S-412

Ice Information Product Specification

Edition 2.0.0 – January 2025

IHO

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Document History

Changes to this Specification are coordinated by WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM). New editions will be made available via the IHO web site.

Version Number	Date	Approved By	Purpose
2.0.0	25 October 2025	IIC Technologies	Initial Population of document skeleton

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1 Overview

1.1 Introduction

1.2 Scope

1.3 References

1.4 References

[1] S-100 edition 5.2.0: IHO Universal Hydrographic Data Model, International Hydrographic Organization (https://iho.int/uploads/user/pubs/standards/s-100/S-100_5.2.0_Final_Clean.pdf).

[2] S-44 edition 5.0.0: IHO Standards for Hydrographic Surveys, International Hydrographic Organization (https://iho.int/uploads/user/pubs/standards/s-44/S-44_5E.pdf).

[3] S-4 edition 4.8.0: Regulations for International (INT) Charts and Chart Specifications of the IHO, International Hydrographic Organization (https://iho.int/uploads/user/pubs/standards/s-4/S4_V4-8-0_Oct_2018_EN.pdf).

[4] S-32 edition 1.0.0: Hydrographic Dictionary — Glossary of ECDIS Related Terms, International Hydrographic Organization (https://portal.iho.int/iho-ohi/S32/).

[5] ISO 8601:2004: Data elements and interchange formats — Information interchange — Representation of dates and times, International Organization for Standardization (https://www.iso.org/standard/40874.html).

[6] ISO 19103:2015: Geographic information — Conceptual schema language, International Organization for Standardization (https://www.iso.org/standard/56734.html).

[7] ISO 19111:2007: Geographic information — Spatial referencing by coordinates, International Organization for Standardization (https://www.iso.org/standard/41126.html).

[8] ISO 19115-1:2014/Amd 1:2018: Geographic information — Metadata — Part 1: Fundamentals — Amendment 1, International Organization for Standardization (https://www.iso.org/standard/73118.html).

[9] ISO 19115-2:2009: Geographic information — Metadata — Part 2: Extensions for imagery and gridded data, International Organization for Standardization (https://www.iso.org/standard/39229.html).

[10] ISO/TS 19115-3:2016: Geographic information — Metadata — Part 3: XML schema implementation for fundamental concepts, International Organization for Standardization (https://www.iso.org/standard/32579.html).

1.4.1 Normative

GML OpenGIS® *Geography Markup Language (GML) Encoding Standard* (Version 3.2.1)

S-97 *IHO Guidelines for Creating S-100 Product Specifications*, Edition 1.1.0, June 2020.

S-100 *IHO Universal Hydrographic Data Model*, Edition 5.2.0, June 2024

WMO-No. 574 *Sea-ice Information and Services*, 2024 edition

1.4.2 Informative

ISO 19101 *Geographic Information – Reference Model*, 2003

ISO 19103 *Geographic Information – Conceptual Schema Language*, 2005

ISO 19103-2 *Geographic Information – Conceptual Schema Language – Part 2*, 2005

ISO 19109 *Geographic Information – Rules for Application Schema*, 2005

ISO 19110 *Geographic Information – Methodology for Feature Cataloguing*, 2005

ISO 19111 *Geographic Information – Spatial Referencing by Coordinates*, 2007

ISO 19115-1 *Geographic information — Metadata — Part 1: Fundamentals* — 2014/Amd 1: 2018

ISO 19115-3 *Geographic information — Metadata — Part 3: XML Schema implementation for fundamental concepts* — 2016

ISO 19117 *Geographic Information – Portrayal*, 2012

ISO 19131 *Geographic Information – Data Product Specifications*, 2008

ISO 19139-1 *Geographic information — XML schema implementation — Part 1: Encoding rules* — 2019

MANICE *Manual of Standard Procedures for Observing and Reporting Ice Conditions*, Meteorological Service of Canada, 2005

1.5 Terms, definitions and abbreviations

1.5.1 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.

1.5.2 Terms and definitions

Application Schema

Conceptual schema for data required by one or more applications.

Attribute

(1) Named property of an entity.

NOTE Describes a geometrical, thematic, or other characteristic of an entity.

(2) Feature within a classifier that describes a range of values that instances of the classifier may hold.

NOTE An attribute is semantically equivalent to a composition association; however, the intent and usage is normally different.

NOTE “Feature” used in this definition is the UML meaning of the term.

Boundary

Set that represents the limit of an entity.

NOTE Boundary is most commonly used in the context of geometry, where the set is a collection of points or a collection of objects that represent those points.

Coordinate

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

NOTE In a **coordinate reference system**, the coordinate numbers are qualified by units.

Coordinate Reference System

Coordinate system which is related to an object by a datum.

Curve

1-dimensional geometric primitive, representing the continuous image of a line.

NOTE The boundary of a curve is the set of points at either end of the curve. If the curve is a cycle, the two ends are identical, and the curve (if topologically closed) is considered to not have a boundary. The first point is called the start point, and the last is the end point. Connectivity of the curve is guaranteed by the “continuous image of a line” clause. A topological theorem states that a continuous image of a connected set is connected.

Data Quality

A set of elements describing aspects of quality, including a measure of quality, an evaluation procedure, a quality result, and a scope.

Data Type

Specification of a value domain with operations allowed on values in this domain.

NOTE Data types include primitive predefined types and user-definable types.

NOTE A data type is identified by a term, for example Integer.

Dataset

An identifiable collection of data.

NOTE A dataset may be a smaller grouping of data which, though limited by some constraint such as spatial extent or feature type, is located physically within a larger dataset. Theoretically, a dataset may be as small as a single feature contained within a larger dataset. A hardcopy map or chart may be considered a dataset.

Datum

Parameter or set of parameters that define the position of the origin, the scale, and the orientation of a **coordinate** system.

ECDIS

A navigation information system which with adequate back-up arrangements can be accepted as complying with the up-to-date chart required by regulations V/19 and V/27 of the 1974 SOLAS Convention, as amended, by displaying selected information from a System Electronic Navigational Chart (System Database) with positional information from navigation sensors to assist the Mariner in route planning and route monitoring, and if required display additional navigation-related information.

Enumeration

A fixed list of valid identifiers of named literal values. Attributes of an enumerated type may only take values from this list.

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.

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.

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.

Feature Catalogue

A catalogue containing definitions and descriptions of the **feature** types, **feature attributes** occurring in one or more sets of geographic data.

Geometric Primitive

Geometric object representing a single, connected, homogeneous element of geometry.

NOTE Geometric primitives are non-decomposed objects that present information about geometric configuration. They include points, curves and surfaces.

Multiplicity

Specification of the number of possible occurrences of a property, or the number of allowable elements that may participate in a given relationship.

EXAMPLES: 1..* (one to many); 1 (exactly one); 0..1 (zero or one)

Point

0-dimensional geometric primitive, representing a position.

NOTE The boundary of a point is the empty set.

Portrayal Catalogue

Collection of defined portrayals for a feature catalogue.

NOTE Content of a portrayal catalogue includes portrayal functions, symbols, and portrayal context.

1.5.3 Abbreviated terms

This Product Specification adopts the following convention for presentation purposes:

BSH	Bundesamt für Seeschifffahrt und Hydrographie (Germany)
CRS	Coordinate Reference System
ECDIS	Electronic Chart Display and Information System
ENC	Electronic Navigational Chart
EPSG	European Petroleum Survey Group
ETSI	Expert Team on Sea Ice
GML	Geography Markup Language
IHO	International Hydrographic Organization
ISO	International Organization for Standardization
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
UTF-8	Unicode Transformation Format-8
WMO	World Meteorological Organization
XML	eXtensible Markup Language

1.6 General data product description

Title	Ice Information Product Specification.
Abstract	Ice Information for ship navigation
Acronym	S-411
Content	Ice features as vector data
Spatial Extent	**Description**: Areas specific to navigation in ice covered regions.

East Bounding Longitude: 180°
West Bounding Longitude: -180°
North Bounding Latitude: 90°
South Bounding Latitude: -90°

Purpose Navigation in ice covered regions

1.7 Product Specification metadata

Title Ice Information Product Specification

S-100 Version 5.2.0

S-411 Version 2.0.0

Date 31 December 2025

Language English (optional additional)

Classification Unclassified

Contact

Identifier

Maintenance Changes to this product specification are coordinated by JCOMM ETSI.

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Identifier S-412

Maintenance Changes to the Product Specification S-412 are coordinated by the JCOMM, and must be made available via the IHO web site.

1.8 WMO Product Specification Maintenance

1.8.1 Introduction

Changes to S-412 will be released by the WMO as a New Edition, revision, or clarification.

1.8.2 New Edition

New Editions of S-412 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.

1.8.3 Revision

Revisions are defined as substantive semantic changes to S-412. Typically, *revisions* will change S-412 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-412. 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-412.

1.8.4 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-412.

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.

1.8.5 Version Numbers

The associated version control numbering to identify changes (n) to S-412 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	S-412 dataset
Hierarchical Lelvel	MD_ScopeCode -005
Hierarchical Level Name	Dataset

Extent

EX_GeographicExtent — Global coverage of maritime areas.

EX_TemporalExtent — Not defined for this product specification.

EX_VerticalExtent -Not defined for this product specification.

3 Data Product Identification

A dataset that conforms to this Product Specification may be identified by its discovery metadata as defined in clause 12.

Title

Abstract	S-412 datasets must be produced in accordance with the rules defined in the S-412 Product Specification. The S-412 Product Specification contains all the information necessary to enable producers to produce a consistent dataset; and manufacturers to use that data efficiently within navigation systems.
Topic Category	Transportation, climatology, meteorology, atmosphere
Geographic Description	
Spatial Resolution	Each Data Coverage feature of an *WEATHER* dataset must indicate a value for an optimum viewing scale. Recommended values for scales can be found in the S-101 ENC Product Specification. Producers should note that at the smaller scales, geographic details will have no perceptible visual separation on a graphic display, and are therefore encouraged to determine display scales taking into account the content and intended navigation purpose of the dataset.

Purpose	Navigation in ice covered regions
Language	English (Mandatory), other (Optional)
Classification	Data may 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	Vector
Point of Contact	Producing Agency
Use Limitation	Not for sole use in navigation; must be used with an ENC.

4 Data Content and Structure

4.1 Introduction

4.2 Application Schema

4.2.1 Domain model

4.2.2 S-412 Features

4.2.2.1 Meta Features

4.2.2.2 Geographic Features

4.2.3 Attributes

S-412 defines attributes as either simple or complex in line with the S-100 GFM.

4.2.3.1 Simple attributes

S-412 uses 3 types of simple attributes; these types are listed in Annex A – Data Classification and Encoding Guide, clause 2.4.2. Descriptions of the simple attributes included in S-412 can be found in Annex A, Sections 27, 28 and 30.

4.2.3.2 Complex attributes

Complex attributes are aggregations of other attributes that are either simple or complex. The aggregation is defined by means of attribute bindings. Examples of modelling complex attributes can be found in S-100 Part 2a, Appendix 2a-A. Descriptions of the complex attributes included in S-412 can be found in Annex A – Data Classification and Encoding Guide

4.3 Feature Catalogue

4.3.1 Introduction

The S-412 Feature Catalogue describes the feature types, attributes and attribute values which may be used in an S-412 product.

The S-412 Feature Catalogue is available as an XML document which conforms to the S-100 XML Feature Catalogue Schema and can be downloaded from the IHO website (https://registry.iho.int/). S-412 Annex A – Data Classification and Encoding Guide, constitutes a human readable interpretation of the Feature Catalogue along with information on how features should be encoded.

The feature Catalogue for Ice Information contains only geographic and meta features. The ice features which can be used in ECDIS are defined within the ICE domain of the IHO Registry.

4.3.2 Feature types

Feature types contain descriptive attributes that characterize real-world entities. The word ‘feature’ may be used in one of two senses – feature type and feature instance. A feature type is a class and is defined in a Feature Catalogue. A feature instance is a single occurrence of the feature type and represented as an object in a dataset. A feature instance is located by a relationship to one or more spatial instances. A feature instance may exist without referencing a spatial instance.

4.3.3 Geographic

Geographic (geo) feature types carry the descriptive characteristics of a real-world entity (a location or place on the surface of the Earth). In the context of Ice Information products, this comprises most of the features (with the exception of DataCoverage) and represents those features with a real-world existence.

4.3.4 Meta

QN — is data coverage needed?

Only one metadata feature is defined, DataCoverage. This defines the area of coverage bounded by the dataset, and any features within it. DataCoverage contains a mandatory optimumDisplayScale attribute and two optional maximum, and minimum display scale attributes.

4.3.5 Attributes

S-412 defines attributes as either simple or complex in line with the S-100 GFM.

4.3.5.1 Simple attributes

S-412 uses three types of simple attributes; they are listed in the following Table:

Table 4-1

Type	Definition
Integer	An integer number.
Real	A floating point number.
Enumeration	One or more of a list of predefined values.

4.3.6 Application Schema implementation

4.3.6.1 Implementation description

4.3.7 Feature Types Summary

1) Summary of implemented features

Table 4-2

Index	Alias	Name
Feature	Weather Warning	Weather Warning

5 Coordinate Reference Systems (CRS)

5.1 Introduction

For exchange of ice data WGS84 (EPSG:4326) must be used

5.2 Horizontal Coordinate Reference System

Table 5-1 — S-412 Coordinate Reference Systems (EPSG Codes)

EPSG Code	Coordinate Reference System
4326	WGS84
The full reference to EPSG can be found at https://epsg.org.	

Horizontal Coordinate Reference System	EPSG: 4326
Projection	NONE (*although use of projected coordinates in datasets for future editions will be considered*)
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	Technical Commission for Oceanography and Marine Meteorology (JCOMM)
URL	https://wmo.int//

5.3 Vertical Coordinate Reference System

In this product there are no direct vertical coordinates which require the use of a vertical coordinate reference system.

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

6.1 Completeness

6.1.1 Commission

6.1.2 Omission

6.2 Logical consistency

6.2.1 Conceptual consistency

6.2.2 Domain consistency

6.2.3 Format consistency

6.3 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

7 Data Capture and Classification

8 Data Maintenance

8.1 Maintenance and Update Frequency

9 Portrayal

9.1 Rules

9.2 Symbols

9.2.1 Symbols and abbreviated terms

10 Data Product Format (encoding)

10.1 Introduction

This clause describes encoding rules for S-100 base ice datasets. For the encoding of ice datasets GML 3.2.1 is used as per S-100, Part 10b.

10.2 Encoding Rules

10.2.1 Longitude / Latitude

- Longitude and latitude must be encoded in decimal degrees, e.g.: 12.567 56.765
- Number of decimals is not specified.

10.3 Encoding Examples

11 Data Product Delivery

11.1 Format Specification

At the moment there is only one type of dataset supported. This is GML encoded ice feature collections according to S-100 Part 10b.

11.2 Introduction

11.3 Exchange Set

11.4 Exchange Catalogue

11.4.1 Exchange Catalogue Naming

11.4.2 Dataset size

11.4.3 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-412 dataset naming conventions must follow these rules and no further restrictions are made in this product specification.

412YYYYØØØØØØØØØØØØ.GML

412	the first 3 characters identify the dataset as an S-412 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 a GML file (according to S-100, Part 10b).

11.5 Exchange Set

11.6 Support Files

No support files are included in any of the S-412 features currently. If they are supported in the future then their specification and delivery will be added to this section.

11.7 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.

11.8 Data integrity and encryption

S-100, Part 15 defines the algorithms for compression, encrypting and digitally signing datasets based on the S-100 Data Model. Use of encryption is optional. Digital Signatures are mandatory for all datasets.

11.8.1 Use of compression

The data producer decides if compression will be used on the S-412 product files (GML). It is expected that a hydrographic office will make a policy decision and that all the S-412 datasets from the producer will be either compressed or uncompressed.

It is recommended to compress all the dataset files. The ZIP compression method defined in S-100, Part 15, Clause 5.2 should be used where applicable.

11.8.2 Use of digital signatures

Digital signatures must be used on all files included in a S-412 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 as defined in S-100, Part 17.

12 Metadata

12.1 Introduction

There are two kinds of metadata to prepare:

- ISO 19139 Metadata
  This kind of metadata implementation can be read by broad range of software.
- S100 Metadata
  The S100 metadata are for describing the structure of Exchange Catalogue

12.1.1 ISO 19139 Metadata

For the description of ice data following metadata are necessary:

Table 12-1

Element Name	Description	Namespace
MD_Metadata	root element	gmd
fileIdentifier	Id for dataset	gmd
language	Product language	gmd
characterSet	Used characterset	gmd
contact	Contact data	gmd
dateStamp	date of publishing	gmd
identificationInfo	Specific info about product	gmd

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<gmd:MD_Metadata     xmlns:gmd="http://www.isotc211.org/2005/gmd"
                     xmlns:gco="http://www.isotc211.org/2005/gco"
                     xmlns:gml="http://www.opengis.net/gml/3.2">
        <gmd:fileIdentifier> ... </gmd:fileIdentifier>
        <gmd:language> ... </gmd:language>
        <gmd:characterSet> ... </gmd:characterSet>
        <gmd:contact> ... </gmd:contact>
        <gmd:dateStamp> ... </gmd:dateStamp>
        <gmd:identificationInfo> ... </gmd:identificationInfo>
</gmd:MD_Metadata>
```

Figure 12-1

12.1.1.1 fileIdentifier

Table 12-2

Element Name	Description	Namespace
fileIdentifier	Id for dataset	gmd
CharacterString	String contained id value	gmd

12.1.1.2 language

Table 12-3

Element Name	Description	Namespace
language	Language of dataset	gmd
LanguageCode	Code for language	gmd

```
<gmd:language>
    <gmd:LanguageCode
        codeList="http://www.isotc211.org/2005/resources/Codelist/ML_
gmxCodelists.xml#LanguageCode"
        codeListValue="eng">English
    </gmd:LanguageCode>
</gmd:language>
```

Figure 12-2

12.1.1.3 characterSet

Table 12-4

Element Name	Description	Namespace
characterSet	characterSet of dataset	gmd
MD_CharacterSetCode	Code for characterSet	gmd

LanguageCode element contains two attributes:

- codeList Link to the list containing the codes for languages
- codeListValue value from the list defining the used language

```
<gmd:characterSet>
    <gmd:MD_CharacterSetCode
        codeList="http://www.isotc211.org/2005/resources/Codelist/ML_
gmxCodelists.xml#MD_CharacterSetCode"
        codeListValue="utf8">UTF 8
    </gmd:MD_CharacterSetCode>
```

```
</gmd:characterSet>
```

Figure 12-3

12.1.1.4 contact

Table 12-5

Element Name	Description	Namespace
contact	Contact for questions to dataset	gmd
CI_ResponsibleParty	ISO Element for contact data	gmd
individualName	Name of responsible person	gmd
CharacterString	individualName value (text)	gco
organisationName	Name of responsible organisation	gmd
CharacterString	organisationName value (text)	gco
contactInfo	Contact information	gmd
CI_Contact	ISO Element for contact information	gmd
phone	phone	gmd
CI_Telephone		gmd
voice		gmd
CharacterString	Voice telephone value (text)	gco
facsimile		gmd
CharacterString	Fax number value (text)	gco
address		gmd
deliveryPoint		gmd
CharacterString	Postal Address (street, house number)	gco
city		gmd
CharacterString	City name value (text)	gco
administrativeArea		gmd
CharacterString	Administrative Area name value (text)	gco
postalCode		gmd
CharacterString		gco
electronicMailAddress		gmd
CharacterString	Email value (text)	gco
role		gmd
CI_RoleCode		gmd

CI_RoleCode element contains two attributes:

- codeList: link to the list containing the codes for roles
- codeListValue: value from the list defining the used roles

```
<gmd:contact>
    <gmd:CI_ResponsibleParty>
        <gmd:individualName>
            <gco:CharacterString>Jürgen Holfort</gco:CharacterString>
        </gmd:individualName>
        <gmd:organisationName>
            <gco:CharacterString>FMHA Germany (BSH)</gco:CharacterString>
        </gmd:organisationName>
        <gmd:contactInfo>
            <gmd:CI_Contact>
                <gmd:phone>
                    <gmd:CI_Telephone>
                        <gmd:voice>
                            <gco:CharacterString>+49 (0) 381 4563-782</gco:
CharacterString>
                        </gmd:voice>
                        <gmd:facsimile>
                            <gco:CharacterString>+49 (0) 381 4563-949</gco:
CharacterString>
                        </gmd:facsimile>
                    </gmd:CI_Telephone>
                </gmd:phone>
                <gmd:address>
                    <gmd:CI_Address>
                        <gmd:deliveryPoint>
                            <gco:CharacterString>Neptunallee 5</gco:
CharacterString>
                        </gmd:deliveryPoint>
                        <gmd:administrativeArea>
                            <gco:CharacterString>Rostock</gco:CharacterString>
                        </gmd:administrativeArea>
                        <gmd:postalCode>
                            <gco:CharacterString>18057</gco:CharacterString>
                        </gmd:postalCode>
                        <gmd:electronicMailAddress>
                            <gco:CharacterString>ice@bsh.de</gco:
CharacterString>
                        </gmd:electronicMailAddress>
                    </gmd:CI_Address>
                </gmd:address>
            </gmd:CI_Contact>
        </gmd:contactInfo>
        <gmd:role>
            <gmd:CI_RoleCode
                codeList="http://www.isotc211.org/2005/resources/Codelist/
gmxCodelists.xml#CI_RoleCode" codeListValue="originator">originator</gmd:CI_
RoleCode>
            </gmd:role>
    </gmd:CI_ResponsibleParty>
</gmd:contact>
```

Figure 12-4

12.1.1.5 dateStamp

Table 12-6

Element Name	Description	Namespace
dataStamp	Date Stamp	gmd
Date	Formatted String (yyyy-MM-dd)	gco

The dateStamp should be used for the publication date (just day using gco:date or including the time using gco:datetime). The date and time where the ice chart is considered valid should be given in identificationinfo (see 10.1.1.6). Classic operational ice charts should have a time stamp within the temporal extent given in identificationinfo, a dateStamp preceding the temporal extent denotes a prognosis chart, a dateStamp that is more recent then the temporal extent denotes an historic reanalysis or a climatological chart.

```
<gmd:dateStamp>
  <gco:Date>2013-02-25</gco:Date>
</gmd:dateStamp>
```

Figure 12-5

12.1.1.6 identificationInfo

Table 12-7

Element Name	Description	Namespace
identificationInfo		gmd
MD_DataIdentification		
citation		
CI_Citation		
title		
CharacterString		gco
date		
CI_Date		
date		gco
dateType		
CI_DateTypeCode		
abstract		
CharacterString		gco
language		
LanguageCode		
characterSet		
MD_CharacterSetCode		
topicCategory		
MD_TopicCategoryCode		
extent		
EX_Extent		
geographicElement		
EX_GeographicBoundingBox		
westBoundLongitude		
Decimal		gco

Element Name	Description	Namespace
eastBoundLongitude		
Decimal		gco
southBoundLatitude		
Decimal		gco
northBoundLatitude		gmd
Decimal		gco
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EX_TemporalExtent		gmd
extent		gmd
TimePeriod		gml
beginPosition		gml
endPosition		gml

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        </gmd:title>
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          <gmd:CI_Date>
            <gmd:date>
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  </gmd:language>
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xml#MD_CharacterSetCode"
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  </gmd:characterSet>
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TopicCategoryCode>
  </gmd:topicCategory>
```

```
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                <gml:endPosition>2013-02-27</gml:endPosition>
              </gml:TimePeriod>
            </gmd:extent>
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        </gmd:temporalElement>
      </gmd:EX_Extent>
    </gmd:extent>
  </gmd:MD_DataIdentification>
</gmd:identificationInfo>
```

Figure 12-6

12.2 Language

The language used in metadata must be English. Other languages are optional and only as addition to the English version.

Metadata used for the discovery, identification, and use of S-412 datasets in S-100-based navigation systems (specifically, an S-100 capable ECDIS) is encoded in the exchange catalogue. This metadata conforms to S-100, Part 17, with any product-specific restrictions noted in this section.

12.3 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.

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.

The following clauses define the mandatory and optional metadata needed for S-412. 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-412 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-412 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-412-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.

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12.4 S100_ExchangeCatalogue

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

S-412 uses S100_ExchangeCatalogue without modification.

12.4.1 S100_ExchangeCatalogueIdentifier

S-412 uses S100_ExchangeCatalogueIdentifier without modification.

12.4.2 S100_CataloguePointOfContact

S-412 uses S100_CataloguePointOfContact without modification.

12.5 S100_DatasetDiscoveryMetadata

Dataset discovery metadata in S-412 restricts certain attributes and roles as described in Table 12-8. Optional S-100 attributes which are mandatory in S-412 are indicated in the Remarks column.

Table 12-8 — 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-412.** **References to support file discovery metadata are not permitted because S-412 does not use support files.**
Attribute	fileName	Dataset file name	1	URI	See S-100, Part 1, Clause 4.6 **Format: file:/S-412/DATASET_FILES/<dsname>** **Dataset file name <dsname> must be according to format defined in [subsec-dataset-file-naming].**
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-412
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-412** **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 12-12**
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-412**
Attribute	encodingFormat	The encoding format of the dataset	1	S100_EncodingFormat	**The only allowed value is GML** **Table 12-11**
Attribute	dataCoverage	Provides information about data coverages within the dataset	**1**..*	S100_DataCoverage	**Mandatory in S-412** **Table 12-9**
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 [subsec-dataset-file-naming].** **For example, *412DE00KD54.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-412**

12.5.1 S100_NavigationPurpose

S-412 uses S100_NavigationPurpose without modification.

12.5.2 S100_DataCoverage

S-412 uses S100_DataCoverage without modification, but with additional remarks and changes to the multiplicity.

Table 12-9 — 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-412.**
Attribute	optimumDisplayScale	The scale at which the data is optimally displayed	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-412 uses S100_Purpose without modification, but with a restriction on the allowed values.

Table 12-10 — 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-412.**
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-412 uses S100_EncodingFormat with a restriction on the allowed values to permit only the S-100 GML format for S-412 datasets.

Table 12-11 — S100_EncodingFormat parameters

Role name	Name	Description	Code	Remarks
Enumeration	S100_EncodingFormat	The encoding format	-	**The only value allowed in S-412 is "GML".**
Value	GML	The GML data format as defined in S-100, Part 10b	3	-

12.5.5 S100_ProductSpecification

S-412 uses S100_ProductSpecification without modification, but with additional remarks and changes to the multiplicity.

Table 12-12 — 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-412, this name is "Ice Information" (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: 1.2.1 for S-412 Edition 1.2.1**
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-412, this identifier is "S-412" (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-412 is numbered *xxx*.

12.5.6 S100_ProtectionScheme

S-412 uses S100_ProtectionScheme without modification.

12.6 S100_CatalogueDiscoveryMetadata

S-412 uses S100_CatalogueDiscoveryMetadata without modification.

12.6.1 S100_CatalogueScope

S-412 uses S100_CatalogueScope without modification.

12.6.2 PT_Locale

S-412 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.

12.7 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-412 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.”

13 Dataset Encoding

13.1 Introduction

A dataset is a grouping of features, attributes, geometry and metadata which comprises a specific coverage.

13.2 Dataset Rules

In order to facilitate the efficient processing of S-412 data the geographic coverage of a given **maximum display** scale may be split into multiple datasets.

The discovery metadata of a dataset must list all the **Data Coverage** features contained within that dataset and their assigned scale attributions.

Datasets must not cross the 180° meridian; this includes both the **Data Coverage** features and the bounding box for the dataset.

13.3 Data Coverage rules

- All base datasets (new dataset, new edition) must contain at least one **Data Coverage** feature.
- The data boundary of the base dataset is defined by the extent of the **Data Coverage** features and must be contained within the bounding box.
- The **Data Coverage** features within a dataset must not overlap, however **Data Coverage** features from different datasets may overlap if they have differing **maximum display scales**.
- Datasets may overlap, however there must be no overlapping **Data Coverage** features of the same **maximum display scale**, except at the agreed adjoining national data limits, where, if it is difficult to achieve a perfect join, a 5 metre overlapping buffer zone may be used; and for this situation, there must be no gaps in data.
- When a dataset has multiple **Data Coverage** features, then the **minimum display scale** must be the same for all **Data Coverage** features within the dataset. The **maximum display scale** for multiple **Data Coverage** features within a dataset may be different.
- When a dataset has multiple **Data Coverage features** then the **maximum display scale** of the dataset must be equal to the largest **maximum display scale** of the **Data Coverage** features.
- The **maximum display scale** is considered to be the equivalent of the compilation scale of the data.

14 Display Scale Range

A scale range of a dataset is used to indicate a range of scales between which a producer considers the data is intended for use. The smallest scale is defined by the **minimum display scale** and the largest scale by the **maximum display scale**. These scales must be set at one of the scales specified elsewhere in this product specification.

When the system's viewing scale is smaller than the value indicated by **minimum display scale**, features within the **Data Coverage** feature are not displayed.

15 Geometry

15.1 S-412 Geometry

S-412 features are encoded as vector entities which conform to S-100 geometry configuration level 3a (S-100 clause 7-4.3).

Level 3a is described by the following constraints:

- Each curve must reference a start and end point (they may be the same).
- Curves must not self intersect. See S-100 Figure 7-5.
- Areas are represented by a closed loop of curves beginning and ending at a common point.
- In the case of areas with holes, all internal boundaries must be completely contained within the external boundary and the internal boundaries must not intersect each other or the external boundary. Internal boundaries may touch other internal boundaries or the external boundary tangentially (that is at one point) as shown in S-100 Figure 7-6.
- The outer boundary of a surface must be in a clockwise direction (surface to the right of the curve) and the curve orientation positive. The inner boundary of a surface must be in a counter-clockwise direction (surface to the right of the curve) and the curve orientation negative. See S-100 Figure 7-7.

16 List of annexes

These Annexes are separate files and can be found either in the S-411 Product Specification distribution package or at the locations indicated.

Annex A Data Classification and Encoding Guide. Separate document. IHO Geospatial Information Registry, https://registry.iho.int

Annex B Encoding Format. GML schema, Schematron rule files, and schema documentation. S-100 schema server, https://schemas.s100dev.net **TBC**

Annex C Feature catalogue. XML file. IHO Geospatial Information Registry, https://registry.iho.int

Annex D Validation Checks. Separate document. IHO Geospatial Information Registry, https://registry.iho.int **TBC**

Annex E Portrayal Catalogue. Zip archive of portrayal catalogue. IHO Geospatial Information Registry, https://registry.iho.int