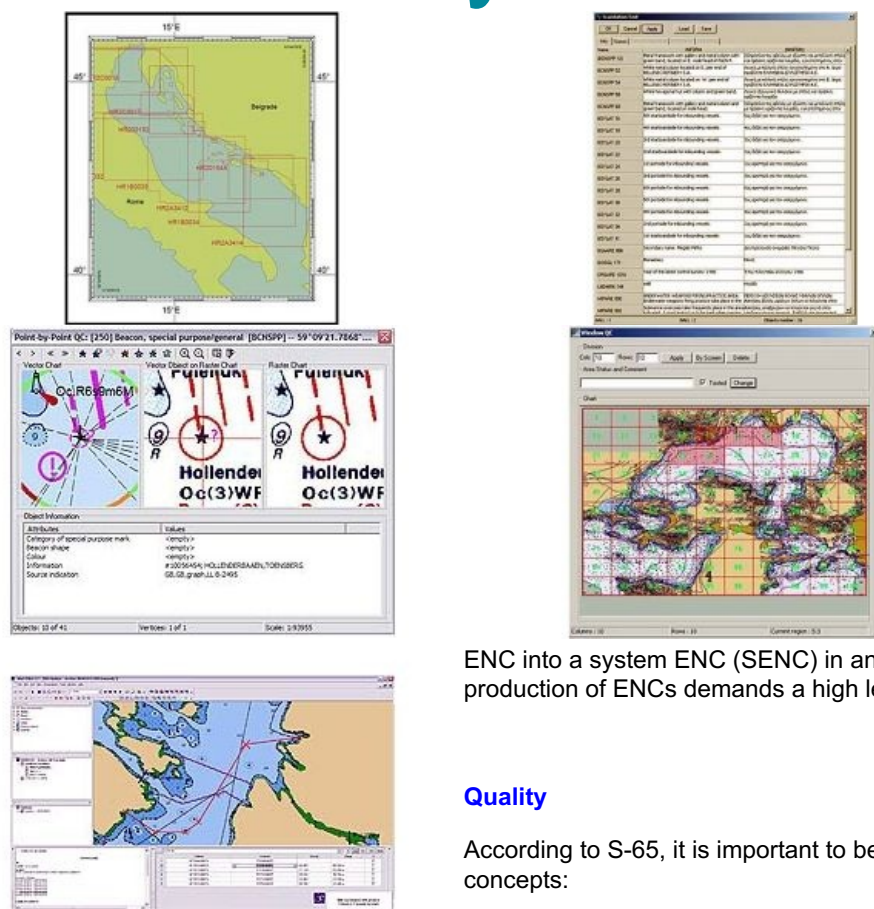


ENC Life Cycle



From the quality perspective, an electronic navigational chart (ENC) as a product is more demanding than its paper predecessor. Quality control and quality assurance of an ENC is a complex matter. The task of ensuring ENC quality during practical chart production is much broader than the direct implementation of standards. Obviously, to meet the ENC challenge, different life-cycle steps must be taken.<P>

Electronic navigational charts (ENCs) consist of digitised data conforming to the International Hydrographic Organization's (IHOs) S-57 ENC Product Specification that records all relevant charted features necessary for safe navigation, such as coastlines, bathymetry, buoys, lights, etc. An electronic chart display and information system (ECDIS) converts the

ENC into a system ENC (SENC) in an internal format optimised for efficient display. The production of ENCs demands a high level of quality control and assurance (QC/QA).

Quality

According to S-65, it is important to bear in mind the difference between these two concepts:

- QC: the checks made on a product after production

- QA: the overall set of processes, of which QC forms a part, designed to ensure that a product is produced correctly and without errors.

The term ENC QC/QA is not limited to the production process for individual chart cells, but must be considered throughout the entire ENC life cycle (Figure 1). The life cycle for an ENC includes source data assessment and verification, product compilation, validation and publication, followed by continuous product maintenance and finally termination. This is a complex procedure where quality processes must be integrated. The issuing Authorities' are responsible for the full ENC life cycle.

QC cannot be limited to verifying

S-57 encoding with successful testing stipulated by IHO S-58. A cartographer knows that there are a variety of scenarios that cannot be detected by automatic testing; these are related to the quality of the source data, digitising and product collection within IHO S-57 Exchange Sets. Although 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. The IHO S-52 standard 'Specifications for chart content and display aspects of ECDIS' defines how ENC data are displayed on an ECDIS system. The same display standard must be used within the production, QC/QA and approval phases ensuring the highest quality for the end-product.

Planning

ENC planning (Table 1, below) is defined by 'the establishment of a seamless and adequate ENC coverage within given usage bands, and assurance of source data quality required to enable safe navigation'. To allow for effective quality management in the planning process, the producer should have effective tools and technologies at hand, enabling access to all required source data (and its meta-data) and have them visualised for easy comparison (Figure 2). The meta-data must hold enough information so that qualified decisions can be made.

Coverage model (paper chart equivalent or cell-grid based)

Usage (scale) band (Small-/large-scale coverage; priorities)
Available sources (existing products, surveys, fair sheets, survey sheets, etc.)
Bilateral agreements (covering national border areas)

Source Data

Source data assessment (Table 2, below) involves not only the collection of available and required source data for the ENC product(s) but also must ensure the highest possible quality for chart coverage. The producer needs tools and technologies to assess and fine-tune the sources to (at least) meet the minimum requirement for ENC production. This includes (but is not limited to) product-dependent data cleaning/collection, normalisation and transformation of analogue sources where the quality aspect for normalisation is vital.

Source data retrieval
Normalising/transformation (raster sources)
Processing Survey data (product preparation for source survey data)
Other Available sources (list of lights, old repromats)
Databases (other available sources, land data, international available data, etc.)

Production

A production tool should be consistent with respect to data format input and output in order to ensure and enable a highest possible quality throughout the production process (see Table 3, below). Limiting the number of conversions to and from data formats will improve the quality of data and, consequently, the need for special attention by the operator with respect to QC. The internal format used is based on the IHO S-57 standard. Therefore, any data imported into the production environment is 'directly' - with assistance of controlled import routines - converted to S-57 (Figure 3). The users can then validate the imported data on-the-fly, allowing resources to be allocated to other more important processes within a production stream.

Meta-data (accessibility to required meta-data)
Positional accuracy (must be accessible and of high enough quality)
Digitising/S-57 Encoding (integrated QC means avoiding/limiting human error)
Import (should be directly to S-57 format, enabling on-the-fly object and attribute creation and consequently QC)

S-58 validation (automatic testing routines towards IHO S-58 checks)
Coverage accuracy (visual means must be available to handle edge matching, coverage consistency, etc.)

With the IHO S-58 standard, the producer has been provided with a common platform for testing and validating the ENC's and their S-57 encoding. This further improves the quality of the end-product. Even though the S-58 standard provides effective means to test and ensure the quality of an ENC, there are still a variety of important elements that are not covered by the standard. For example, the correct presence and location for the objects, their attribute values, positional accuracy, etc. (Figure 4, right). An effective production must be able to provide secure and effective means to also quality assure these items (Figure 5, below).

Approved Cell

Final QC (full testing, manual and automatic, is required before an ENC is finalised)
ENC stamping (upon completion of all QC/QA routines the ENC file is 'stamped' so that any further changes made will automatically create S-57 update (ER) files
Exchange Set creation (S-57 defines exchange set parameters for release of an ENC file as a set of files, named S-57 Exchange set. This is a collection of ENC(s) and referenced and required files)
S-63 Encryption (depending on policy, the ENC Exchange Set may be encrypted to avoid piracy and illegal copying of the data)
Distribution (depending on policy, distribution of ENC's may be made through international ENC centres or private industry, or a combination of both)

When the production of an S-57 cell is declared completed and approved, the 'approval' of the cell will result in a 'Published' ENC (Table 4). Any changes made to or on an approved ENC will automatically create an update file. In a practical sense, encryption is a direct change of the data itself and QA must therefore also be performed on the encrypted data set. Validation and QA, in this respect, implies the ability to decrypt the Exchange Set, perform consistency checks and subsequent approval of the data set. The complexity of IHO S-63 is rather high, but nevertheless the user/producer must be able to perform such validation to further ensure safe navigation for mariners. In most cases, this validation takes place within a Regional ENC Co-ordinating Centre (RENC) organisation; but such testing must be conducted even for 'internally' released ENC's. Furthermore, there is the issue of 'one-flavour ENC's'. When an ENC is accepted based on S-58 and a RENC's approval criteria, there is still room for individual (national) encoding, for example, resulting in different objects/attributes usage compared with a neighbouring country.

Update and Maintenance

An ENC not covered by a maintenance program cannot be classified as an ENC. This is not defined according to when an update is actually available for the chart, but according to when an ENC was 'last checked' for updates. To raise the quality of the maintenance process (Table 5), the source messages - for example, the notice to mariners (NtMs) - are fully integrated within the production line (Figure

6). This means that source messages for NtMs or general corrections are used for the update task and its QC.

Source assessment (there is a high requirement for the quality of sources used for updating ENC's, both positional and product relevant)

ENC update production (ENC update creation should be handled/covered by standard production routines)

ENC re-issue (the amount of updates determine whether an ENC should be re-issued, meaning that all update files are combined within the ENC base (EN) file)

ENC update validation (ENC updates do undergo the same level of QC as does the main ENC file, and update files must therefore be tested individually and as an integrated part of the main ENC file)

ENC update distribution (distribution of ENC updates undergoes the same QC requirements as for ENC distribution)

Termination

New edition (the amount or nature of corrections/maintenance determines whether the ENC is to be issued as a new edition)

Termination (the ENC product is defined as obsolete, which results in a 'termination' update file, and no further updates may be done on that ENC)

When an ENC is to be terminated or issued as a new edition (Table 6), for instance because of new available coverage/products, the operator must be able to validate and quality assure the decision. When an ENC is issued as a new edition, the old edition is updated with an update file stating 'terminated, new edition available'. This operation automatically creates an update file for the terminated ENC at the same time as the new ENC file is published. If an ENC is removed from the product portfolio, an update file is created with the update instruction 'terminated'. This will then 'close' the life cycle for this ENC. It is vital that both these processes are safeguarded and ensured. The 'termination' process must be accessible only when defined criteria are fulfilled and the cancellation update must be created automatically (and distributed through standard distribution means). From a QC perspective, a termination must result in a 'locked' data set, to which no further corrections or changes can be applied.

Quality Management

ENCs are more demanding from a quality perspective than their paper predecessor. They are used with a very accurate and sophisticated instrument, such as ECDIS. Deficiency in data quality may compromise the very idea of computer-aided navigation. As we have seen in practice, ISO-9000 certification is not always a guarantee for the final quality of base cell file (EN) and update cell file (ER) products (mainly because the matter of certification is not the cartographic technology but the administrative procedure that supports production). Obviously, to meet the ENC challenge, a quality management system must be technically integrated with the production system at each

stage of chart production and maintenance. This has been well understood by many data producers, and intensive development in this area can be seen.

Complex Matter

The quality of an ENC is a complex matter. As explained, the task of ensuring ENC quality during practical chart production is much broader than the direct implementation of S-57 and S-58 requirements. Specific tools at each step in the production process must be used in accordance with error-proof technology, and the entire process must be controlled via an established quality management system. This is the most practical approach to providing mariners with reliable ENCs of really high quality.

<https://www.hydro-international.com/content/article/enc-life-cycle>
