

S-100: The New IHO Geospatial Standard for Hydrographic Data

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Introduction

This paper describes the key IHO Geospatial Standard for Hydrographic Data to be known as S-100 - *IHO Geospatial Standard for Hydrographic Data*. Details have yet to be finalised; the first draft of S-100 was released for stakeholder comment in March 2008 and is not expected to be an active standard until at least 2009 or 2010. Nevertheless, the concepts and supporting organisational framework behind the standard are already beginning to take shape. The purpose of this paper is to draw attention to S-100 and to seek comment and the active involvement of both existing and potential stakeholders in the development and implementation of the standard. The paper explains what is planned in the development of S-100. In particular, it provides a brief description of how the standard will be aligned with geospatial standards under development by the International Organisation for Standardisation (ISO) and the benefits to be gained for IHO and its stakeholders.

In the meantime, S-57 will continue to exist as a designated format for ENC data to be used in ECDIS for the foreseeable future.

Background

IHO Publication 57 (IHO S-57) is the IHO Transfer Standard for Digital Hydrographic Data. It is the standard intended to be used for the exchange of digital hydrographic data between hydrographic offices, and for the distribution of hydrographic data to manufacturers, mariners and other data users (e.g., environmental management organizations). It was developed so that the transfer of all forms of hydrographic data would take place in a consistent and uniform manner. However, to date, S-57 Edition 3.0/3.1 has been used almost exclusively for encoding Electronic Navigational Charts (ENCs) for use in Electronic Chart Display and Information Systems (ECDIS).

While S-57 was intended to support all types of hydrographic data, customers and the technology for hydrographic data, this has not happened. One of the reasons for this is that S-57 is not a contemporary standard that is widely accepted in the GIS domain. Accordingly, the IHO has embarked on the development of a new standard – S-100 – that will comply with the ISO 19100 series of geographic information standards being developed by ISO Technical Committee 211. S-100 should therefore form an attractive basis upon which a wide range of

digital products and transfer standards for hydrographic and related applications can be developed.

History of S-57

IHO S-57 was formally adopted as an official IHO standard at the 14th International Hydrographic Conference in May 1992. It includes:

- A general introduction with list of references and definitions
- A theoretical data model on which the standard is based
- The data structure and format that are used to implement the data model
- General rules for encoding data into the ISO 8211 encapsulation

In addition to the main document, there are two appendices:

Appendix A is the Object Catalogue. It provides the official, IHO-approved data schema that can be used within an exchange set to describe real-world entities.

Appendix B contains the IHO-approved Product Specifications. These contain additional sets of rules for specific applications. Currently, the only product specification in S-57 that is in wide use is for an Electronic Navigational Chart (ENC). A product specification for an IHO Object Catalog Data Dictionary was also included but for all practical purposes has never been implemented.

S-57 Edition 3.0 was released in November 1996. Edition 3.1 containing minor revisions and some additional attribute values was issued in November 2000. Currently, S-57 3.1 is “frozen”. It will remain valid until no longer required.

A Supplement to Edition 3.1, designated S-57 Edition 3.1.1 came into effect in January 2007 to include the new features and attributes required to enable the encoding of the recently introduced Archipelagic Sea Lanes, Environmentally Sensitive Sea Areas (ESSA) and Particularly Sensitive Sea Areas (PSSA) by the IMO. The inclusion of the Supplement avoided the need to release a new edition of S-57 and the consequential effects on both data producers and equipment manufacturers. The Edition 3.1.1 Supplement operates concurrently with S-57 Edition 3.1 and is available solely for the use of those data producers that need to include the new features.

Current Limitations of S-57 Edition 3.1

Although S-57 Edition 3.1 has many good aspects, it does have limitations:

- It was primarily developed to meet the ENC requirement called for in an IMO-compliant ECDIS.
- It has an inflexible maintenance regime. Freezing standards for lengthy periods is counter-productive.
- As presently structured, it cannot support future requirements (e.g., gridded bathymetry, or time-varying information).
- Embedding the data model within the encapsulation (i.e., file format) restricts the flexibility and capability of using a wider range of transfer mechanisms.
- It is regarded by some as a limited standard focused exclusively for the production and exchange of ENC data.

In order to address these and other limitations, the IHO Committee on Hydrographic Requirements for Information Systems (CHRIS) authorised work to begin on a major

revision of Edition 3.1. This revision will result in a new standard that includes both additional content and a new data exchange format. The draft version was released in early 2008 as part of the development and testing phase for the standard (see also diagram 5).

New name

During the years that S-57 has been in use, many people have come to regard the IHO S-57 standard and the ENC Product Specification as the same thing. In reality, the ENC Product Specification is, in effect, the specific implementation of S-57 for the purpose of producing an ENC for use in ECDIS. This resulted in the impression by many within the ECDIS and ENC community that the work on a new S-57 Edition 4.0 standard that would better support other hydrographic products as well as ENCs would radically change the current ENC, thus affect existing ENC production and ECDIS implementation. This was not the intention.

At the 17th Meeting of CHRIS (September 2005), it was decided that the S-57 Edition 4.0 that was currently under development would henceforth be designated as S-100 - *IHO Geospatial Standard for Hydrographic Data*. Any product specifications developed using S-100 would follow in an S-10x series as they are produced. Under this schema, at some future date when an ENC Product Specification based on S-100 is developed, it will be designated S-101.

Goal/Objectives

The primary goal for S-100 is to be able to support a greater variety of hydrographic-related digital data sources, products, and customers (see Figure 1). This includes imagery and gridded data, 3-D and time-varying data (x, y, z, and time), and new applications that go beyond the scope of traditional hydrography (for example, high-density bathymetry, seafloor classification, marine GIS, etc.). It will also enable the use of Web-based services for acquiring, processing, analyzing, accessing, and presenting data.

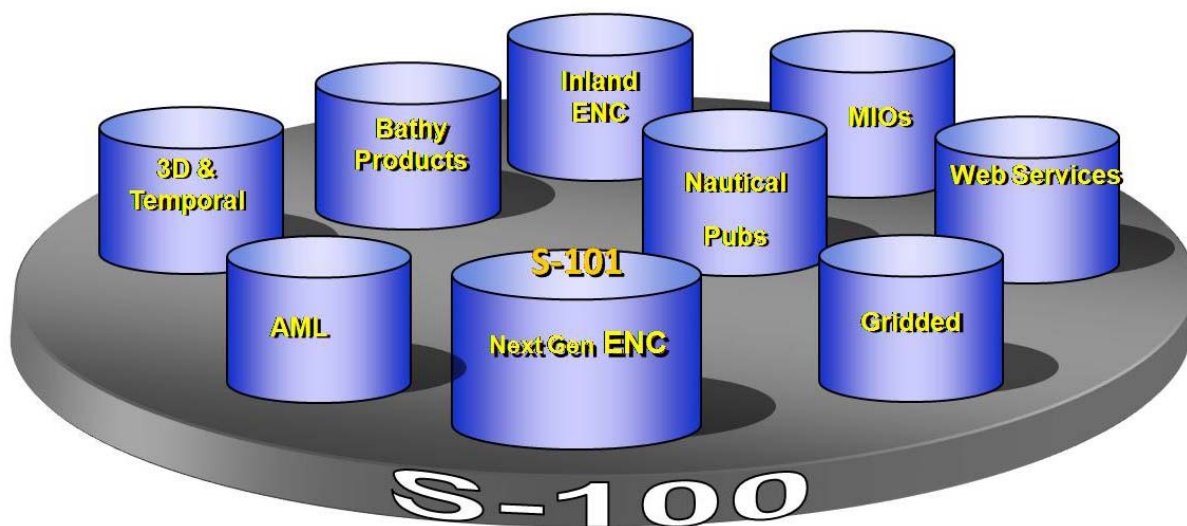


Figure 1 - S-100 will support a far greater variety of data sources, products and services

Other goals include:

- Separating the data content from the carrier (file format). In this way, data can be manipulated and encoded without being permanently tied to a single exchange mechanism.
- Manageable flexibility that can accommodate change. The content of future product specifications will be a subset of S-100, including separate feature catalogues. This will

allow the core standard to evolve (through extension) without the need to introduce new versions of product specifications.

- An ISO-conforming registry on the IHO Web site containing registers for feature data dictionaries, portrayal and metadata. The registers will accommodate both core hydrographic content and other chart related content , such as, Nautical Publications, Inland ENC and Marine Information Overlays.

ISO Standards for Geographic Information

The International Organization for Standardization (ISO) is a non-governmental international standards organization comprising a worldwide federation of national standards bodies from over 130 countries. In response to a growing demand for geographic information standards, ISO established Technical Committee 211 (ISO/TC211) in 1994. The aim of ISO/TC211 is to establish a structured set of standards for information concerning geographic objects or phenomena. IHO, together with many other geographic standards development organizations, is a Class A Liaison Organization to ISO/TC211. Currently, there are over 22 Class A members, including:

- Digital Geographic Information Working Group (DGIWG),
- Global Spatial Data Infrastructure (GSDI),
- Open Geospatial Consortium (OGC),
- United Nations Geographic Information Working Group (UNGIWG).

ISO 19100 Standards

The standards developed by ISO/TC211 are contained in the ISO 19100 series of geographic information standards. For all forms of geographic data, these standards specify the methods, tools, and services for:

- Data management (including definition and description),
- Acquiring, processing, analyzing, accessing, and presenting data,
- Transferring data in digital electronic form between different users, systems and locations.

In the most general sense, these standards fall into one of the following categories:

- Framework and Reference Model,
- Profiles and Functional Standards,
- Data Models and Operators,
- Data Administration,
- Geographic Information Services.

Currently, there are over 40 standards in the ISO 19100 series. These include both formally adopted and draft International Standards for spatial and temporal schema, metadata, imagery and gridded data, profiles, portrayal, encoding, and so forth.

Alignment with ISO/TC211

Given the prominence of ISO standards and their worldwide recognition and use, it makes sense for IHO to adopt the ISO/TC211 suite of standards for S-100.

In 1999, ISO/TC211 invited the IHO and the NATO Digital Geographic Information Working Group (DGIWG) to enter into a cooperative agreement for future standards development. Rather than work at cross-purposes, it was considered prudent to harmonize the data content contained in IHO S-57 (i.e., the Object Catalogue) with that of NATO DIGEST (the DGIWG Feature Data Dictionary – formerly called Feature Attribute Coding Catalog or FACC). Further, the intent was to develop hydrographic standards that were compatible with a broad range of other ISO geospatial standards. This was agreed by the 12th CHRIS meeting in October 2000. Currently members of both organizations attend each other's meetings and have played important roles in the harmonization process.

S-100 Framework

S-100 comprises multiple components that will be aligned with the ISO 19100 series of geospatial standards. Developing S-100 in this way will enable hydrographic data to be included in many more general geospatial applications as well as in the traditional hydrographic domains.

Alignment with the ISO 19100 series of geographic standards will require that S-100 is organized and defined in a different way when compared to S-57. More specifically, it will require a new framework or structure, and a revised set of terms to describe the components of S-100.

The relationship between S-100 work packages and their ISO base classes is shown in Figure 2.

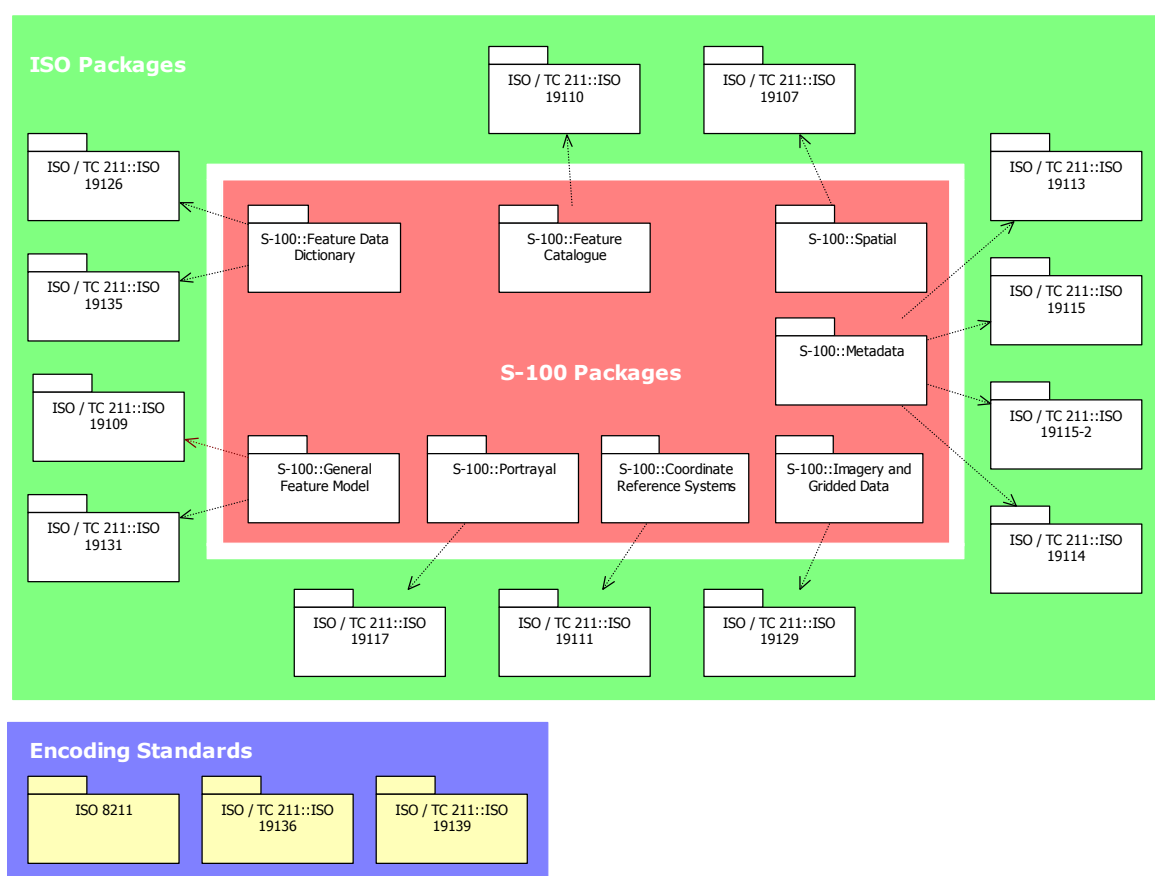


Figure 2 - IHO S-100 Components and their Associated ISO Standards

Registry Component

Perhaps the most significant aspect in terms of alignment with the ISO TC/211 standards is the employment of a “registry” containing one or more “registers” (see Figure 2).

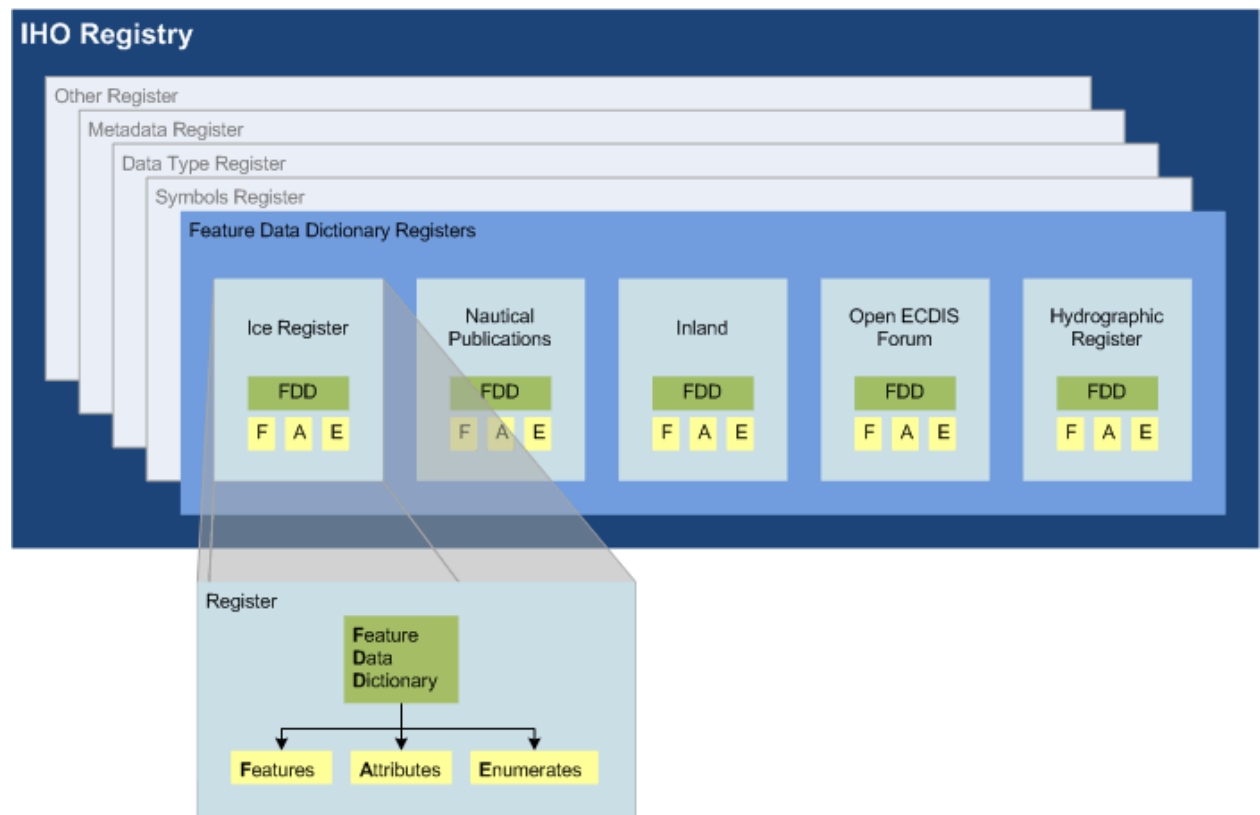


Figure 3 – The IHO Registry for S-100 will comprise a collection of registers

A “registry” is the entire information system (or location) in which a collection of registers is located. In the case of S-100, IHO will host a registry that will provide a facility to store various registers of hydrographic-related information such as feature data dictionaries, data types, and metadata.

Unlike S-57, the feature dictionaries will only consist of the definitions for features, attributes and enumerations. Binding between these definitions, units of measure, format and so on, will be included in a feature catalogue which will be specific to each product specification. Initially there will be registers for Hydrographic Information (based on the existing S-57 feature and attribute catalogues), Dynamic Ice Coverage, Nautical Publications and Inland ENC. Other types of information that do not fit into these categories may be included in the Open ECDIS Forum (OEF) register. For each register there will be an organization that will be responsible for its content and management. A major benefit of the registry concept is its flexibility. Multiple versions of similar entries in a data dictionary can be maintained using unique identification and classification. For instance, an entry can be classified as being either:

- valid (latest version),
- superseded (previous version/s),
- retired (no longer recommended for use),

- non valid (proposed but not accepted or no longer acceptable).

In this way product feature catalogues will reference items that will always remain valid even if a newer version of the referenced item is registered at a later date. This means that if a new item is registered or an existing item upgraded, new versions of existing product specifications are not required. *Non valid* items will be visible in the Registers to ensure that any future proposals for similar items have not been previously rejected. The S-100 registry entered into use in 2007 when the IHO Standardisation of Nautical publications Working group and the Inland ECDIS Harmonization Group began populating Registers with relevant information in support of Digital Nautical Publications and Inland ENC's respectively.

Metadata Component

Increasingly, hydrographic offices are collecting, storing and archiving large quantities of digital data which are becoming an important national asset. Knowledge of the quality of hydrographic data is crucial in ensuring that the data is used appropriately; different users and different applications often have different data quality requirements. In order to provide relevant details, data custodians will need to record quality information about their data. This will be at least one part of a metadata requirement.

The S-100 metadata component makes provision for the creation of metadata records that provide information about the identification, spatial and temporal extent, quality, application schema, spatial reference system, and distribution of digital geographic data. It is applicable to the cataloguing of datasets, clearinghouse activities, and the full description of geographic and non-geographic resources. Although it is primarily intended to describe digital geographic data, it may also be used to describe other resources such as charts, maps, textual documents and non-geographic resources.

Feature Catalogue Component

This component provides improved flexibility:

- feature catalogues for individual product specifications can be constructed using either items referenced from the data dictionary registers or new items defined in the catalogue itself.
- decisions about the binding between features and attributes will be defined in the individual catalogue along with the unit of measure for numeric attributes.
- a new Information Type is introduced which does not have any spatial attribution and will provide information about a feature by association. For example this could be a note associated with a pipeline or buoy etc.
- a new complex attribute type. This is an extension of the ISO concept of an attribute of an attribute.

Spatial Component

The one and two-dimensional geometry of S-57 is being updated in S-100 to accommodate the use of a wider range of database and encoding applications. For example, the use of a composite curve to consolidate the individual curve components of a feature will simplify operations on such a feature in the software environment. Surfaces are being introduced to solve issues of area features truncated by data boundaries. This will accommodate the encoding of one area feature with one set of geometry, unlike in S-57 where several features using individual geometries are required to model what is actually a single feature.

Imagery and Gridded Component

This component defines specific grid organizations to be used for hydrographic data and images associated with hydrographic data. Both simple grids and complex multi-dimensional grids are defined.

Hydrographic soundings are by their nature a set of measured data points. These data points can be represented in a grid structure in several different ways, including elevation models, using a regular grid spacing, and irregular grids with variable size cells or picture elements (pixels) that closely correspond to the handling of soundings as point sets.

Images are also of great importance for hydrographic data. This includes images from sensors such as aerial photography or LIDAR, photographs that can be associated with vector based feature oriented data and scanned paper chart products, commonly known as “Raster Charts.” All of these applications of imagery and gridded data will be catered for in S-100.

Encoding Component

S-100 itself will not mandate particular encoding formats. This means that the developers of product specifications can decide on the suitable encoding standard for their particular applications.

Initially S-100 will only provide an updated schema for ISO 8211 and schemas for GML including a version for Simple Features for use in web feature services. This will eventually be extended to include other formats as and when required.

Product Specification Component

A Product Specification is a description of all the features, attributes and relationships of a given application and their mapping to a dataset. It is a complete description of all the elements required to define a particular geographic data product.

This component is intended to ensure that any data product specification will maintain a similar structure.

A product specification consists of the following basic parts:

- product identification.
- data content and structure
- coordinate reference system.
- data quality.
- data capture.
- data maintenance
- portrayal
- encoding
- product delivery

Maintenance Component

S-100 will never be “frozen” although the frequency of new versions will be strictly controlled by the IHO as the Registry Owner. There will be three types of change proposal in S-100: clarification, correction and extension. Any change proposal must be one of these types.

The maintenance regime has been changed considerably in comparison to that in S-57. The concept of a change being both a clarification and a correction has been removed. The new version control mechanism will be as follows :

- Clarifications denoted as 0.0.x.
- Corrections denoted as 0.x.0.
- Extensions denoted as x.0.0.

New Terminology (IHO S-57 → IHO S-100)

Some of the terms and definitions currently used in S-57 Ed. 3.1 will not be used in S-100. They will be re-defined or modified to conform with the same terms used in the ISO TC/211 series of standards.

Some examples of the changes in terminology include:

<u>S-57 Ed. 3.1</u>	→	<u>IHO S-100</u>
[none] *		a registry for a standard contains a number of registers
object		feature
attribute		feature attribute
attribute values		enumerated values
object catalogue		a feature data dictionary contains features and attributes but without any mandatory relationship. Using this, a specific feature catalogue (mandating relationships between features and attributes) can be specified for a variety of requirements (e.g., a product specification).
edge		curve
node		point
face		surface
application profile		application schema

- * The closest thing to a registry/registers that currently exists are the arrangements on the Open ECDIS Forum (OEF). During the past six years, it has served as a useful mechanism/database for registering additional objects/attributes that were not contained in S-57 Edition 3.0/3.1.

Benefits

There are many benefits to be gained from adopting S-100:

- Using ISO-developed components and terminology will help ensure that S-100 and future extensions are in the mainstream of the geospatial information industry. This should also help to encourage a greater use and thereby lower costs in implementing S-100 for hydrographic and other types of geospatial applications (for example, Marine GIS).
- Conformance with the ISO/TC211 standards will maximize the use of commercial-off-the-shelf (COTS) software applications and development.
- New components of S-100 will not be developed in isolation from the rest of the geospatial information technology community.
- Any new requirements can be incorporated within the established framework of ISO/TC211 based standards.

- Rather than being regarded as simply a standard for hydrography, S-100 will be interoperable with other ISO/TC211 standards and profiles such as NATO DIGEST.
- There are many national standards bodies that will take full advantage of S-100 being aligned with ISO/TC211 standards.
- Compatible hydrographic data will be available to more than just hydrographic offices and ECDIS equipment.
- It will enable hydrographic offices to use compatible sources of geospatial data, for example combining topography and hydrography to create a coastal zone map.

Migrating from S-57 Edition 3.1 to S-100

ENC data conforming to S-57 Edition 3.1 will continue to be a requirement for type-approved, IMO-compliant ECDIS for the foreseeable future - even after S-100 has been released. As a consequence, **hydrographic offices will continue, as at present, to produce Edition 3.1 ENC data to support this.**

Implications for the ENC Product Specification

It goes without saying that if any improved ENC Product Specification (such as S-101) is to be adopted in the future, it must provide mariners with useful new functionality. This could include such things as “plug and play” updating of data, symbology and software enhancements as well as the more efficient use of additional data created under S-100.

Also, any development of S-101 will be undertaken over several years, and will involve the active participation of all stakeholders, including hydrographic offices, ENC software producers, ECDIS manufacturers, mariners, and other maritime users. The development, implementation and transition into force must also follow the IHO CHRIS governance model for IHO technical standards as illustrated in Figure 5.

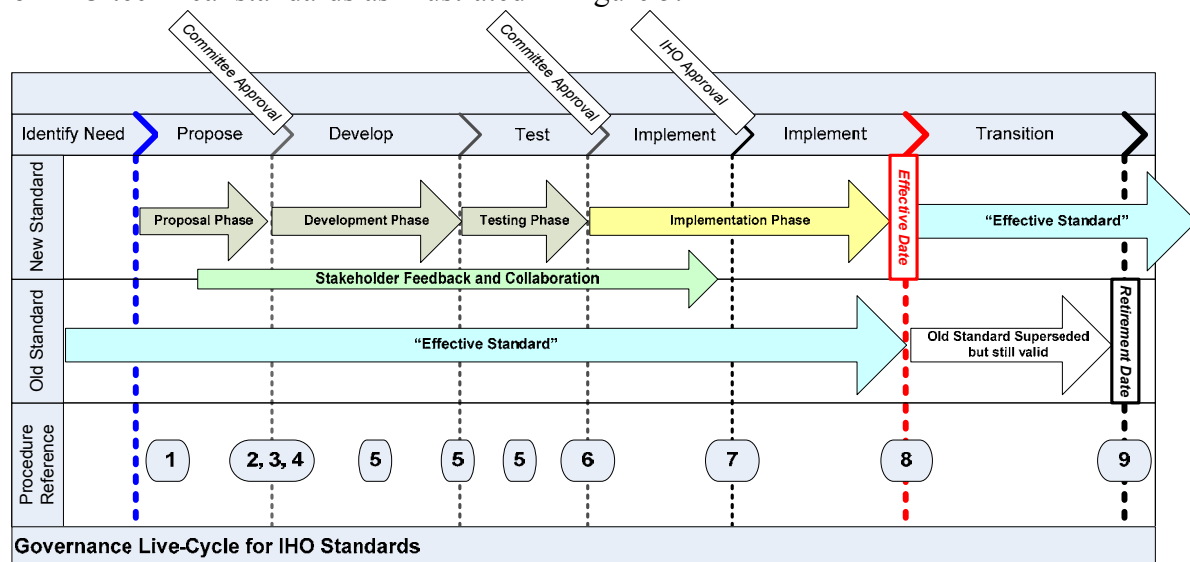


Figure 4 - Typical Lifecycle of an IHO Standard

As a consequence of the extensive development process, any improved ENC Product Specification (S-101) could not come into force before at least 2012 and even then, the standard would sit alongside the existing S-57 Edition 3.1 Product Specification for some time. Furthermore, it is intended that any ECDIS which are upgraded to use S-101 ENCs **will continue to be able to use S-57 Edition 3.1 ENCs as well.**