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**S-100**



Published by the

International Hydrographic Organization

4b quai Antoine 1er

Principauté de Monaco

Tel: (377) 93.10.81.00

Fax: (377) 93.10.81.40

info@iho.int

www.iho.int

**Universal Hydrographic Data Model**

**Edition 5.2.0 – June 2024**

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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. Since 2015, S-100 has been further developed by the S100 Working Group (S100WG).

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 (for example, gridded bathymetry, or time-varying information).
* Embedding the data model within the encapsulation that is, 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  04 December 2009 |
| 2.0.0 | June 2015 | IHO Circular Letter  No 39/2015  05 June 2015 |
| 3.0.0 | June 2017 | IHO Circular Letter  No 32/2017  02 May 2017 |
| 4.0.0 | December 2018 | IHO Circular Letter  No 60/2018  17 December 2018 |
| 5.0.0 | December 2022 | IHO Circular Letter  No 45/2022  12 December 2022 |
| 5.1.0 | October 2023 | IHO Circular Letter  No 36/2023  31 October 2023 |
| 5.2.0 | June 2024 | IHO Circular Letter  No 27/2024  07 June 2024 |

Summary of Substantive Changes in Edition 5.2.0

|  |  |
| --- | --- |
| Change Summary | Clauses Effected |
| **Part 3 – General Feature Model and Rules for Application Schema** | |
| Add note stating that there has been only limited implementation of spatial attributes so far in S-100. | 3-5.3.5 |
| Add new clause specifying the use of interoperabilityIdentifier to allow for the discovery of instances of the same “thing” within the same dataset or between different datasets, including different product Specifications. | 3-10.1 |
| **Part 4a - Metadata** | |
| Amended incorrect cross-reference from Appendix 4a-E to Appendix 4a-D. | 4a-5.2 |
| Amended incorrect cross-reference from clause 4a-5.6.3 to clause 4a-5.7.3. | 4a-5.4, 4a-5.6 |
| Added note stating that for Product Specifications to be used in S-100 ECDIS the metadata extension rules described in the Appendix do not apply to the Exchange Catalogue profile as described in S-100 part 17. | Appendix 4a\_D |
| **Part 5 – Feature Catalogue** | |
| Corrected Figure 5-A-1 and Table 5-A-16, and added new Table 5-A-21, to allow for the capability to define the display visibility level of attributes in end user systems. | Appendix 5-A |
| Corrected multiplicity for Class S100\_FC\_FeatureAssociation, Role subType from [0..] to [0..\*]. | Appendix 5-A, Table 5-A-10 |
| **Part 8 – Imagery and Gridded Data** | |
| Removed Table 8-1 and replaced with text referencing ISO 19115-1/2 (Table moved to Appendix 8-D). [All following Table numbers amended accordingly.] Added paragraph clarifying requirement for metadata to conform to S-100 parts 10c and 17. | 8-4.3.1 |
| Amended paragraph to remove language about S100\_IF\_Collection metadata being optional. Sentence added clarifying that structural, acquisition, and quality metadata are optional except for elements required to describe the coverage format. Amended Figure 8-19 to remove overlapping role names for the association S100\_IF\_Collection / S100\_IF\_CollectionMetadata. | 8-5.3 |
| Applied corrections for clarity and grammar. Sentences added to clarify where these abstract classes are realized. | 8-5.3.6, 8-5.3.7, 8-5.3.8 |
| Removed reference to point set data. | 8-5.3.9 |
| Clause heading amended from “Imagery and Gridded Data Metadata” to “Metadata” and clause condensed to avoid duplication of Figure (former Figure 8-28) and accompanying text content in clause 8-5.3. [All following Figure numbers amended accordingly.] Multiple revisions to remove duplicative language, remove digressions and introduce a reference to quality metadata. Sentence added mentioning the new location of suggested metadata supporting scanned paper charts. | 8-9 |
| The former clause 8-13 (Metadata for scanned image) moved to Appendix 8-D. | 8-13 (Edition 5.1.0) |
| New clause “Typical metadata” (metadata-related content moved from clause 8-4.3.1). | 8-D-1 |
| New clause heading “Derivation of S-100 metadata and ISO metadata” inserted and Table number for the pre-existing table “Relationship between packages of metadata and metadata classes” added. | 8-D-2 |
| New clause “Metadata for scanned image” added (content moved from the former clause 8-13). | 8-D-3 |
| **Part 9 - Portrayal** | |
| Inserted enhanced guidance for the implementation of the text drawing instruction. (NOTE: All Table numbers, and all Figure numbers from Figure 9-9, amended as a result of these changes.) | 9-11.1.11 |
| Clarified LineStyle Class table to indicate that, even though a pen must be provided, it is not used when drawing symbolized lines without a dash component. | 9-12.1.4.2 |
| Corrected the syntax of the hatch association for Class HatchFill. | 9-12.5.1.7 |
| Revised entire Appendix 9-B to more fully define the SVG Profile in S-100. | 9-B |
| **Part 9a – Portrayal (Lua)** | |
| Removed incorrect requirement that *crsDirection* and *crsLength* must match for *AugmentedRay*. | 9a-11.2.2.6 |
| **Part 10a – ISO/IEC 8211 Encoding** | |
| Corrected field description syntax (amend “{}” to “()”). | 10a-4.8.5, 10a-5.2.2, 10a-6.1.2.1, 10a-7.2.1.8, 10a-7.2.1.10, 10a-7.3.2.4 |
| Added Note regarding interpretation of the syntax used in the format control section of the Data Descriptive Field in previous versions of S-100. | 10a-5.2.2, 10a-6.1.2.1, 10a-7.2.1.8, 10a-7.2.1.10, 10a-7.3.2.4 |
| Corrected syntax for the Data Descriptive Field for the Vertical Datum field structure. | 10a-6.2.2.6 |
| Corrected format descriptor for the Data Descriptive Field for the 3-D Floating point Coordinate List field structure – 3b24 amended to 3b48. | 10a-7.2.1.10 |
| Corrected syntax for the Data Descriptive Field for the Derivatives fields (DRVF and DRVI) to remove extraneous character “!” (from “DRVO!”) and add grouping; and corrected curve record structure accordingly. | 10a-7.2.1.12, 10a-7.2.4.2 |
| Corrected format descriptor for the Data Descriptive Field for the Polynomial Spline Parameter field structure to remove redundant KNUM subfield and corrected curve record structure accordingly. | 10a-7.2.4.2, 10a-7.2.4.2.8 |
| Corrected curve record structure, entry Spline Parameter (SPLI) field to conform with the field structure. | 10a-7.2.4.2 |
| Corrected syntax for the Data Descriptive Field for the Segment Header field structure. | 10a-7.2.4.2.4 |
| Corrected the subfield content and specification for subfield Degree in the polynomial spline parameter field structure. | 10a-7.2.4.8 |
| **Part 10c – HDF5 Data Model and File Format** | |
| Added new clause to clarify array and cell indexing. | 10c-9.1.1 |
| Corrected remark in Table 10c-6, row 1 (Product Specification number and version) to read “productIdentifier and version fields”. | 10c-9.4 |
| Corrected Table 10c-6, row 23 (Metadata) to amend multiplicity from [1] to [0..1]. Added clarification to Remarks. | 10c-9.4 |
| Inserted a new paragraph at the end of the clause specifying the location for TIN coverages. | 10c-9.6.1 |
| Amended Table 10c-12 to allow for northings/eastings from a Projected CRS in the bounding box fields in addition to currently allowed Geographic reference coordinates. | 10c-9.7 |
| **Part 11 – Product Specifications** | |
| Added guidance on implementation of new attribute interoperabilityIdentifier. | Appendix 11-E |
| **Part 15 – Data Protection Scheme** | |
| Amended specification to allow Permit files to have multiple pairs of header/products elements relating to different end user systems. | Entire |
| Updated 2nd paragraph to ensure S-100 is aligned with S-63 in terms of permitting duplicate HW\_ID and therefore shared / duplicated UPN. | 15-4.4 |
| Updated Figure 15-5 and associated guidance to allow Permit files to have multiple pairs of header/products elements relating to different end user systems. | 15-7.4.1, 15-7.4.3 |
| Corrected Table 15-6, entry for XML element issueDate to be consistent with Figure 15-5 and the Part 15 Schema. | 15-7.4.2 |
| Replaced example PERMIT.XML file with a corrected version. | 15-7.4.6 |
| Updated clause to clarify the length of the q parameter in keys generated for digital signatures; and amended setup specifications and examples accordingly. | 15-8.4, 15-8.5, 15-8.6, 15-8.7, 15-8.10, 15-8.11 |
| Corrected incorrect clause numbers (15-8.4.1.and 15-8.4.2 in S-100 Edition 5.1.0). | 15-8.5.1, 15-8.5.2 |
| Clarified that the IHO will have both a Scheme Administrator certificate to create scheme Data Server certificates, and an IHO Data Server certificate used to digitally sign and distribute, for example, S-100 Portrayal/Feature/Interoperability catalogues. | 15-8.5.1 |
| Updated the examples of digital signatures to use XML examples conforming to the Part 17 Exchange Catalogue model. | 15-8.8 |
| Updated Figure 15-8 to change S100\_SE\_DigitalSignatureReference enumeration value to ECDSA-384-SHA2 (value 8). | 15-8.11 |
| Clarified the character string to be populated for attribute schemeAdministrator on class S100\_SE\_CertificateContainerType where IHO is the Scheme Administrator. | 15-8.11.1 |
| **Part 17 – Discovery Metadata for information Exchange Catalogues** | |
| Added clarification regarding fileless dataset cancellation. | 17-4.4.1 |
| Updated Figure 17-7 to change S100\_SE\_DigitalSignatureReference enumeration value to ECDSA-384-SHA2 (value 8). | 17-4.4.1 |
| Added clarification that the S-100 Exchange Catalogue profile cannot be extended at the Product Specification level. | 17-4.5 |
| Added new note for Class table S100\_DataCoverage specifying the method by which the boundingPolygon is to be represented in GML encoding. | 17-4.5 |

# 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 Geospatial Information (GI) Registry which can be used in conjunction with the S-100 standard. The IHO GI Registry contains the following additional components;

* Concept Register.
* Data Dictionary Register.
* Portrayal Register.
* Register of IHO Data Producer Codes.
* Register of S-100 based Product Specifications.
* A help and guidance repository containing supporting documentation and tools to support S-100 based Product Specification development, such as Catalogue Builders.

The IHO GI 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 its Registers and the IHO GI Registry is implemented using these concepts.

# Scope

S-100 – IHO *Universal Hydrographic Data Model* comprises a set of 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.

# Abbreviations used in this publication

2-D Two-dimensional

2.5D Two and a half dimensional

API Application Programming Interface

ASCII American Standard Code for Information Interchange

CRS Coordinate Reference System

CSL Conceptual schema language

DEF Data Exchange Format

DIS Draft International Standard

ECDIS Electronic Chart Display and Information System

ECS Electronic Chart System

ENC Electronic Navigational Chart

EPSG European Petroleum Survey Group

FCD Feature Concept Dictionary

FDIS Final Draft International Standard

GFM General Feature Model

GML Geography Markup Language

HDF Hierarchical Data Format

HSSC IHO Hydrographic Services and Standards Committee (formerly CHRIS)

IALA International Association of Lighthouse Authorities

ICC International Colour Consortium

IEC International Electrotechnical Commission

IETF Internet Engineering Task Force

IHB International Hydrographic Bureau

IHO International Hydrographic Organization

IMO International Maritime Organization

IOGP International Association of Oil and Gas Producers (formerly OGP)

ISO International Organization for Standardization

ISO/TC211 ISO Technical Committee for Geographic information/Geomatics

JPEG Joint Photographic Experts Group

MRN Maritime Resource Name

OCL Object Constraint Language

ODP Open Distributed Processing

OEM Original Equipment Manufacturer

OGC Open Geospatial Consortium

OMG Object Management Group

OSI Open Systems Interconnection

RENC Regional ENC Coordinating Centre

RFC Request for Comments

RNC Raster Navigational Chart

RSS Recommended Security Scheme

SENC System-ENC

SKOS Simple Knowledge Organization System

TC Technical Committee

TIFF Tagged Image File Format

TIN Triangulated Irregular Network

TS Technical Specification

TSMAD Transfer Standard Maintenance and Application Development Working Group

S-100WG S-100 Working Group

SVG Scalable Vector Graphics

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

# 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.

# 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 |
| Concept and Data Dictionary Registers | S-100 Part 2a | ISO 19135:2005, Geographic Information -Procedures for registration of items of geographic information  ISO 19126:2009, Geographic Information – Feature concept dictionaries and registers |
| Portrayal Register | S-100 Part 2b | ISO 19135:2005, Geographic Information -Procedures for registration of items of geographic information  ISO 19126:2009, Geographic Information – Feature concept dictionaries and registers  ISO 19117:2012, Geographic Information - Portrayal |
| 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 19115-1:2014, Geographic information – Metadata. Amended by Amendment 1, 2018 |
| Metadata for Imagery and Gridded Data | S-100 Part 4b | ISO 19115-1:2014, Geographic information – Metadata – Part 1: Fundamentals. As amended by Amendment 1, 2018  19115-2:2009. Geographic information – Metadata – Part 2: Extensions for imagery and gridded data |
| 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 |  |
| Portrayal (Lua) | S-100 Part 9a | Lua Portrayal Implementation |
| 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 |
| HDF5 Encoding | S-100 Part 10c | HDF5 Data Model and File Format |
| Product Specifications | S-100 Part 11 | ISO 19131:2008 Geographic information – Data product specifications |
| S-100 Maintenance Procedures | S-100 Part 12 |  |
| S-100 Scripting Language | S-100 Part 13 | Provides scripting support for S-100 based Product Specifications |
| Online Communication Exchange | S-100 Part 14 | Specifies an online exchange mechanism for S-100 |
| Encryption and Data Protection | S-100 Part 15 | Specifies encryption and data protection for S-100 based products |
| Interoperability Catalogue Model | S-100 Part 16 | Defines a framework for creating rules for the interoperation of S-100 data products |
| Harmonised Portrayal of S-100 Products | S-100 Part 16a | Specifies the principles for harmonising portrayal and other presentational functionalities across different S-100 based data products |
| Discovery Metadata for Information Exchange Catalogues | S-100 Part 17 | Provides a specification for describing and creating exchange catalogues that enables users to identify, discover and manage content of S-100 Exchange Sets |
| Language Packs | S-100 Part 18 | Provides the generic methodology for implementing multi-lingual support; and informative examples for a primary use case, the creation of multi-lingual support for S-100 Feature Catalogues. |

## 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.

## 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 Modelling Language (UML) static structure diagram, and a set of basic data type definitions as the conceptual schema language for specification of geographic information.

## 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 Concepts, Data Dictionaries, Portrayal and Meta Data. This Part describes the contents, structure and management of these Registers.

## Part 2a – Concept and Data Dictionary Registers

The Concept Register specifies hydrographic core conceptual information (definitions, camelCase, etc) that may be used to describe geographic or meta data information. The use of a Register to store hydrographic definitions significantly improves the IHOs ability to manage and extend multiple products based on S-100 which can be made available for use in a relatively short timescale. As such, the Register supports wider use of registered items by making them publicly available; and increases their visibility to potential users. The Concept Register is the primary resource where all registered concepts are stored and managed as “stateless” concepts (that is, items are not assigned a type and there is no defined binding of concepts to other concepts within the Register). Each concept shall be included as a single instance in the Register and will be used as the common source from which Data Dictionary Register and Meta Data Register concepts are derived and used to model features, attributes etc. for use in S-100 based Product Specifications.

The Data Dictionary Register expands on the concepts stored in the Concept Register (S-100 Part 2a), by including the assignment of item types and feature binding in discrete Domains within the Register. This allows S-100 based Product Specification developers to develop their data models to best suit their specific requirements for representation of the real world.

This Part describes the content of the Registers and specifies procedures to be followed in establishing, maintaining, and publishing dictionaries of unique, unambiguous and permanent identifiers that are assigned to items of geographic, hydrographic and metadata information. In order to accomplish this purpose, this Part specifies elements of information that are necessary to provide identification and definitions to the registered items.

## Part 2b – Portrayal Register

This Part describes the content of the portrayal register. A Portrayal Register specifies the portrayal of data. The portrayal of data is independent of the data but closely related to the data. That is the attributes within the data set drive the portrayal process, but there may be many different portrayals for the same data. The use of a Register to store aspects of portrayal will significantly improve the IHO’s ability to manage and extend multiple products based on S-100 which can be made available for use in a relatively short timescale. This Register will support wider use of registered items by making them publicly available and increase their visibility to potential users.

## 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.

## Part 4 – Metadata

Increasingly, hydrographic organizations are collecting, storing and archiving large quantities of digital data which are becoming an important national asset. Characterising the data resources and facilitating their discovery, access, retrieval, and use is required in order for users to be able to understand the assumptions and limitations of data resources and evaluate the resources’ applicability for their intended use. Further, 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 information about the characteristics and quality of their data (that is metadata) in order to facilitate discovery, access, retrieval and use, and assure reliability.

ISO 19115-1, 19115-2, and 19157 provide an abstract structure for describing digital geographic information by defining the resources’ characteristics and quality metadata elements and establishing a common set of metadata terminology, definitions, and extension procedures.

This Part also describes how to use ISO 19115-1, 19115-2 and 19157 metadata classes, elements and conditions, and incorporates rules for populating quality metadata. It also incorporates quality measures as described in ISO 19113, 19114 and 19157.

## 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 Data 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.

## 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 Geodesy Subcommittee of the IOGP Geomatics Committee. Complete CRS definitions may be communicated by means of the namespace EPSG and a code, such as 4326 (that is, 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.

## 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.

## 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.

## Part 9 – Portrayal

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

## Part 9a – Portrayal (Lua)

This Part defines the additions and changes to S-100 Part 9 necessary to implement portrayal using the scripting mechanism defined in S-100 Part 13. Products which specify use of a portrayal catalogue as described in this part must also require implementation of S-100 Part 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.

## Part 10a – ISO/IEC 8211 Encoding Schema

This Part specifies the structure and physical constructs required for the implementation of exchange data sets encoded in the ISO 8211 format.

## Part 10b – GML Encoding

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

## Part 10c – HDF5 Data Model and File Format

This Part specifies the structure and constructs required for the implementation of exchange datasets encoded in the Hierarchical Data Format version 5 (HDF5).

## 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.

## 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 in accordance to S-100.

NOTE All S-100 based Product Specifications will include a maintenance section.

## Part 13 – Scripting

This Part defines a standard mechanism for including scripting support in S-100 based products. Scripting provides for processing of S-100 based datasets via script files written in the Lua programming language.

## Part 14 – Online Communication Exchange

This Part describes the components and processes needed to specify an online exchange of information. It could be a set of data or data which may have a continuous nature. The latter is also known as “streaming data”, wherein the data requires a more dynamic information flow to be available; that is, beyond that found with the exchange of static datasets mostly handled as files.

## Part 15 – Encryption and Data Protection

This Part specifies the mechanisms, structures and content required for the implementation of copy protections and/or authentication methods by S-100 product specifications. It defines standardized methods and algorithms for the encryption of file based components of datasets as well as feature and portrayal catalogues. Algorithms and methods for the production of digital signatures are defined as well as the surrounding infrastructure required for key management and identity assurance within the IHO Data Protection Scheme.

## Part 16 – Interoperability Catalogue Model

This Part defines a framework for creating rules for the interoperation of S-100 data products, including harmonized graphical presentations and handling of alarms and indications. It can be used to establish system specific rules which are contained in an Interoperability Catalogue, a type of meta-product that describes how groups of products are to be used and displayed simultaneously.

## Part 16a – Harmonised Portrayal of S-100 Products

This Part specifies the principles for harmonising portrayal and other presentational functionalities across different S-100 based data products for the purpose of improving the user experience and reducing ambiguities within systems utilising multiple S-100 based data products. It also describes the relevant International Maritime Organization (IMO) guidance and resources within International Hydrographic Organization (IHO) that support efforts in portrayal harmonisation. It does not address the portrayal process, functionality, or architecture, which are addressed in other S-100 Parts (especially Parts 9 and 9A), but instead focuses on presentational design aspects, such as display organisation, colours, and symbology.

## Part 17 – Discovery Metadata for Information Exchange Catalogues

This Part provides a specification for describing and creating Exchange Catalogues that enables users to identify, discover and manage content of the S-100 Exchange Sets. More importantly it leverages XML to allow machine to machine discovery and exchange of information about geographic datasets commonly produced by hydrographic organizations. Its purpose is 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.

For information exchange, there are several categories of metadata required: metadata about the overall Exchange Catalogue; metadata about each of the datasets contained in the Catalogue; and metadata about the support files that make up the package. If the Exchange Catalogue contains any Feature, Portrayal or Interoperability Catalogues there is a provision to carry additional metadata about those.

This Part is intended for developers and implementers of metadata applications, and provides a basic understanding of the principles and the overall requirements for standardisation of geographic information. It should be used in conjunction with the standards listed under clause S-100 Part 4a, clause 4a-4 – Normative references.

## Part 18 – Language Packs

This Part details how multi-lingual support for XML elements of the S-100 framework may be implemented. A generic mechanism and structures are described for production of individual language packs which implement translations of any XML content.

This is designed to provide multi-lingual instances of XML resources which support Product Specifications for provision to end users. Implementing systems are then able to construct translated instances of those supporting resources. This Part is not specific to any one individual class of XML resource. It does not detail how multi-lingual support may be added to S-100 Product Specifications, datasets or any external resources they may reference. It provides a generic mechanism which can be applied to any XML based elements of the S-100 framework to adapt them for multi-lingual implementations.

This Part of S-100 provides the generic methodology for implementing such support; and informative examples for a primary use case, the creation of multi-lingual support for S-100 Feature Catalogues.