenbach, Jonas, Alexander).

AIS

An automatic communication and identification system intended to improve the safety of navigation by assisting in the efficient operation of vessel traffic services (VTS), ship reporting, ship-to-ship and ship-to-shore operations.

A transponder is an example of an AIS. AIS information may be displayed on an ECDIS.

area

The 2-dimensional geometric primitive of an object that specifies location.

ARPA (Automatic Radar Plotting Aid)

A system wherein radar targets are automatically acquired and tracked and collision situations computer assessed and warnings given.

attribute

A characteristic of an object. Attributes are either qualitative or quantitative. Attributes required for ECDIS are defined in Appendix A of S-57, IHO Object Catalogue.

C-47

IHO Capacity Building Publication 47, titled "Training Courses in Hydrography and Nautical Cartography"

cartographic object

Feature object which contains information about the cartographic representation (including text of real world entities).

The ENC Product Specification prohibits the use of cartographic objects in ENCs.

cell

The basic unit for the distribution of ENC data covering a defined geographical area bounded by two meridians and two parallels, the content of which must not exceed 5 Mbytes, and which is intended for a particular navigational purpose.

chain

A sequence of one or more edges.

**chain node**

Data structure in which the geometry is described in terms of edges, isolated nodes and connected nodes. Edges and connected nodes are topologically linked. Nodes are explicitly coded in the data structure. Areas are defined by the sequence of edges that comprise their boundaries. Lines are comprised of edges. Point feature objects may only be referred to as isolated nodes.

CHRIS (Committee on Hydrographic Requirements for Information Systems)

A Committee of the IHO tasked with promoting and coordinating the development of official digital products and services. CHRIS has now been superseded by the Hydrographic Services and Standards Committee (HSSC).

collection object

A feature object which describes the relationship between other objects. An example of a collection object in S-57 is "aggregation" which is used, for example, to group together the different objects which together constitute a Traffic Separation Scheme.

compilation

In cartography, the selection, assembly, and graphic presentation of all relevant information required for the preparation of a new map/chart or a new edition thereof. Such information may be derived from other maps/charts, aerial photographs, surveys, new data, and other sources.

compilation scale

The scale at which the ENC data was compiled.

Note that the consistency recommendations (Ref I) indicate that compilation scale should be considered as the optimal scale for display for that ENC.

connected node

A node referred to as a beginning and/or end node by one or more edge. Connected nodes are defined only in the chain-node, planar graph and full topology data structures.

data model

A conceptual specification of the sets of components and the relationships among the components pertaining to the specific phenomena defined by the model reality. A data model is independent of specific systems or data structures. The S-57 data model defines real world entities as a combination of descriptive and spatial characteristics. These characteristics are defined in terms of feature objects and spatial objects and the relationship between them.

data set

A logical grouping of S-57 data to which the S-57 data set descriptive records apply. The data set descriptive records contain meta data. The use of data set descriptive records is product specific and is, therefore, defined by a product specification. If the data set descriptive records are repeated for each file in an exchange set, an instance of a file containing the data set descriptive records is called a data set. If the data set descriptive records are encoded generally for the whole exchange set, the exchange set is referred to as a data set.

**data structure**

A computer interpretable format used for storing, accessing, transferring and archiving data.

datum (vertical)

Any level surface (e.g. mean sea level) taken as a surface of reference from which to reckon elevations.

display category

The ECDIS Performance Standards establish three categories for SENC objects:

display base: The level of information which cannot be removed from the display. It consists of information that is required at all times in all geographic areas and all circumstances.

standard display: The level of SENC information that is shown when a chart is first displayed on ECDIS. It is the recommended minimum level of display for safe navigation.

all other information: displayed individually (by class) on demand.

edge

A one-dimensional spatial object, located by two or more coordinate pairs (or two connected nodes). An edge must reference a connected node at both ends and must not reference any other nodes.

electronic chart

Very broad term to describe the data, the software, and the electronic system, capable of displaying chart information. An electronic chart may or may not be equivalent to the paper chart required by SOLAS.

Electronic Chart Display and Information System (ECDIS)

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/20 of the 1974 SOLAS Convention, 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.

Electronic Chart Systems (ECS)

Generic term for equipment which displays chart data but which is not intended to comply with the IMO Performance Standards for ECDIS, and is not intended to satisfy the SOLAS Chapter V requirement to carry a navigational chart.

Electronic Navigational Chart (ENC)

The data base, standardized as to content, structure and format, issued for use with ECDIS on the authority of government authorized hydrographic offices. The ENC contains all the chart information necessary for safe navigation and may contain supplementary information in addition to that contained in the paper chart (eg sailing directions) which may be considered necessary for safe navigation.



ENC Product Specification

Appendix B1 of S-57 which specifies the content, structure and other mandatory aspects of an ENC.

exchange set

The set of files representing a complete, single purpose (i.e. product specific) data transfer. The ENC Product Specification defines an exchange set which contains one Catalogue file and at least one data set file.

face

A two dimensional spatial object. A face is a continuous area defined by a loop of one or more edges which bound it. A face may contain interior holes, defined by closing loops of edges. These interior boundaries must be within the outer boundary. No boundary may cross itself or touch itself other than at the beginning/end node. None of the boundaries may touch or cross any other boundary. Faces are defined only in the full topology data structure.

feature

Representation of a real world phenomenon. For example, a particular cardinal buoy represented through a symbol on a chart.

feature object

An object which contains the non-locational information about real world entities. Feature objects are defined in Appendix A of S-57, IHO Object Catalogue.

feature record

A feature record is the implemented term used in the S-57 data structure for a feature object (i.e. a feature object as defined in the data model is encoded as a feature record in the data structure). There are four types of feature records: geo, meta, collection and cartographic.

geo object

A feature object which carries the descriptive characteristics of a real world entity. The positional information is provided through the spatial object.

Geographic Information System (GIS)

A computer based system for handling and integrating data from a variety of sources which is directly or indirectly spatially referenced to Earth.

geometric primitive

One of the three basic geometric units of representation: point, line and area.

Global Maritime Distress and Safety System (GMDSS)

A global communications service based upon automated systems, both satellite based and terrestrial, to provide distress alerting and promulgation of maritime safety information to mariners. This system has been developed by IMO through the SOLAS Convention.

Global Navigation Satellite System (GNSS)

A world-wide position, time and velocity radio determination system comprising space, ground and user segments of which GPS and GLONASS are components.



GLONASS (Global Navigation Satellite System)

A space-based, radio-positioning, navigation and time-transfer system operated by the Government of the Russian Federation. GLONASS to which differential corrections have been applied is known as Differential GLONASS (DGLONASS).

GPS (Global Positioning System)

A space-based, radio-positioning, navigation and time-transfer system operated by the United States Government. GPS to which differential corrections have been applied is known as Differential GPS (DGPS).

HSSC (Hydrographic Services and Standards Committee)

The technical steering committee of the IHO tasked, among other things, with promoting and coordinating the development of official digital products and services.

International Electrotechnical Commission (IEC)

A worldwide non-governmental organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international cooperation on all questions concerning standardization in the electrical and electronic fields. Committee 80, Working Group 7 of IEC is responsible for developing the Performance Requirements for ECDIS to be published as document IEC 61174.

International Hydrographic Organization (IHO)

The IHO is an intergovernmental consultative and technical organization that was established in 1921 to support the safety of navigation and the protection of the marine environment. The object of the organization is to bring about:

- (a) The co-ordination of the activities of national hydrographic offices;
- (b) The greatest possible uniformity in nautical charts and documents;
- (c) The adoption of reliable and efficient methods of carrying out and exploiting hydrographic surveys;
- (d) The development of the sciences in the field of hydrography and the techniques employed in descriptive oceanography.

International Maritime Organization (IMO)

The specialized agency of the United Nations responsible for measures to improve the safety of international shipping and to prevent marine pollution from ships.

isolated node

An isolated zero-dimensional spatial object that represents the geometric location of a point feature. An isolated node is never used as a beginning or end *node*.

line

The one-dimensional geometric primitive of an object that specifies location.

meta object

A feature object which contains information about other *objects*. For example compilation scale or vertical datum.

**navigational purpose**

The specific purpose for which a cell has been compiled. There are six such purposes, namely berthing, harbour, approach, coastal, general and overview.

node

A zero-dimensional spatial object, located by a coordinate pair. A node is either isolated or connected.

Notice to Mariners (NtM)

A periodical notice issued by maritime administrations, or other competent authorities, regarding changes in aids to navigation, dangers to navigation, important new soundings, and, in general, all such information as affects nautical charts, sailing directions, light lists and other nautical publications.

object

An identifiable set of information. An object may have *attributes* and may be related to other objects. Also see spatial object and feature object.

Object Catalogue

The Object Catalogue is the feature schema for S-57. Its primary function is to provide a description of real world entities. It contains a list of feature object classes (each relating to a real world entity), attributes and allowable attribute values.

object class

A generic description of objects which have the same characteristics.

Examples of object classes in S-57 are "buoy, cardinal" and "caution area".

own ship's safety contour

The contour related to the own ship selected by the mariner from the contours provided for in the SENC, to be used by ECDIS to distinguish on the display between the safe and the unsafe water, and for generating anti-grounding alarms.

Performance Standards for ECDIS

Minimum performance requirements for ECDIS, adopted by IMO 5 December 2006 as MSC resolution and published as Annex to IMO Resolution MSC.232(82).

planar graph

A 2-dimensional data structure in which the geometry is described in terms of *nodes* and edges which are topologically linked. A special case of a chain-node data structure in which edges must not cross. Connected nodes are formed at all points where edges meet.

point

The 0-dimensional geometric primitive of an object that specifies location.

polygon

A non-self intersecting, closed chain defining the boundary of an *area*.

**product specification**

A defined subset of the entire specification combined with rules, tailored to the intended usage of the transfer data. See ENC product specification.

Presentation Library

A set of mostly digital specifications, composed of symbol libraries, colour schemes, look-up tables and rules, linking every object class and attribute of the SENC to the appropriate presentation of the ECDIS display. Published by IHO as Annex A to S-52.

raster

A regular array with information pertaining to each element (pixel) or group of elements.

Regional ENC Coordinating Centre (RENC)

An organizational entity where IHO Member States have established cooperation amongst each other to guarantee a world-wide consistent level of high quality data, and for bringing about coordinated services with official ENCs and updates to them

Regional Hydrographic Commission (RHC)

A body created under IHO Resolution T 1.3 composed of representatives from member states' hydrographic services within a defined geographic area (typically an INT charting area), meeting at regular intervals to discuss mutual hydrographic and chart production issues.

Re-issue

A re-issue of an ENC includes all the updates applied to the ENC up to the date of the reissue. A re-issue does not contain any new information additional to that previously issued by updates. The update sequence is not interrupted by a re-issue. After a re-issue, subsequent updates may be incorporated into the SENC created from this reissue or to the SENC created from the original ENC and kept continuously updated.

S-4

IHO Publication S-4, titled "Regulations of the IHO for International (INT) Charts and Chart Specifications of the IHO".

S-8

IHO Publication S-8, titled "FIG/IHO/ICA Standards of Competence for Nautical Cartographers".

S-52

IHO Publication S-52, titled "Specifications for chart content and display aspects of ECDIS".

S-57

IHO Publication S-57, titled "IHO Transfer Standard for Digital Hydrographic Data". S-57 is The international transfer standard for digital hydrographic data.

The major components of S-57 Edition 3.1 are; Theoretical Data Model, Data Structure, Object Catalogue, ENC Product Specification, Use of the Object Catalogue for ENC.



S-58

IHO Publication S-58, titled "IHO Recommended ENC Validation Checks". S-58 specifies the checks that, as a minimum, producers of ENC validation tools should include in their validation software.

S-62

IHO Publication S-62, titled "ENC Producer Codes". S-62 provides a list of Agency Codes for all producers of ENCs, in particular Hydrographic Offices.

S-63

IHO Publication S-63, titled "IHO Data Protection Scheme". S-63 describes the IHO ENC security scheme and provides test data. It is intended for use by all those ECDIS manufacturers and data distributors participating in an ENC service with data encrypted.

S-66

IHO Publication S-66, titled "Facts about electronic charts and carriage requirements". S-66 provides a high level guide to the production, maintenance and distribution of Electronic Navigational Charts (ENCs).

S-100

IHO Publication S-100, titled "IHO Universal Hydrographic Data Model". S-100 is a new standard that will eventually supersede S-57. It complies with the ISO 19100 series of geographic standards and will support a greater variety of hydrographic-related digital data sources, products, and customers than S-57.

safety depth

The depth defined by the mariner, e.g. the ship's draft plus underkeel clearance, to be used by the ECDIS to emphasize soundings on the display equal to or less than this value.

SOLAS (Safety Of Life At Sea)

International Convention for the Safety of Life at Sea developed by IMO. The contracting governments undertake to promulgate all laws, decrees, orders and regulations and to take all other steps which may be necessary to give the present Convention full and complete effect, so as to ensure that, from the point of view of safety of life, a ship is fit for the service for which it is intended.

spaghetti data

A *data* structure in which all lines and points are unrelated to each other (i.e. no topological relationships exist in the data structure). This data structure is not permitted for ENC.

spatial object

An object which contains locational information about real world *entities*. For example, in S-57 the location of a buoy or the boundary of a caution area.

System Electronic Navigational Chart (SENC)

A data base resulting from the transformation of the *ENC* by ECDIS for appropriate use, updates to the ENC by appropriate means and other data added by the mariner. It is this data base that is actually accessed by ECDIS for the display generation and other navigational functions, and is equivalent to an up-to-date paper chart. The SENC may also contain information from other sources.



topology

The set of properties of geometric forms (such as connectivity, neighbourhood) which is defined with the data model remaining invariant when subject to a continuous transformation.

The level of topology chosen for the ENC allows for colour fill, activation of area warnings, e.g. depth area warnings, cautionary areas. The different levels of topology are described in the S-57 Data Model.

Transfer Standard Maintenance and Applications Development Working Group (TSMAD)

An HSSC working group that is responsible for the maintenance of digital data standards including S-57 and S-100 to satisfy new hydrographic requirements.

update

Either short for update information or, as a verb, applying the update mechanism. An ENC Update (official update) is a data set produced for changing an existing ENC in the ECDIS SENC (automatic updating). An ENC Update must conform to the ER application profile of S-57.

Use of the Object Catalogue

Annex A of S-57 Appendix B.1 describing how to encode information relevant to a specific navigational purpose. Must be used in conjunction with the ENC Product Specification.

Use of the Object Catalogue is maintained by means of new editions, published as required by the Transfer Standard Maintenance and Applications Development Working Group. The contents of a new edition do not invalidate the contents of the previous edition.

vector

Direct connection between two points, either given as two sets of coordinates (points), or by direction and distance from one given set of coordinates, or a point in a vector space defined by one set of coordinates relative to the origin of a coordinate system.

WEND (World-wide Electronic Navigational chart Database)

A common, worldwide network of ENC datasets based on IHO standards designed specifically to meet the needs of international maritime traffic using ECDIS which conform to the IHO Performance Standards for ECDIS.

World Geodetic System (WGS)

A global geodetic reference system developed by the USA for satellite position fixing and recommended by IHO for hydrographic and cartographic use.



World-Wide Navigational Warning System (WWNWS)

A service established for the purpose of coordinating the transmission of radio navigational warnings in geographical areas using coastal and satellite communication services.

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