S-411

Marine Protected Areas Product Specification

Edition 1.1.0 – December 2024

IHO

International Hydrographic Organization

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Contents

Document History

Changes to this Specification are coordinated by IHO NIPWG. New editions will be made available via the IHO web site. Maintenance of the Specification shall conform to IHO Resolution 2/2007 (as amended).

Table — Document History

Version Number	Date	Approved By	Purpose
1.0.0	April 2014?	S100WG?	Approved edition of S-411
1.1.0	Nov 2024	S100WG	Basic document structure in place tidied up some of the S-102 elements

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1 Overview

1.1 Scope

1.2 References

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1.3 Terms, definitions and abbreviations

1.3.1 Use of language

Within this document:

- “Must” indicates a mandatory requirement.
- “Should” indicates an optional requirement, that is the recommended process to be followed, but is not mandatory.
- “May” means “allowed to” or “could possibly” and is not mandatory.

1.3.2 Terms and definitions

1.3.2.1 Accuracy

Closeness of agreement between a test result and the accepted reference values.

NOTE A test result can be from an observation or measurement.

1.3.2.2 Coordinate

One of a sequence of *n* numbers designating the position of a point in N-dimensional space.

NOTE The numbers must be qualified by units and CRS.

1.3.2.3 Coordinate Reference System

Coordinate system which is related to the real world by a datum.

1.3.2.4 Coverage

Feature that acts as a function to return values from its range for any direct position within its spatial, temporal, or **spatiotemporal domain**.

NOTE In other words, a coverage is a feature that has multiple values for each attribute type, where each direct position within the geometric representation of the feature has a single value for each attribute type.

EXAMPLE: Examples include a digital image, polygon overlay, or digital elevation matrix

1.3.2.5 Coverage Geometry

Configuration of the **domain** of a **coverage** described in terms of **coordinates**.

1.3.2.6 Direct Position

Position described by a single set of **coordinates** within a **coordinate reference system**.

1.3.2.7 Domain

Well-defined set.

NOTE Domains are used to define the domain set and range set of attributes, operators, and functions.

1.3.2.8 Depth

The vertical distance from a given water level to the bottom. In this standard, depth refers to the S-32 definition of “Depth Charted”.

NOTE The numbers must be qualified by units and datum.

1.3.2.9 Feature

Abstraction of real-world phenomena.

NOTE A feature may occur as a type or an instance. Feature type or feature instance should be used when only one is meant.

1.3.2.10 Feature Attribute

Characteristic of a **feature**.

NOTE A feature attribute type has a name, a data type, and a domain associated to it. A feature attribute instance has an attribute value taken from the value domain of the feature attribute type.

1.3.2.11 Function

Rule that associates each element from a **domain** (source, or domain of the function) to a unique element in another domain (target, co-domain, or **range**).

NOTE The range is defined by another domain.

1.3.2.12 Geometric Object

Spatial object representing a set of **direct positions**.

NOTE A geometric object consists of a geometric primitive, a collection of geometric primitives, or a geometric complex treated as a single entity. A geometric object may be the spatial characteristics of an object such as a feature or a significant part of a feature.

1.3.2.13 Grid

Network composed of two or more sets of curves in which the members of each set intersect the members of the other sets in a systematic way.

NOTE The curves partition a space into grid cells.

1.3.2.14 Grid Point

Point located at the intersection of two or more curves in a **grid**.

1.3.2.15 Lidar

An optical remote sensing technique that uses a laser pulse to determine distance.

NOTE Lidar may be used to determine depth in shallow water areas.

1.3.2.16 Navigation Surface

A **coverage** representing the bathymetry and associated uncertainty with the methods by which those objects can be manipulated, combined, and used for a number of tasks, certified for safety of navigation.

1.3.2.17 Range <coverage>

Set of values associated by a **function** with the elements of the **spatiotemporal domain** of a **coverage**.

1.3.2.18 Record

Finite, named collection of related items (objects or values).

NOTE Logically, a record is a set of pairs <name, item >.

1.3.2.19 Rectified Grid

Grid for which there is a linear relationship between the **grid coordinates** and the **coordinates** of an external **coordinate reference system**.

NOTE If the coordinate reference system is related to the earth by a datum, the grid is a georectified grid.

1.3.2.20 Referenceable Grid

Grid associated with a transformation that can be used to convert **grid coordinate** values to values of coordinates referenced to an **external coordinate reference system**.

1.3.2.21 Sonar

A technique that uses sound propagation through water to determine distance, primarily **depth** measurement.

1.3.2.22 Spatiotemporal Domain <coverage>

Domain composed of **geometric objects** described in terms of spatial and/or temporal **coordinates**.

NOTE The spatiotemporal domain of a continuous coverage consists of a set of direct positions defined in relation to a collection of geometric objects.

1.3.2.23 Surface

Connected 2-dimensional geometric primitive, representing the continuous image of a region of a plane.

NOTE The boundary of a surface is the set of oriented, closed curves that delineate the limits of the surface.

1.3.2.24 Uncertainty

The interval (about a given value) that will contain the true value of the measurement at a specific confidence level.

NOTE Errors exist and are the differences between the measured value and the true value. Since the true value is never known it follows that the error itself cannot be known. Uncertainty is a statistical assessment of the likely magnitude of this error. The numbers must be qualified by units.

In this document an S-102 uncertainty is always considered to be 1-dimensional and at the 2-sigma or 95% confidence level.

1.3.2.25 Vector

Quantity having direction as well as magnitude.

NOTE A directed line segment represents a vector if the length and direction of the line segment are equal to the magnitude and direction of the vector. The term vector data refers to data that represents the spatial configuration of features as a set of directed line segments.

1.3.3 Abbreviated terms

This Product Specification adopts the following convention for presentation purposes:

CRS	Coordinate Reference System
DCEG	Data Classification and Encoding Guide
ECDIS	Electronic Chart Display Information System
ENC	Electronic Navigational Chart
EPSG	European Petroleum Survey Group

HDF	Hierarchical Data Format
HSSC	IHO Hydrographic Services and Standards Committee (formerly CHRIS)
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IOGP	International association of Oil and Gas Producers (formerly OGP)
ISO	International Organization for Standardization
MRN	Maritime Resource Name
S-100 WG	S-100 Working Group
S-102 PT	S-102 Project Team
TS	Technical Specification
TSMAD	Transfer Standard Maintenance and Application Development Working Group
UML	Universal Modelling Language
URI	Uniform Resource Identifier
XML	eXtensible Markup Language

1.4 General S-102 data product description

Title Marine Protected Area Product Specification.

Abstract A Marine Protected Area (MPA) is a protected area whose boundaries include an area of the ocean. They include areas of the intertidal or sub-tidal terrain, together with their overlying water and associated flora, fauna, historical and cultural features, which have been reserved by law or other effective means to protect part or all of, the enclosed environment. For example, MPAs may be established to protect fish species, rare habitat area, or entire ecosystems. MPAs can range from, simple declarations to protect a resource, to areas that are extensively regulated. The degree to which environmental regulations affect shipping varies according to whether MPAs are located in territorial waters, exclusive economic zones, or high seas. These limits are regulated by the law of the sea. Most MPAs are located in the territorial waters of coastal states, where enforcement can be ensured. MPAs can also however be established in a state's exclusive economic zone and even within international waters. For example in 1999, Italy, France and Monaco jointly established a cetacean sanctuary in the Ligurian Sea named the Pelagos Sanctuary for Mediterranean Marine Ma

Acronym S-122

Content Datasets conforming to this specification will contain all relevant MPA information for the area of coverage. Additionally there will be relevant metadata data quality, production authority, data sources and publication date.The DCEG provides guidance on how data product content must be captured. Annex A, in addition to [tsf], will provide implementation guidance for developers.

Spatial Extent
Description: Global coverage of maritime areas.
East Bounding Longitude: 180°
West Bounding Longitude: -180°
North Bounding Latitude: 90°
South Bounding Latitude: -90°

Purpose Describing marine protected area information in the maritime domain for utilization in ECDIS, and to allow the producer to exchange marine protected area information with interested stakeholders.

1.5 Product Specification metadata

This information uniquely identifies this Product Specification and provides information about its creation and maintenance. For further information on dataset metadata, see Section 12.

Title	Marine Protected Area Product Specification
S-100 Version	5.2.0
S-122 Version	1.2.1
Date	November 2024
Language	English
Classification	Unclassified
Contact	International Hydrographic Bureau 4 Quai Antoine 1er B.P. 445 MC 98011 MONACO CEDEX Telephone: +377 93 10 81 00 Fax: +377 93 10 81 40 Email: info@iho.int
URL	www.iho.int
Identifier	S-122
Maintenance	Changes to the Product Specification S-122 are coordinated by the IHO NIPWG, and must be made available via the IHO web site. Maintenance of the Product Specification must conform to IHO Resolution 2/2007, as amended.

1.6 IHO Product Specification Maintenance

1.6.1 Introduction

Changes to S-122 will be released by the IHO as a New Edition, revision, or clarification.

1.6.2 New Edition

New Editions of S-122 introduce significant changes. *New Editions* enable new concepts, such as the ability to support new functions or applications, or the introduction of new constructs or data types. *New Editions* are likely to have a significant impact on either existing users or future users of S-122. All cumulative *revisions* and *clarifications* must be included with the release of approved New Editions.

1.6.3 Revision

Revisions are defined as substantive semantic changes to S-122. Typically, *revisions* will change S-122 to correct factual errors; introduce necessary changes that have become evident as a result of practical experience or changing circumstances. A *revision* must not be classified as a clarification. Revisions could have an impact on either existing users or future users of S-122. All cumulative *clarifications* must be included with the release of approved *revisions*.

Changes in a revision are minor and ensure backward compatibility with the previous versions within the same Edition. Newer revisions, for example, introduce new features and attributes. Within the same Edition, a dataset of one version could always be processed with a later version of the Feature and Portrayal Catalogues.

In most cases a new feature or portrayal catalogue will result in a *revision* of S-122.

1.6.4 Clarification

Clarifications are non-substantive changes to S-122. Typically, *clarifications*: remove ambiguity; correct grammatical and spelling errors; amend or update cross references; insert improved graphics in spelling, punctuation and grammar. A *clarification* must not cause any substantive semantic change to S-122.

Changes in a *clarification* are minor and ensure backward compatibility with the previous versions within the same Edition. Within the same Edition, a dataset of one clarification version could always be processed with a later version of the Feature and Portrayal Catalogues, and a Portrayal Catalogue can always rely on earlier versions of the Feature Catalogue.

1.6.5 Version Numbers

The associated version control numbering to identify changes (n) to S-122 must be as follows:

New Editions denoted as **n**.0.0

Revisions denoted as n.**n**.0

Clarifications denoted as n.n.**n**

2 Specification Scope

This product specification defines only one general scope which applies to all its sections.

Scope Identification	GeneralScope

3 Data Product Identification

Title	Marine Protected Areas
Alternate Title	None
Abstract	
Topic Category	Main topics for the product, as according to ISO 19115-1:2014/Amd 1:2018 MD_TopicCategoryCode: 006 — elevation 014 — oceans 012 — inlandWaters
Geographic Description	Areas specific to marine navigation.
Spatial Resolution	…
Purpose	…n.
Language	English (Mandatory), other (Optional)
Classification	Data can be classified as one of the following: 1) Unclassified; 2) Restricted; 3) Confidential; 4) Secret; 5) Top Secret; 6) Sensitive but unclassified; 7) For official use only; 8) Protected; 9) Limited distribution

Spatial Representation Type	Type of spatial representation for the product, as defined by the ISO 19115-1:2014/Amd 1:2018 MD_SpatialRepresentationTypeCode: XXX — XXX.
Point of Contact	Producing Agency

4 Data Content and Structure

4.1 Introduction

intro here.

4.2 Application Schema

4.2.1 Application Schema implementation classes

4.2.1.1 Implementation classes description

4.3 Feature Catalogue

4.3.1 Introduction

4.3.2 Feature types

4.3.2.1 Geographic

4.3.2.2 Meta

4.3.3 Feature relationship

4.3.4 Attributes

4.3.4.1 Simple attributes

4.3.4.2 Complex attributes

4.4 Dataset types

4.4.1 Introduction

4.5 Geometry

5 Coordinate Reference Systems (CRS)

5.1 Introduction

The Coordinate Reference System information contained in [tab-s102-coordinate-reference-systems-epsg-codes] is defined in the manner specified in S-100, Part 6. The vertical datum is specified separately using other root group attributes.

5.2 Horizontal Coordinate Reference System

Table 5-1 — S-4111 Coordinate Reference Systems (EPSG Codes)

EPSG Code	Coordinate Reference System
4326	WGS84
32601 — 32660	WGS 84 / UTM Zone 1N to Zone 60N
32701 — 32760	WGS 84 / UTM Zone 1S to Zone 60S
5041	WGS 84 / UPS North (E,N)
5042	WGS 84 / UPS South (E,N)
The full reference to EPSG can be found at https://epsg.org.	

Horizontal Coordinate Reference System	EPSG (see [tab-s102-coordinate-reference-systems-epsg-codes])
Projection	NONE/UTM/UPS
Temporal reference system	Gregorian Calendar
Coordinate Reference System registry	EPSG Geodetic Parameter Dataset
Date type (according to ISO 19115-1:2014/Amd 1:2018)	002 — publication
Responsible party	International Association of Oil & Gas Producers (IOGP)
URL	https://www.iogp.org/

5.3 Vertical Coordinate Reference System

Although in this product there are no direct vertical coordinates the values of the depth attributes are indirectly such coordinates. Therefore, it is important to specify the vertical CRS to which these values conform. The vertical CRS is an earth gravity-based, one-axis coordinate system. The Orientation of the axis is defined by the vertical coordinate system attribute (*verticalCS*) in the root group (see [tab-root-group-attributes]).

The vertical datum must be taken from the code-list specified by the IHO Geospatial Information (GI) Registry for the attribute named *Vertical Datum*. It will be defined in the root group as an HDF5 attribute (see [tab-root-group-attributes]).

5.4 Temporal reference system

The temporal reference system is the Gregorian calendar for date and UTC for time. Time is measured by reference to Calendar dates and Clock time in accordance with ISO 8601:2004, Clause 5.4.4. A date-time variable will have the following 16-character format: *yyyymmddThhmmssZ*.

6 Data Quality

Data quality allows users and user systems to assess fitness for use of the provided data. Data quality measures and the associated evaluation are reported as metadata of a data product. This metadata improves interoperability with other data products and provides usage by user groups that the data product was not originally intended for. The secondary users can make assessments of the data product usefulness in their application based on the reported data quality measures.

6.1 Completeness

6.1.1 Commission

Commission is applicable for S-102. Data Producers must verify that no excess items have been included in the dataset. Such excess items include duplicate items, which must be removed.

If no excess items are present, the dataset PASSES this test.

6.1.2 Omission

Omission is applicable for S-102. Data Producers must verify that no items that should have been included in the dataset have been omitted.

If no necessary items have been omitted, the dataset PASSES this test.

6.2 Logical consistency

6.2.1 Conceptual consistency

Conceptual Consistency is applicable for S-411 and follows the guidelines from S-100, Part 1.

Data Producers must verify that the dataset conforms to the S-100 General Feature Model.

If the dataset conforms to the S-100 General Feature Model, the dataset PASSES this test.

6.2.2 Domain consistency

Domain consistency is applicable for S-411 and follows the guidelines from S-100, Part 5.

Data Producers must verify that the dataset conforms to the S-102 Feature Catalogue and to Annex A.

If the dataset conforms to the S-411 Feature Catalogue and to Annex A, the dataset PASSES this test.

6.2.3 Format consistency

Format Consistency is applicable for S-411 and follows the guidelines from S-100, Part 10c.

Data Producers must verify that the dataset conforms to Section 10 of this Product Specification.

If the dataset conforms to Section 10, the dataset PASSES this test.

6.3 Positional accuracy

6.3.1 Gridded data positional accuracy

6.3.2 Relative internal positional accuracy

6.4 Temporal accuracy

6.5 Thematic accuracy

6.5.1 Thematic classification correctness

6.5.2 Non-quantitative attribute accuracy

6.5.3 Quantitative attribute accuracy

As defined in S-100, Part 4c the data quality for the depth coverage is also defined as a co-located optional coverage, which is the uncertainty. This value particularly refers to the vertical uncertainty at each grid point. The uncertainty coverage supports multiple definitions of vertical uncertainty.

See [tab-codes-defining-how-bathy-depth-uncertainty-determined].

7 Data Capture and Classification

The DCEG describes how data describing the real world should be captured using the types defined in the S-411 Feature Catalogue. The DCEG is located at Annex A.

8 Data Maintenance

8.1 Maintenance and update frequency

Datasets are maintained by replacement on a dataset basis.

8.2 Data source

Data producers must use applicable sources to maintain and update data and provide a brief description of the sources that were used to produce the dataset.

8.3 Production process

Data Producers should follow their established production processes for maintaining and updating datasets.

9 Portrayal

9.1 Introduction

9.2 Portrayal Catalogue

10 Data Product Format (Encoding)

10.1 Introduction

The S-411 data set must be encoded using the Geographical Markup Language (GML).

10.2 Product structure

11 Data Product Delivery

11.1 Introduction

This clause describes how S-411 data will be delivered from the charting authority to the mariner.

Units of Delivery	Exchange Set
Transfer Size	See Clause 11.2.2.
Medium Name	Digital Data Delivery

Other Delivery Information

Each dataset must be contained in a physically separate, uniquely identified file on the transfer medium.

Each exchange set has a single exchange catalogue which contains the discovery metadata for each dataset.

An exchange set is encapsulated into a form suitable for transmission by a mapping called an encoding. An encoding translates each of the elements of the exchange set into a logical form suitable for writing to media and for transmission online. An encoding may also define other elements in addition to the exchange set contents (This is media identification, data extents etc. …) and may define commercial constructs such as encryption and compression methods.

If the data is transformed in S-411 it must not be changed.

This Product Specification defines the encoding which must be used as a default for transmission of data between parties.

The encoding encapsulates exchange set elements as follows:

Mandatory Elements

- S-411 datasets — HDF encoding
- Exchange Catalogue — the XML encoded representation of exchange set catalogue features [discovery metadata].

Optional Elements

- S-411 Feature Catalogue — If it is necessary to deliver the latest Feature Catalogue to the end user it may be done using the S-411 exchange set mechanism for datasets
- S-411 Portrayal Catalogue — If it is necessary to deliver the latest Portrayal Catalogue to the end user it may be done using the S-411 exchange set mechanism for datasets.

11.2 Dataset

11.2.1 Dataset management

11.2.2 Dataset size

11.2.3 Dataset file naming

Dataset naming must follow a standard pattern to give implementers greater predictability of incoming datasets (see S-100, Part 17, Clause 4.3). S-411 dataset naming conventions must follow these rules.

411YYYYØØØØØØØØØØØØ.GML

411	the first 3 characters identify the dataset as an S-411 dataset (mandatory).
YYYY	the fourth to seventh characters identify the producer code according to the Producer Code Register.
ØØØØ	the eighth to the maximum nineteenth characters are optional and may be used in any way by the producer to provide the unique file name. The following characters are allowed in the dataset name: A to Z, 0 to 9 and the special character _ (underscore).
GML	denotes an HDF5 file.

11.3 Exchange Set

The structure of an S-411 Exchange Set must be according to the structure described below, which is based on S-100, Part 17, Clause 4.2.

1) An S-411 Exchange Set must contain an Exchange Set Catalogue, CATALOG.XML, its digital signature CATALOG.SIGN, and may contain any number of S-411 conformant dataset files, support files, and Catalogue files.
2) All content must be placed inside a top root folder named S100_ROOT. This is the only top level root folder in an Exchange Set containing only S-100 products.
3) The S100_ROOT folder must contain a subfolder named S-411. This subfolder holds content specific to the S-411 Product Specification.
4) The S-411 subfolder must contain subfolders for the component dataset files (DATASET_FILES) and Catalogues (CATALOGUES) as required.
5) The required Exchange Set Catalogue XML document instance must be named CATALOG.XML and placed in the S100_ROOT folder, together with its digital signature (CATALOG.SIGN) file. All other digital signatures are included within their corresponding resource metadata records in the CATALOG.XML.

11.4 Exchange Catalogue

The Exchange Catalogue acts as the table of contents for the Exchange Set. The Catalogue file of the Exchange Set must be named CATALOG.XML. No other file in the Exchange Set may be named CATALOG.XML. The contents of the Exchange Catalogue are described in Section 12.

11.5 Data integrity and encryption

S-100, Part 15 defines the algorithms for compressing, encrypting and digitally signing datasets based on the S-100 Data Model. The individual Product Specifications provide details about which of the elements are being used and on which files in the dataset.

11.5.1 Use of compression

The data producer decides if compression will be used on the S-411 product files (HDF5). It is expected that a hydrographic office will make a policy decision and that all the S-411 datasets from the producer will be either compressed or uncompressed.

It is recommended to compress all the dataset files, for example HDF5 files. The ZIP compression method defined in S-100, Part 15, Clause 5.2 must be applied to the product files.

11.5.2 Use of data protection

It is recommended to encrypt all the dataset files, for example HDF5. The encryption method defined in S-100, Part 15 must be applied.

11.5.3 Use of digital signatures

Digital signatures shall be used on all files included in a S-411 compliant Exchange Set to meet the requirements of IMO resolution MSC.428(98) to reduce cyber security risks among users, especially when used in navigations systems at sea. The recommended signature method is defined in S-100, Part 15.

The digital signature information is encoded in the corresponding discovery block in the exchange catalogue for each file included in the Exchange Set.

12 Metadata

12.1 Introduction

The Metadata elements used in the Bathymetric Surface product are derived from S-100 and from ISO 19115-1:2014/Amd 1:2018 and ISO 19115-2:2009. Optionally additional metadata may be derived from ISO/TS 19130:2010 and ISO/TS 19130-2:2014 especially metadata relating to the sonar equipment which may have been used to acquire the bathymetric data.

Metadata used for the discovery, identification, and use of S-411 datasets in S-100-based navigations systems (specifically, an S-100-capable ECDIS) is encoded in the exchange catalogue. This metadata conforms to S-100 Part 17, with product-specific restrictions added.

12.2 Exchange Set metadata

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.

Figure 12-1 depicts the relationships of exchange set elements (datasets and feature/portrayal catalogues) and exchange set metadata. This figure is derived from S-100, Part 17, Figure 2 with relationships not applicable to S-411 omitted.

Figure 12-2 depicts the structure of the exchange catalogue and its component discovery metadata blocks. The structure is the same as in S-100, Part 17.

More detailed information about the various classes is shown in Figure 12-3 with further description in Table 12-1 to Clause 12.8.2. In the cases in which classes are used without modification, refer to S-100, Part 17 for their descriptions.

The discovery metadata classes have numerous attributes which enable important information about the datasets to be examined without the need to process the data (e.g., decryption, decompression, loading). Other Catalogues can be included in the Exchange Set in support of the datasets such as Feature and Portrayal.

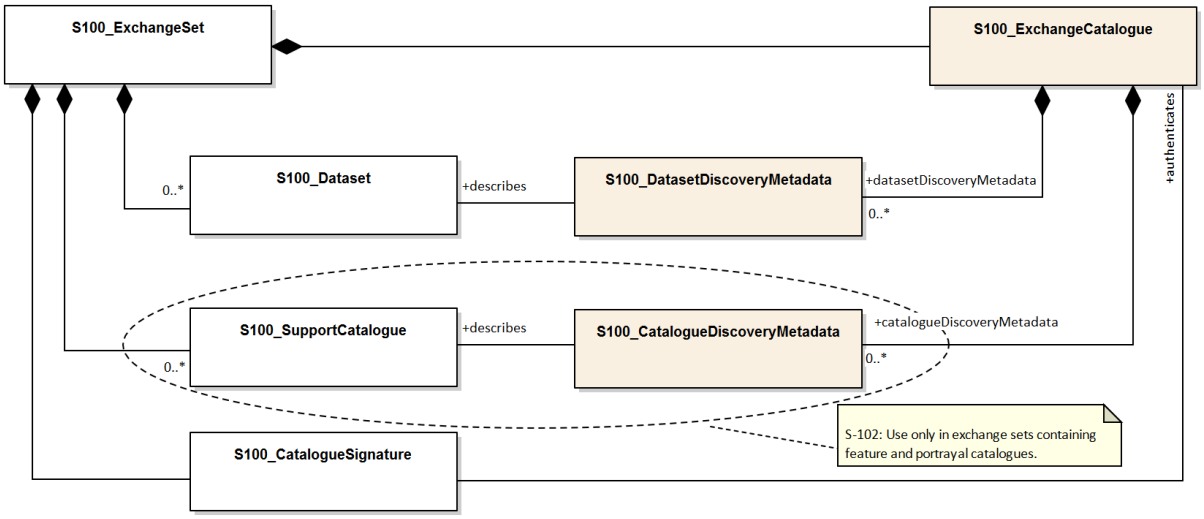

Figure 12-1 — Components and associated metadata for the S-411 exchange set (S-100, Part 17, Figure 2 with items not used by S-411 omitted)

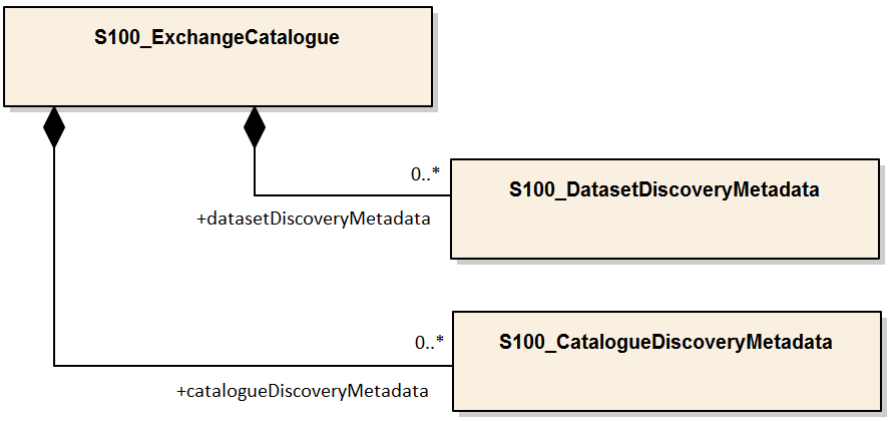

Figure 12-2 — Relationship between exchange catalogue, discovery metadata, and dataset (S-100, Part 17, Figure 6 with items not used by S-411 omitted)

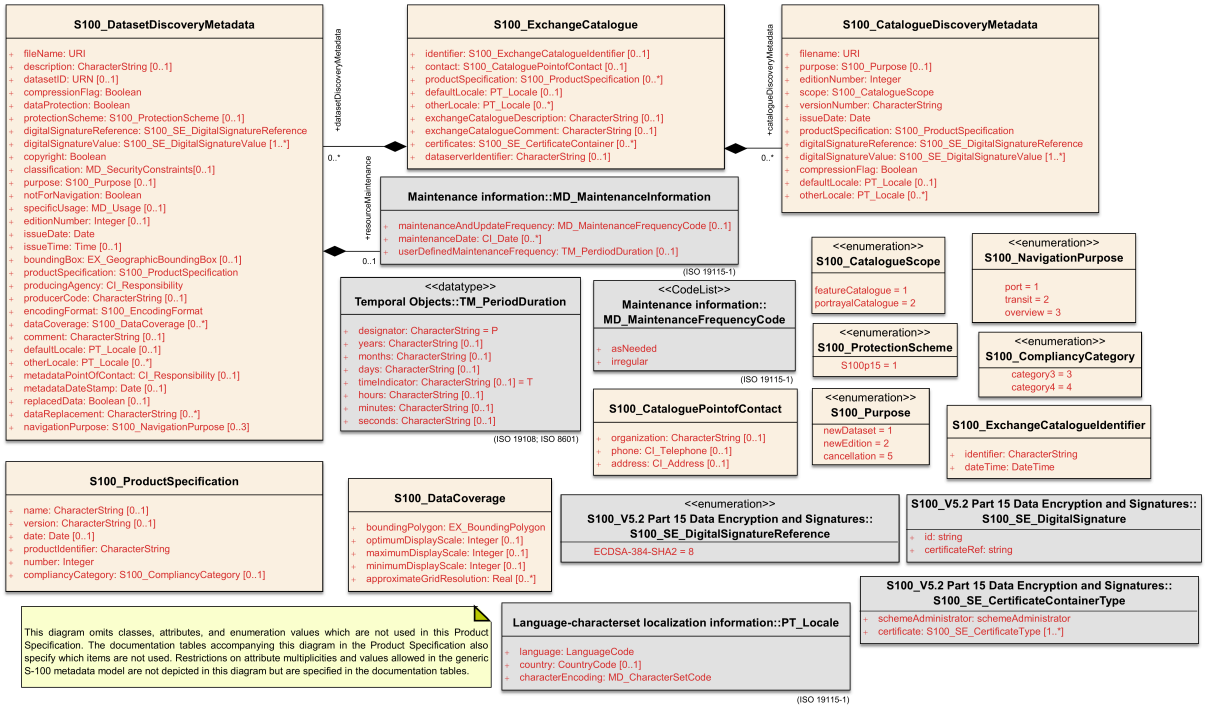

Figure 12-3 — S-411 Exchange Set Class Details (S-100, Part 17, Figure 7 with items not used by S-411 omitted)

The following clauses define the mandatory and optional metadata needed for S-411. In some cases, the metadata may be repeated in a national language. If this is the case it is noted in the Remarks column.

The XML schemas for S-411 exchange catalogues will be available from the IHO Geospatial Information (GI) Registry and/or the S-100 GitHub site (https://github.com/IHO-S100WG).

The S-411 exchange catalogue uses the S-100 exchange catalogue schemas which are available from the S-100 schema server at https://schemas.s100dev.net (downloadable archives are also available on the site for offline use). Implementation of the S-411-specific constraints described in following clauses below is left to developer decision as it can be done in various ways depending on implementation frameworks and the requirements of production or application software.

12.3 Language

The exchange language must be English.

Character strings must be encoded using the character set defined in ISO/IEC 10646-1:2000, in Unicode Transformation Format-8 (UTF-8). A BOM (byte order mark) must not be used.

12.4 S100_ExchangeCatalogue

Each Exchange Set has a single S100_ExchangeCatalogue which contains meta information for the data in the Exchange Set.

S-411 uses S100_ExchangeCatalogue without modification.

12.4.1 S100_ExchangeCatalogueIdentifier

S-411 uses S100_ExchangeCatalogueIdentifier without modification.

12.4.2 S100_CataloguePointOfContact

S-411 uses S100_CataloguePointOfContact without modification.

12.5 S100_DatasetDiscoveryMetadata

Dataset discovery metadata in S-411 restricts certain attributes and roles as described in Table 12-1. Optional S-100 attributes which are mandatory in S-411 are indicated in the Remarks column.

Table 12-1 — S100_DatasetDiscoveryMetadata parameters

Role name	Name	Description	Mult	Type	Remarks
Class	S100_ DatasetDiscoveryMetadata	Metadata about the individual datasets in the Exchange Catalogue	-	-	**The optional S-100 attributes *updateNumber*, *updateApplicationDate*, *referenceID*, and *temporalExtent* are not used in S-411.** **References to support file discovery metadata are not permitted because S-411 does not use support files.**
Attribute	fileName	Dataset file name	1	URI	See S-100, Part 1, Clause 4.6 **Format: file:/S-411/DATASET_FILES/<dsname>** **Dataset file name <dsname> must be according to format defined in Clause 11.2.3.**
Attribute	datasetID	Dataset ID expressed as a Maritime Resource Name	0..1	URN	The URN must be an MRN. **See S-100, Part 3, Clause 10**
Attribute	editionNumber	The edition number of the dataset	**1**	Integer	When a data set is initially created, the Edition number 1 is assigned to it. The Edition number is increased by 1 at each new Edition. Edition number remains the same for a re-issue.

Role name	Name	Description	Mult	Type	Remarks
					Mandatory in S-411
Attribute	issueDate	Date on which the data was made available by the Data Producer	1	Date	-
Attribute	issueTime	Time of day at which the data was made available by the Data Producer	0..1	Time	The S-100 datatype Time **May be required if multiple instances of a product are issued on the same day.**
Attribute	boundingBox	The extent of the dataset limits	**1**	EX_ GeographicBoundingBox	**Mandatory in S-411** **Defined as a rectangle coincident with the outermost cell boundaries of the dataset.**
Attribute	productSpecification	The Product Specification used to create this dataset	1	S100_ ProductSpecification	**Table 12-5**
Attribute	producingAgency	Agency responsible for producing the data	1	CI_Responsibility>CI_ Organisation	See S-100, Part 17, Table 17–3
Attribute	producerCode	The official IHO Producer Code from S-62	1	CharacterString	**Mandatory in S-411**
Attribute	encodingFormat	The encoding format of the dataset	1	S100_EncodingFormat	**The only allowed value is GML** **Table 12-4**
Attribute	dataCoverage	Provides information about data coverages within the dataset	**1**..*	S100_DataCoverage	**Mandatory in S-411** **Table 12-2**
Attribute	comment	Any additional information	0..1	CharacterString	-
Attribute	defaultLocale	Default language and character set used in the dataset	0..1	PT_Locale	In absence of defaultLocale, the language is English, and the character set is UTF-8.
Attribute	otherLocale	Other languages and character sets used in the dataset	0..*	PT_Locale	
Attribute	metadataPointOfContact	Point of contact for metadata	0..1	CI_Responsibility>CI_ Individual	Only if metadataPointOfContact differs from producingAgency

Role name	Name	Description	Mult	Type	Remarks
				or CI_Responsibility>CI_ Organisation	
Attribute	metadataDateStamp	Date stamp for metadata	0..1	Date	May or may not be the issue date
Attribute	replacedData	Indicates if a cancelled dataset is replaced by another data file(s)	0..1	Boolean	See note following S-100, Part 17, Table S100_ DatasetDiscoveryMetadata **Mandatory when purpose = cancellation**
Attribute	dataReplacement	Dataset name	0..*	CharacterString	A dataset may be replaced by 1 or more datasets. **Dataset name must be according to format defined in Clause 11.2.3.** **For example, *411DE00KD54.GML*** See note following S-100, Part 17, Table S100_ DatasetDiscoveryMetadata **Mandatory when replacedData = true**
Attribute	navigationPurpose	Classification of intended navigation purpose (for Catalogue indexing purposes)	**1**..3	S100_NavigationPurpose	If Product Specification is intended for creation of navigational products, this attribute should be mandatory. **Mandatory in S-411**

12.5.1 S100_NavigationPurpose

S-411 uses S100_NavigationPurpose without modification.

12.5.2 S100_DataCoverage

S-411 uses S100_DataCoverage without modification, but with additional remarks and changes to the multiplicity.

Table 12-2 — S100_DataCoverage parameters

Role name	Name	Description	Mult	Type	Remarks
Class	S100_DataCoverage	A spatial extent where data is provided along with the display scale information for the provided data	-	-	This field is used by user systems as part of the data loading and unloading algorithms, and it is strongly encouraged that Product Specifications mandate the use of one or more of the displayScale provided as part of S100_DataCoverage.

Role name	Name	Description	Mult	Type	Remarks
Attribute	boundingPolygon	A polygon which defines the actual data limit	1	EX_ BoundingPolygon	Clause 12.5.2, Note
Attribute	temporalExtent	Specification of the temporal extent of the coverage	**0**	S100_ TemporalExtent	**The *temporalExtent* is not used in S-411.**
Attribute	optimumDisplayScale	The scale at which the data is optimally displayed	0..1	Integer	Example: A scale of 1:25000 is encoded as 25000
Attribute	maximumDisplayScale	The maximum scale at which the data is displayed	0..1	Integer	
Attribute	minimumDisplayScale	The minimum scale at which the data is displayed	0..1	Integer	
NOTE *boundingPolygon* is restricted to a single GML Polygon with one exterior and 0 or more interiors expressed as Linear Rings using SRS EPSG:4326. The exterior and optional interiors shall be composed of a closed sequence of >=4 coordinate positions expressed individually or as a list (posList). The GML polygon shall have a valid GML identifier.					

12.5.3 S100_Purpose

S-411 uses S100_Purpose without modification, but with a restriction on the allowed values.

Table 12-3 — S100_Purpose

Role name	Name	Description	Code	Remarks
Enumeration	S100_Purpose	The purpose of the dataset	-	**The S-100 values *update*, *reissue*, and *delta* are not used in S-411.**
Value	newDataset	Brand new dataset	1	No data has previously been produced for this area.
Value	newEdition	New edition of the dataset or Catalogue	2	Includes new information which has not been previously distributed by updates.
Value	cancellation	Dataset or Catalogue that has been cancelled	5	Indicates the dataset or Catalogue should no longer be used and can be deleted.

12.5.4 S100_EncodingFormat

S-411 uses S100_EncodingFormat with a restriction on the allowed values to permit only the S-100 GML format for S-411 datasets.

Table 12-4 — S100_EncodingFormat parameters

Role name	Name	Description	Code	Remarks
Enumeration	S100_EncodingFormat	The encoding format	-	**The only value allowed in S-411 is "GML".**
Value	HDF5	The HDF5 data format as defined in S-100, Part 10c	3	-

12.5.5 S100_ProductSpecification

S-411 uses S100_ProductSpecification without modification, but with additional remarks and changes to the multiplicity.

Table 12-5 — S100_ProductSpecification parameters

Role name	Name	Description	Mult	Type	Remarks
Class	S100_ ProductSpecification	The Product Specification contains the information needed to build the specified product.	-	-	-
Attribute	name	The name of the Product Specification used to create the datasets	**1**	CharacterString	The name in the GI Registry should be used for this field. **For S-411, this name is "Bathymetric Surface" (as of 25 June 2024).**
Attribute	version	The version number of the Product Specification	**1**	CharacterString	TR 2/2007 specifies versioning of Product Specifications **Example: 3.0.0 for S-411 Edition 3.0.0**
Attribute	date	The version date of the Product Specification	**1**	Date	-
Attribute	productIdentifier	Machine readable unique identifier of a product type	1	CharacterString (Restricted to Product ID values from the IHO Product Specification Register in the IHO Geospatial Information (GI) Registry)	**For S-411, this identifier is "S-411" (without quotes).**
Attribute	number	The number used to lookup the product in the Product Specification Register of the IHO GI registry	1	Integer	For IHO Product Specifications, these numbers should be taken from the IHO Product Specification Register in the IHO GI Registry.

Role name	Name	Description	Mult	Type	Remarks
					The corresponding Idx-number of the IHO Registry for S-411 is numbered 199.
Attribute	compliancyCategory	The level of compliance of the Product Specification to S-100	0..1	S100_CompliancyCategory	See S-100, Part 4a, Clause 4a–5.5 **and Clause 12.5.6 below.**

12.5.6 S100_CompliancyCategory

S-411 exchange sets conforming to this edition of S-411 and using a CRS from the EPSG registry may be encoded as category 3 or 4 when the *compliancyCategory* metadata attribute is populated. Because S-98 interoperability assumes *category4* datasets, *category4* may be used for test purposes, though the absence of test datasets and of a published IHO interoperability catalogue mean this edition of S-411 does not yet qualify for *category4*. **Given the uncertainty about interoperability testing requirements and availability of test datasets, the S-100 WG chair and S-411 PT chair should be consulted for up-to-date guidance.**

Table 12-6 — S100_CompliancyCategory

Role Name	Name	Description	Code	Remarks
Enumeration	S100_ CompliancyCategory	-	-	**S-411 should use *category3* or *category4*, subject to the guidance provided in Clause 12.5.6.**
Value	category3	IHO S-100 compliant with standard encoding	3	**Qualifies as *category2*; plus "The Product Specification uses only an encoding method defined in S-100, Part 10 and Part 4a, Clause 5.5.3"**
Value	category4	IHO S-100 and IMO harmonized display compliant	4	**Qualifies as *category3*; plus additional requirements, including a portrayal catalogue, cybersecurity (digital signatures and encryption), test material, use of a CRS from the EPSG Registry, and compliance with the IHO S-98 interoperability catalogue. S-100, Part 4a, Clause 5.5.4**

12.5.7 S100_ProtectionScheme

S-411 uses S100_ProtectionScheme without modification.

12.6 MD_MaintenanceInformation

S-411 uses MD_MaintenanceInformation without modification.

12.7 MD_MaintenanceFrequencyCode

S-411 uses MD_MaintenanceFrequencyCode without modification.

12.8 S100_CatalogueDiscoveryMetadata

S-411 uses S100_CatalogueDiscoveryMetadata without modification.

12.8.1 S100_CatalogueScope

S-411 uses S100_CatalogueScope without modification.

12.8.2 PT_Locale

S-411 uses PT_Locale without modification. The class PT_Locale is defined in ISO 19115-1:2014/Amd 1:2018. LanguageCode, CountryCode, and MD_CharacterSetCode are ISO codelists which are defined in a codelists file which is part of the S-100 Edition 5.2.0 schema distribution.

12.9 Certificates and Digital Signatures

The classes S100_SE_CertificateContainerType (S-100, Part 15, Clause 8.11.1), S100_SE_DigitalSignatureReference (S-100, Part 15, Clause 8.11.7), and S100_SE_DigitalSignature are defined in S-100, Part 15 and implemented in the S-100 generic schemas.

In accordance with S-100, Part 15, only the ECDSA algorithm is allowed from the S100_SE_DigitalSignatureReference enumeration.

S-411 uses S100_SE_DigitalSignature without modification. As stated in S-100, Part 15, Clause 15–8.11.3:

“The class S100_SE_DigitalSignature is realized as one of either S100_SE_SignatureOnData (a digital signature of a particular identified resource) or an additional digital signature defined using the class S100_SE_AdditionalSignature, each of which is either a S100_SE_SignatureOnData or S100_SE_SignatureOnSignature element as described in S-100, Part 15, Clause 8.8. S-100, Part 17 metadata thus allows for multiple digital signatures, a single mandatory S100_SE_SignatureOnData and any number of additional signatures, either of the data or other signatures.”

Annex A
Data Classification and Encoding Guide

A.1 Features

A.1.1 BathymetryCoverage

Table A-1 — BathymetryCoverage feature parameters

Term: Bathymetry Coverage			
IHO Definition: A set of value items required to define a dataset representing a depth calculation and its associated uncertainty.			
Primitive: S100_IF_GridCoverage			
Attribute	**Allowable Encoding Value**	**Type**	**Multiplicity**
depth	Must be in decimal metres with resolution not to exceed 0.01 metres	real (32-bit Float)	1
uncertainty	Must be in decimal metres with resolution not to exceed 0.01 metres	real (32-bit Float)	0..1

A.1.2 QualityOfBathymetryCoverage

Table A-2 — QualityOfBathymetryCoverage feature parameters

Term: Quality Of Bathymetry Coverage.			
IHO Definition: A set of references to value records that provide localised information about depth, uncertainties, and bathymetry coverage metadata.			
Primitive: S100_IF_GridCoverage			
Attribute	**Constraint**	**Type**	**Multiplicity**
iD	Each record must have a unique identifier.	unsigned 32-bit Integer	1

A.2 Feature Attributes

A.2.1 BathymetryCoverage

Table A-3 — BathymetryCoverage feature attribute parameters

IHO Definition: **depth**. The vertical distance from a given water level to the bottom [S-32].
Unit: metres
Resolution: 0.01
Remarks: • Drying heights (drying depths) are indicated by a negative value.
IHO Definition: **uncertainty**. Estimate characterising the range of values within which the true value of a measurement is expected to lie as defined within a particular confidence level. It is expressed as a positive value.
Unit: metres
Resolution: 0.01
Remarks:

- Represents a +/- value defining the possible range of associated depth.
- Expressed as a positive number.

A.2.2 QualityOfBathymetryCoverage

Table A-4 — QualityOfBathymetryCoverage feature attribute parameters

IHO Definition: **iD**. Meta data record identifier for QualityOfBathymetryCoverage
Unit:
Resolution:
Remarks: