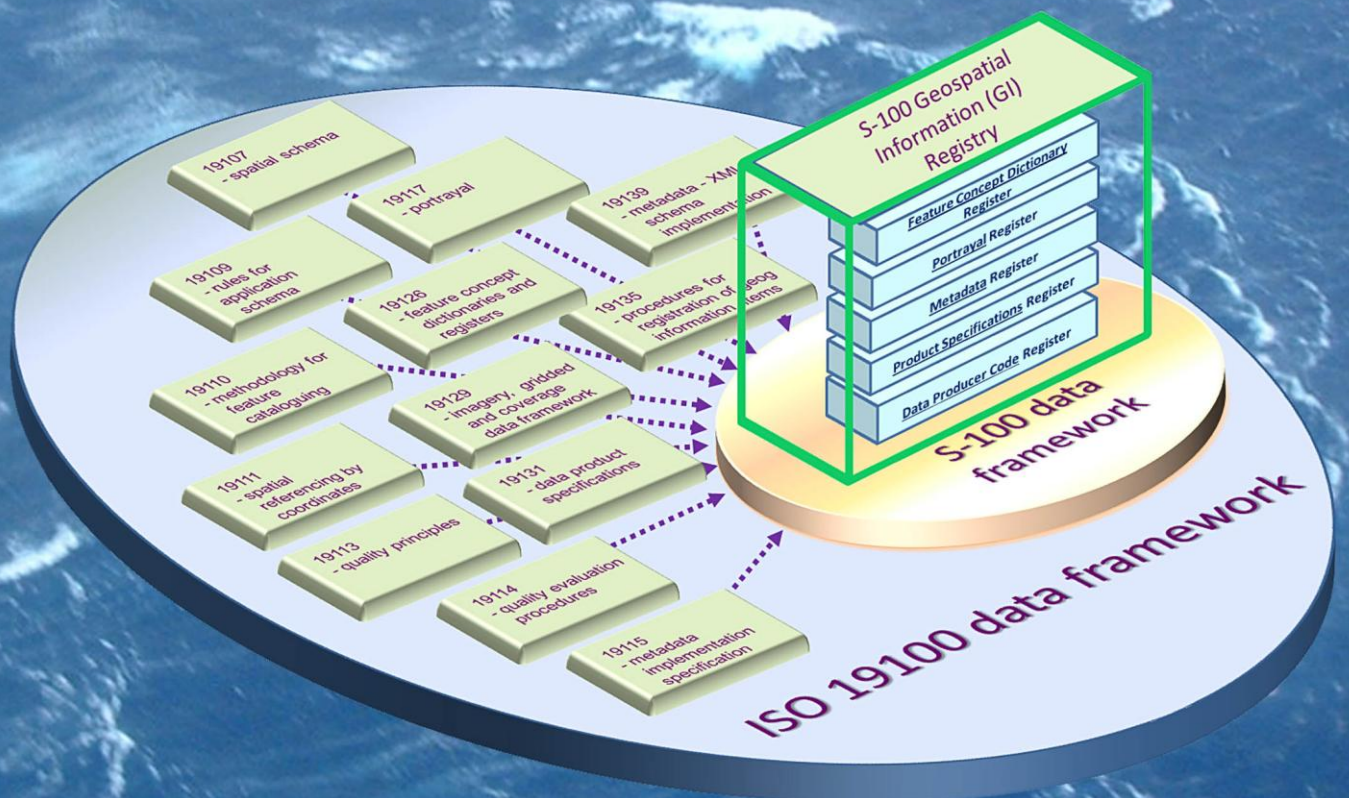




# S-100 - UNIVERSAL HYDROGRAPHIC DATA MODEL

Edition 2.0.0 – June 2015



Published by the  
International Hydrographic Organization  
MONACO

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# INTERNATIONAL HYDROGRAPHIC ORGANIZATION



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Publication S-100

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# **S-100 – Part 0**

## **Overview**

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## Foreword

Development of S-100 – the *IHO Universal Hydrographic Data Model* was included in the IHO Work Programme in 2001. S-100 has been developed by the IHO Transfer Standards Maintenance and Applications Development (TSMAD) Working Group with active participation from hydrographic offices, industry and academia.

S-100 provides a contemporary hydrographic geospatial data standard that can support a wide variety of hydrographic-related digital data sources, and is fully aligned with mainstream international geospatial standards, in particular the ISO 19100 series of geographic standards, thereby enabling the easier integration of hydrographic data and applications into geospatial solutions.

The primary goal for S-100 is to support a greater variety of hydrographic-related digital data sources, products, and customers. This includes the use of imagery and gridded data, enhanced metadata specifications, unlimited encoding formats and a more flexible maintenance regime. This enables the development of new applications that go beyond the scope of traditional hydrography - for example, high-density bathymetry, seafloor classification, marine GIS, et cetera. S-100 is designed to be extensible and future requirements such as 3-D, time-varying data (x, y, z, and time) and Web-based services for acquiring, processing, analysing, accessing, and presenting hydrographic data can be easily added when required.

The S-100 development and maintenance process is specifically aimed at allowing direct input from non-IHO stakeholders, thereby increasing the likelihood that these potential users will maximise their use of hydrographic data for their particular purposes.

S-100 will eventually replace S-57 – the established *IHO Transfer Standard for Digital Hydrographic Data*. Although S-57 has many good aspects, it has some limitations:

- S-57 has been used almost exclusively for encoding Electronic Navigational Charts (ENCs) for use in Electronic Chart Display and Information Systems (ECDIS).
- S-57 is not a contemporary standard that is widely accepted in the GIS domain.
- 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.

The transition from S-57 to S-100 will be carefully monitored by the IHO to ensure that existing S-57 users, particularly ENC stakeholders are not adversely affected. S-57 will continue to exist as the designated format for ENC data for the foreseeable future.

In the meantime, all existing and potential users of hydrographic information and data are encouraged to use S-100 as the basis for new applications, seeking input to the further development of the standard if their particular requirements are not yet catered for.

## Document Control

Edition Number	Date	Reference
1.0.0	January 2010	IHO Circular Letter No 83/2009 4 December 2009
2.0.0	June 2015	IHO Circular Letter No 39/2015 05 June 2015



## Introduction

Standards should encapsulate the use of best practice methods and procedures. They should include guidance on how to implement efficient production methods and optimize the quality of an organizations products and services, and should also enable interoperability between disparate technologies through the use of common interfaces. The S-100 standard attempts to achieve all of these objectives. Furthermore it provides a framework of components that can be used by interested communities to develop their own maritime geospatial products and services.

The S-100 standard has been developed with the advantage of hindsight based on experience gained through the development and use of the existing IHO Transfer Standard for Digital Hydrographic Data (known as S-57). S-100 has been documented using an object-oriented notation known as the Unified Modelling Language (UML). (Although UML defines nine types of diagrams, only class, object and package diagrams have been used in S-100).

The S-100 standard provides a theoretical framework of components that are based on the ISO 19100 series of standards and specifications. These standards and specifications are also used as the basis for most contemporary geospatial standards development activities and are closely aligned with other standards development initiatives such as the Open Geospatial Consortium (OGC).

The IHO has also developed an associated Registry which can be used in conjunction with the S-100 standard. The IHO Registry contains the following additional components;

- Feature Concept Dictionary (FCD) Registers.
- Portrayal Registers.
- Registers of IHO producer codes.

The IHO Registry provides the infrastructure and mechanisms required to manage and maintain the resources listed above, and to extend them as required.

### Note

S-100 provides a schema and overarching management procedures for a registry and registers and the IHO Registry is implemented using these concepts.

## 0-1 Scope

S-100 – IHO *Universal Hydrographic Data Model* comprises twelve related parts that give the user the appropriate tools and framework to develop and maintain hydrographic related data, products and registers. These standards specify, for hydrographic and related information, methods and tools for data management, processing, analysing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations. By following this set of geospatial hydrographic standards users will be able to build constituent parts of an S-100 compliant product specification.

S-100 conforms as far as is reasonably possible to the ISO TC 211 series of geographical information standards, and where necessary has been tailored to suit hydrographic requirements.

S-100 details the standard to be used for the exchange of hydrographic and related geospatial data between national hydrographic offices as well as between other organizations and for its distribution to manufactures, mariners and other data users.

S-100 comprises multiple parts that profile standards developed by the ISO Technical Committee 211. ISO TC 211 is responsible for the ISO series of standards for geographic information. The objective is that, together, the standards will form a framework for the development of sector specific applications that use geographic information. S-100 is an example of such an application.

This standard specifies the procedures to be followed for:

- 1) establishing and maintaining registers of hydrographic and related information;
- 2) creating product specifications, feature catalogues and a definition of the general feature model;
- 3) using spatial, imagery and gridded data, and metadata specifically aimed at fulfilling hydrographic requirements.

## 0-2 Abbreviations used in this publication

2-D	Two-dimensional
2.5D	Two and a half dimensional
CRS	Coordinate Reference System
CSL	Conceptual schema language
DIS	Draft International Standard
ECDIS	Electronic Chart Display and Information System
ENC	Electronic Navigational Chart
EPSG	European Petroleum Survey Group (Since 2005 OGP Surveying and Positioning Committee)
FCD	Feature Concept Dictionary
FDIS	Final Draft International Standard
GFM	General Feature Model
GML	Geography Markup Language
HSSC	IHO Hydrographic Services and Standards Committee (formerly CHRIS)
IEC	International Electrotechnical Commission
IHB	International Hydrographic Bureau
IHO	International Hydrographic Organization
ISO	International Organization for Standardization
ISO/TC211	ISO Technical Committee for Geographic information/Geomatics
OCL	Object Constraint Language

ODP	Open Distributed Processing
OGC	Open Geospatial Consortium
OGP	International Association of Oil and Gas Producers
OMG	Object Management Group
RNC	Raster Navigational Chart
TC	Technical Committee
TS	Technical Specification
TSMAD	Transfer Standard Maintenance and Application Development Working Group
S-100WG	S-100 Working Group
UML	Unified Modelling Language
URI	Uniform Resource Identifier
URL	Universal Resource Locator
XLink	XML Linking Language
XMI	XML Metamodel Interchange
XML	Extensible Markup Language
XSD	World Wide Web Consortium XML Schema Definition
XSL	eXtensible Stylesheet Language

### **0-3 Objectives of S-100**

The objectives of S-100 are:

- 1) To comply with the emerging ISO standards for geographic information being produced by ISO TC 211;
- 2) To provide support for a greater variety of marine or hydrographic-related digital data, products and customers;
- 3) To separate the data content from the encoding format, enabling format neutral product specifications;
- 4) To enable manageable flexibility that can accommodate change. The intention is that product specifications will be allowed to evolve through extension without the need to publish new versions of existing product specifications;
- 5) To provide an ISO-conformant registry managed by the IHO containing registers such as feature concept dictionaries and product feature catalogues that are flexible and capable of managed expansion;
- 6) To provide separate registers for different user communities.

## 0-4 S-100 Parts

S-100 comprises multiple parts that are derived from various ISO 19100 series of standards. Table 0-1 lists the individual parts, their associated part numbers and ISO 19100 conformance.

**Table 0-1 — S-100 Parts**

Part Title	Part Number	ISO19100 Standard
Conceptual Schema Language	S-100 Part 1	ISO 19103:2005, Geographic information - Conceptual schema language ISO
Management of IHO Geospatial Information Registers	S-100 Part 2	ISO 19135:2005, Geographic Information - Procedures for registration of items of geographic information
Feature Concept Dictionary Registers	S-100 Part 2a	ISO 19135:2005, Geographic Information - Procedures for registration of items of geographic information  ISO/DIS 19126:2008, Geographic Information – Feature concept dictionaries and registers
General Feature Model and Rules for Application Schema	S-100 Part 3	ISO 19109:2005, Geographic information - Rules for application schema
Metadata	S-100 Part 4a	ISO 19115:2005, Geographic information - Metadata.
Metadata for Imagery and Gridded Data	S-100 Part 4b	ISO 19115:2005, Geographic information - Metadata.
Metadata – Data Quality	S-100 Part 4c	ISO 19113, Geographic information - Quality principles ISO 19114, Geographic information - Quality evaluation procedures ISO 19138, Geographic information - Quality measures
Feature Catalogue	S-100 Part 5	ISO 19110:2005, Geographic Information - Methodology for feature cataloguing
Coordinate Reference Systems	S-100 Part 6	ISO 19111:2007, Geographic information - Spatial referencing by coordinates
Spatial Schema	S-100 Part 7	ISO 19107:2003, Geographic information - Spatial schema
Imagery and Gridded Data	S-100 Part 8	ISO 19123:2007, Geographic information - Schema for coverage geometry and functions ISO 19129, Geographic information - Imagery, Gridded and Coverage Data Framework
Portrayal	S-100 Part 9	
Encoding Formats	S-100 Part 10	
ISO/IEC 8211 Encoding	S-100 Part 10a	ISO/IEC 8211:1994, Specification for a data descriptive file for information interchange structure implementations
GML Encoding	S-100 Part 10b	ISO 19136:2007 Geographic information - Geography Markup Language
Product Specifications	S-100 Part 11	ISO 19131:2008 Geographic information – Data product specifications
S-100 Maintenance Procedures	S-100 Part 12	

## **0-4.1. Profiles**

The ISO base standards provide a large number of options to the developer wishing to use them for practical applications. The concept of a profile provides a method of adapting the base standards so that they meet specific implementation requirements.

A profile is a set of one or more base standards and, where applicable, the identification of chosen clauses, classes, subsets, options and parameters of those base standards, that are necessary to accomplish a particular function. ISO 19106 describes two levels of conformance for profiling the ISO 19100 series of standards. Each part of S-100 documents the level used in the conformance statement for that part.

S-100 is a set of profiles of the ISO TC 211 standards for Geographic Information. The relationship between S-100 standard core parts and their ISO base classes is shown in Table 0-1.

## **0-4.2. Part 1 – Conceptual Schema Language**

This Part defines the conceptual schema language and basic data types for use within the IHO community. It identifies the combination of the Unified Modeling Language (UML) static structure diagram, and a set of basic data type definitions as the conceptual schema language for specification of geographic information.

## **0-4.3. Part 2 – Management of IHO Geospatial Information Registers**

The International Hydrographic Organization (IHO) has developed a Registry in conformance with ISO 19135 - *Procedures for registration of items of geographic information*. This registry contains an extensible number of registers, encompassing Feature Concept Dictionaries, Portrayal and Meta Data. This part describes the contents structure and management of these registers.

## **0-4.4. Part 2a – Feature Concept Dictionary Registers**

A feature concept dictionary specifies definitions that may be used to describe geographic information. The use of registers to store definitions will significantly improve the IHO's ability to manage and extend multiple products based on S-100 which can then be made available for use in a relatively short timescale. These registers will support wider use of registered items by making them publicly available and increase their visibility to potential users.

## **0-4.5. Part 2b – Portrayal Registers**

This section is reserved for portrayal schema which are under development.

## **0-4.6. Part 3 – General Feature Model**

This part introduces the rules for developing an application schema which is a fundamental element of any S-100 based product specification. Equally fundamental to the creation of the application schema is a General Feature Model (GFM) which is a conceptual model for features, their characteristics and associations. It also introduces the concept of the information type. The GFM is a profile of the GFM presented in ISO 19109 Rules for Application Schemas.

## **0-4.7. Part 4 – Metadata**

Increasingly, hydrographic organizations 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 for the application for the data, as different users and different applications often have different data quality requirements. In order to achieve this, data custodians will need to record quality information about their data (i.e. metadata) in order to assure reliability.

ISO 19115 provides an abstract structure for describing digital geographic information by defining the quality metadata elements and establishing a common set of metadata terminology, definitions, and extension procedures.

This part also describes how to use ISO 19115 metadata classes, elements and conditions, and incorporates rules for populating quality metadata. It also incorporates quality measures as described in ISO 19113, 19114 and 19138.

#### **0-4.8. Part 5 – Feature Catalogue**

A feature catalogue is a document that describes the content of a data product. It uses item types, for example, features and attributes, from one or more feature data dictionaries. The basic level of classification in a feature catalogue is by feature type and information type. A feature catalogue should be available in electronic form for any set of geographic data that contains features. A feature catalogue may also comply with the specifications of this part of S-100 independently of any existing set of geographic data.

A feature catalogue is defined for each product specification. Features and attributes are bound in a feature catalogue. The definitions of features and attributes are drawn from a Feature Concept Dictionary.

This part defines the methodology for cataloguing feature types. It also specifies how the classification of feature types is organized into a feature catalogue and presented to the users of a set of geographic data. This part is applicable to creating catalogues of feature types in previously un-catalogued domains and to revising existing feature catalogues to comply with standard practice. This part applies to the cataloguing of feature types that are represented in digital form. Its principles can be extended to the cataloguing of other forms of geographic data.

Part 5 is applicable to the definition of geographic features at the type level. This international standard is not applicable to the representation of individual instances of each type.

#### **0-4.9. Part 6 – Coordinate Reference Systems**

This part is applicable to producers and users of hydrographic information. Its principles can be extended to many other forms of geographic information such as maps, charts, and text documents.

This part defines the conceptual schema for the description of spatial referencing by coordinates. It describes the minimum data required to define a one, two and three dimensional spatial coordinate reference. All the elements necessary to fully define spatial referencing by means of coordinate systems and datums are contained in this section. It also describes the information required to change coordinates from one coordinate reference system to another and all the elements necessary to describe the parameters and methods of coordinate operations. Coordinate operations include projections and datum transformations.

Coordinate reference system information can be presented in full using the elements defined in this part or by reference to a register of coordinate reference system information. A register of coordinate reference system information may be managed in accordance with ISO 19135 (see Part 2).

There are no plans for the IHO to implement a register of coordinate reference systems. An example of an existing register of coordinate reference system information which may be used is the EPSG geodetic parameter dataset which is managed by the Surveying and Positioning Committee of the OGP. Complete CRS definitions may be communicated by means of the namespace EPSG and a code, such as 4326 (i.e. EPSG:4326). This code within the EPSG namespace identifies the ellipsoidal coordinate system based on WGS84 datum. The EPSG database is not managed in accordance with ISO 19135.

### 0-4.10. Part 7 – Spatial Schema

This part defines the information necessary for describing and manipulating the spatial characteristics of features. It is based on ISO 19107 - *Geographical Information - Spatial schema*, however the spatial requirements of S-100 are less comprehensive than the requirements of ISO 19107. This profile contains the subset of ISO 19107 classes which are included in S-100.

### 0-4.11. Part 8 – Imagery and Gridded Data

This part identifies the content model for gridded data for use in Hydrographic and related applications, including imagery and gridded data. It describes the organization, type of grid and associated metadata and spatial referencing. The encoding and portrayal of imagery and gridded data is external to this part of S-100, although the manner by which encoding and portrayal makes use of the identified content models are identified. This part is based on the ISO 19129 Imagery, gridded and coverage data framework.

### 0-4.12. Part 9 – Portrayal

This part specifies the portrayal model for defining and organizing symbols and portrayal rules necessary to portray S-100 product Features.

### 0-4.13. Part 10 – Encoding Formats

This part covers encoding formats. S-100 does not mandate particular encoding formats so it is left to developers of product specifications to decide on suitable encoding standards and to document their chosen format. The issue of encoding information is complicated by the range of encoding standards that are available. Table 0-2 provides an incomplete list of available encoding standards from which schemas can be developed as extensions to S-100 as required.

**Table 0-2 – Example Encoding Standards**

Encoding Name	Description
ISO/IEC 8211	The encoding standard currently used to encode S-57 ENC data.
GML	Geography Markup Language
XML	Extensible Markup Language
GeoTIFF	Extension of the TIFF specification to allow the storage of geo-referencing information.
HDF-5	Hierarchical Data Format version 5
JPEG2000	Joint Photographic Experts Group - Commonly used method for the compression of photographic images.

Successful data interchange depends on knowledge of the content, defined in the feature catalogue, and the structure, defined in the application schema, of a dataset, and the encoding rules that are applied.

### 0-4.14. Part 10a – ISO/IEC 8211 Encoding Schema

This part specifies the structure and physical constructs required for the implementation of exchange data sets.

#### **0-4.15. Part 10b – GML Encoding**

This part specifies the structure and physical constructs required for the implementation of the Geographic Markup Language data format.

#### **0-4.16. Part 11 – Product Specifications**

This part explains Product specifications. It is a descriptive IHO profile of ISO 19131 for data product specifications and describes data product specifications for hydrographic and hydrographically-related requirements for geographic data products.

The aim of this profile is to ensure a clear and consistent structure for any data product specification. This profile will conform with all the other standards that have been developed under the IHO S-100 framework.

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.

#### **0-4.17. Part 12 – Maintenance**

This part specifies procedures to be followed in maintaining and publishing the various parts of S-100. It does not cover the maintenance of the S-100 registry, as register owners specify the procedures for updating their registers. Additionally, it does not cover the maintenance regime of product specifications that are written against S-100.

NOTE All S-100 based product specifications will include a maintenance section.