INTERNATIONAL HYDROGRAPHIC ORGANIZATION

IHO ELECTRONIC NAVIGATIONAL CHART PRODUCT SPECIFICATION

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Phase 1	May 2009	J. Powell	Initial Draft
Phase 1	June 2010	J. Powell	Merged all the phases back into a single document
Phase 1	July 2010	J. Powell	Added comments from AHO
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Phase 1	December 2010	J. Powell	Revised based on TSMAD 21
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Phase 2	April 2011	J.Powell	Revised based on comments from TSMAD22. Changed version to 0.1.0 to reflect movement to phase 2.
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Draft 0.0.0	April/May 2014	J.Powell	Included S-101 portrayal. Most of the portrayal is covered by the catalogue, so much of the old S-52 guidance goes into the implementation guidance annex.
Draft 0.0.1	February 2015	J.Powell	Added adjudicated comments from TSMAD29
Draft 0.0.2	January 2016	J.Powell	Incorporated editorial issues that were noted in draft 0.0.1. Also includes a revised

			metadata section.
Draft 0.0.2	July 2017	J.Powell	Incorporated the decisions from S101PT1 and updated some editorial issues. Numbering remained the same to be consistent with the DCEG numbering.
Draft 1.0.0 Beta 1	June 2018	J. Wootton	Editorial review and clean-up in preparation for final approval to publish as an evaluation and testing version.

Contents

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Introduction

S-101 is the Electronic Navigational Chart Product Specification, produced by the International Hydrographic Organization. S-101 is designed to allow content, content definition (Feature Catalogues) and presentation (Portrayal Catalogues) to be updateable without breaking system implementations.

Based on the IHO Universal Hydrographic Data Model S-100, S-101 includes all the necessary components for both Hydrographic Offices to produce Electronic Navigational Charts (ENCs) and marine navigation systems (principally Electronic Chart Display and Information Systems (ECDIS)) to be able to ingest and properly display them. This Product Specification is designed to be flexible with the introduction of machine readable Feature and Portrayal Catalogues that will allow for managed change; and will enable the introduction of new navigationally significant features and their portrayal using a “just in time” methodology.

1 Overview

1.1 Scope

This document describes an S-100 compliant product specification for Electronic Navigational Charts, which will form the base navigation layer for an S-100 based marine navigation system. It specifies the content, structure, and metadata needed for creating a fully compliant S-101 ENC and for its portrayal within an S-100 system. This product specification includes the content model, the encoding, the feature catalogue, portrayal catalogue, metadata, and implementation guidance for developers.

1.2 References

1.2.1 Normative

S-52 IHO Specifications for Chart Content and Display Aspects of ECDIS, Edition 6.0.1

S-100 IHO Universal Hydrographic Data Model, Edition 4.0.0

ISO 3166-1 Codes for the Representation of Names of Countries and their Subdivisions – Part 1: Country Codes

ISO/IEC 8211:1994 Specification for a Data Descriptive File for Information Interchange Structure Implementations

ISO 8601:2004 Data Elements and Interchange Formats – Information Interchange – Representation of Dates and Times

ISO 19103:2005 Geographic Information – Conceptual Schema Language

ISO 19111:2007 Geographic Information – Spatial Referencing by Coordinates

ISO 19115:2003 Geographic Information – Metadata

ISO 19131:2008 Geographic Information – Data Product Specifications

ISO/IEC 19501:2005 Information Technology – Unified Modelling Language (UML) Version 1.4.2

FIPS 186 Federal Information Processing Standards – Digital Signature Standard

1.2.2 Informative

ISO 19101:2003 Geographic Information – Reference Model

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

ISO 19105:2000 Geographic Information – Conformance and Testing

ISO 19107:2003 Geographic Information – Spatial Schema

ISO 19108:2002 Geographic Information – Temporal Schema

ISO 19109:2005 Geographic Information – Rules for Application Schema

ISO 19110:2005 Geographic Information – Methodology for Feature Cataloguing

ISO 19113:2002 Geographic Information – Quality Principles

ISO 19117:2012 Geographic Information – Portrayal

ISO 19118:2005 Geographic Information – Encoding

ISO/TS 19138:2006 Geographic Information – Data Quality Measures

ISO 19157:2013 Geographic Information – Data Quality

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

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

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

Aggregation
Special form of **association** that specifies a whole-part relationship between the aggregate (whole) and a component part.

Alarm
(MSC.302/A) a high-priority **alert**. Condition requiring immediate attention and action by the bridge team, to maintain the safe navigation of the ship.

Alert
(MSC.302/A) announcement of abnormal situations and conditions requiring attention. Alerts are divided in four priorities: emergency alarms, **alarm**s, warnings and cautions. An alert provides information about a defined state change in connection with information about how to announce this event in a defined way to the system and the operator.

Application Schema
Conceptual schema for data required by one or more applications.

Association
Semantic relationship between two or more classifiers that specifies connections among their instances.

Attribute
Named property of an entity.

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

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.

Caution
(MSC.302/A) lowest priority of an **alert**. Awareness of a condition which does not warrant an **alarm** or warning condition, but still requires attention out of the ordinary consideration of the situation or of given information.

CIE Colours
One of the first mathematically defined colour spaces the CIE XYZ colour space was created by the International Commission on Illumination 1931.

Class
Description of a set of objects that share the same **attributes**, operations, methods, **relationships**, and semantics.

NOTE A class represents a concept within the system being modelled. Depending on the kind of model, the concept may be real-world (for an analysis model), or it may also contain algorithmic and computer implementation concepts (for a design model). A classifier is a generalization of class that includes other class-like elements, such as data type, actor and component.

Classification
The process of determining the appropriate **data type** within a **feature catalogue** for a particular real world feature, including consideration of **data quality**.

Colour Token
An alphanumeric code identifying a colour and its use in systems. The day and night colours which are identified by the token are given in the colour tables (in **CIE colour** coordinates). Note that several colour tokens may share the same colour.

EXAMPLE: CHBLK – black/grey (general)

Complex Line Styles
Lines that are themselves symbols, or that have symbols interlaced. Examples of a line as a symbol are a submerged pipeline LC(PIPSOL05), or the T T T lines indicating the inside of an area LC(ENTRES51). A simple or complex line may have a symbol interlaced, such as an anchor for anchorage area LC(ACHARE51).

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 that is related to an object by a datum.

NOTE For geodetic and vertical datums, the object will be the Earth.

Coordinate Tuple
Ordered list of **coordinates**.

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.

Curve Segment
1-dimensional geometric object used to represent a continuous component of a **curve** using homogeneous interpolation and definition methods.

NOTE The geometric set represented by a single curve segment is equivalent to a curve.

Data Product
A **dataset** or dataset series that conforms to a data product specification.

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.

EXAMPLES: Integer, Real, Boolean, String, DirectPosition and Date

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.

Display Category
The IMO ECDIS Performance Standard establishes three display categories for the presentation of SENC features. Display base: always on the display. Standard display: the system default display. Other: all other features in the SENC.

Display Priority
Hierarchy to determine which **feature** is to be displayed when two features overlap. Priority 2 overwrites 1.

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 (SENC) with positional information from navigation sensors to assist the Mariner in route planning and route monitoring, and if required display additional navigation-related information.

ECDIS Chart 1
An ECDIS version of INT 1, including all symbols, line styles and colour coding used for chart presentation. Intended for the Mariner for both familiarization with ECDIS and to look up specific symbols.

ENC
The **dataset**, standardized as to content, structure and format, issued for use with **ECDIS** by or on the authority of a Government authorized Hydrographic Office or other relevant government institution, and conforming to IHO standards. The ENC contains all the chart information necessary for safe

navigation and may contain supplementary information in addition to that contained in the paper chart which may be considered necessary for safe navigation.

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 [ISO 19101:2003].

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

EXAMPLE The phenomenon named 'London Eye' may be classified as a feature instance with other phenomena into a feature type 'landmark'.

Feature Association
Relationship that links instances of one **feature** type with instances of the same or a different **feature** type.

Feature Attribute
Characteristic of a **feature**.

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

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.

NOTE In a **feature catalogue**, a feature **attribute** may include a value domain but does not specify **attribute** values for feature instances.

EXAMPLE 1: A feature attribute named *colour* may have an attribute value *green* which belongs to the data type *text*

EXAMPLE 2: A feature attribute named *length* may have an attribute value *82.4* which belongs to the data type *real*

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

Geometric Primitive
A plain **point**, a plain **curve**, a plain **surface** as defined in geometry (that is without any meaning attached).

Human Readable
A representation of information that can be naturally read by humans.

Identifier
A linguistically independent sequence of characters capable of uniquely and permanently identifying that with which it is associated.

Indication
Visual indication giving information about the condition of a system or equipment.

Instance
Entity to which a set of operations can be applied and which has a state that stores the effects of the operations.

NOTE See **feature**.

Machine Readable
A representation of information that can be processed by computers.

Maximum Display Scale
The larger value of the ratio of the linear dimensions of features of a dataset presented in the display and the actual dimensions of the features represented (largest scale) of the scale range of the dataset.

Metadata
Data about data.

Minimum Display Scale
The smaller value of the ratio of the linear dimensions of features of a dataset presented in the display and the actual dimensions of the features represented (smallest scale) of the scale range of the dataset.

Model
Abstraction of some aspects of universe of discourse.

NOTE A semantically complete abstraction of a system.

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)

No Symbol Feature
In some cases, the database contains information that is not intended for display. (An example might be a general area such as 'Great Australian Bight' which would be available for an answer to cursor interrogation of the sea area.)

Opaque Fill
The background is completely filled with the colour fill (for example, depth area). The **point** and **curve** SENC features may be overwritten. The raw radar image is a special case of opaque fill which overwrites all other features except those with "priority over radar" (OVERRADAR).

Overscale Indication
The overscale indication is intended to remind the mariner that the size of chart errors is magnified as the display scale increases. A 1 mm error at compilation scale of 1:20,000 becomes a 1.3 mm error at a display scale of 1:15,000 and a 2 mm error at 1:10,000. This overscale indication is displayed as a factor (for instance “X1.3” and “X2” using the examples above), and a pattern when overscale is beyond a factor of X2; and is required by the IMO Performance Standards for ECDIS whenever the display scale exceeds the **dataset** compilation scale.

Pattern Fill
A method of identifying areas by large, faintly coloured symbols well spaced out across the area. A pattern spacing algorithm ensures that the pattern symbols are visible without being so dense as to cause clutter. Used to ensure pattern symbols are always visible at any display scale.

Pivot Point
The point around which a symbol gets scaled and rotated. When the symbol is placed in the world space, the symbol's pivot point is positioned exactly on the feature’s position and all elements of the symbol are geometrically related to that position.

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.

Radar Priority
The IMO ECDIS Performance Standard requires that radar can be switched off with a "single action control" in order to see SENC and Mariners information clearly. However certain other information, such as planned route, safety contour, coastline should always be written over the radar.

Radar Transparency
A method of varying the transparency of radar in a continuous progression from no radar to a totally opaque radar overlay, by merging the radar colour with the colour of the feature it overlays at each pixel.

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

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

Relationship
Semantic connection among model elements.

NOTE Kinds of relationships include association, generalization, metarelationship, flow, and several kinds grouped under dependency.

Scale Minimum
The smallest scale at which a feature is displayed (for example, a minor light, with a scale minimum of 1:45,000, would not be displayed at a scale of 1:90,000).

SENC
In **ECDIS** means a database, in the manufacturer's internal ECDIS format, resulting from the loss-less transformation of the entire **ENC** contents and its updates. It is this database that is accessed by ECDIS for the display generation and other navigational functions, and is at least equivalent to an up-to-date paper chart. The SENC may also contain information added by the mariner and information from other sources.

Simple Line Styles
Solid lines, dots and dashes.

Skin of the EARTH
A defined set of non-overlapping geographic features of geometric primitive surface, covering an area equivalent to that of meta-features **Data Coverage**.

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.

Symbol Size
The size is specified in normalized units of 0.01 mm. The minimum dimension is always more than 4 mm. This size applies to display on a standard minimum screen.

Symbology Instruction
A machine readable symbolization order used in look-up tables to link feature-classes to symbols, in straight forward cases (that is where a conditional symbology instruction is not required).

Temporal Reference System
Reference system against which time is measured.

Text Label
A textual description of a **feature**. Can be formatted to include standard text as well as **feature attribute** values. For example, light descriptions, place names etc.

Transparent Fill
A method of identifying features of **geometric primitive surface** by covering a given percentage of each 4 pixel square with the fill colour, leaving the remainder "transparent". Used to ensure the information underneath shows through.

Vertical Datum
Datum describing the relation of gravity-related heights or depths to the Earth.

Warning
(MSC.302/A) **alert** for condition requiring immediate attention, but no immediate action by the bridge team. Warnings are presented for precautionary reasons to make the bridge team aware of changed conditions which are not immediately hazardous, but may become so if no action is taken.

1.3.3 Abbreviations

CRS	Coordinate Reference System
DCEG	Data Classification and Encoding Guide
ECDIS	Electronic Chart Display and Information System
ENC	Electronic Navigational Chart
EPSG	European Petroleum Survey Group
GFM	General Feature Model
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISO	International Organization for Standardization
MSVS	Mariners Selected Viewing Scale
PDF	Portable Document Format
SENC	System Electronic Navigational Chart
SOLAS	Safety of Life at Sea
SVG	Scalable Vector Graphics
S-100WG	IHO S-100 Working Group
S-101PT	S-101 Project Team

TIFF Tagged Image File Format

UML Unified Modelling Language

URL Universal Resource Locator

XML Extensible Markup Language

1.4 S-101 General Data Product Description

NOTE This information contains general information about the data product.

Title: Electronic Navigational Chart

Abstract: An Electronic Navigational Chart (ENC) is a vector chart produced on the authority of a government authorized Hydrographic Office or other relevant government institution. Its primary purpose is for use within an Electronic Chart Display and Information System (ECDIS) to meet International Maritime Organization (IMO) and Safety of Life at Sea (SOLAS) chart carriage requirements; however it may also be used as the base dataset in other S-100 based marine navigation systems. The ENC contains an extraction of real world information necessary for the safe navigation of vessels.

Content: The Product Specification defines all requirements to which ENC data products must conform. Specifically it defines the data product content in terms of features and attributes within the feature catalogue. The display of features is defined by the symbols and rule sets contained in the portrayal catalogue. The Data Classification and Encoding Guide (DCEG) provides guidance on how data product content must be captured. (Annex A.)

Spatial Extent:

Description: Areas specific to marine navigation.

East Bounding Longitude: 180°

West Bounding Longitude: -180°

North Bounding Latitude: 90°

South Bounding Latitude: -90°

Purpose: The purpose of an ENC dataset is to provide official navigational data for navigation systems for the safe passage and route planning of vessels between destinations.

1.5 Data product specification metadata

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

Title: The International Hydrographic Organization Electronic Navigational Chart Product Specification

S-100 Version: 4.0.0

S-101 Version: 1.0.0 (Implementation version for evaluation and testing purposes only)

Date: December 2018

Language: English

Classification: Unclassified

Contact: International Hydrographic Organization

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URL: www.iho.int

Identifier: S-101

Maintenance: Changes to the Product Specification S-101 are coordinated by the S-101 Project Team (S-101PT), a Project Team under the IHO S-100 Working Group (S-100WG), and must be made available via the IHO web site. Maintenance of the Product Specification must conform to IHO Technical Resolution 2/2007, as amended.

1.5.1 IHO Product Specification Maintenance

1.5.1.1 Introduction

Changes to S-101 will be released by the IHO as a new edition, revision, or clarification.

1.5.1.2 New Edition

New Editions of S-101 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-101. All cumulative *revisions* and *clarifications* must be included with the release of approved New Editions.

1.5.1.3 Revisions

Revisions are defined as substantive semantic changes to S-101. Typically, revisions will change S-101 to correct factual errors; or 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-101. All cumulative *clarifications* must be included with the release of approved corrections 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 catalogue or portrayal catalogue will result in a revision of S-101.

1.5.1.4 Clarification

Clarifications are defined as non-substantive changes to S-101. Typically, clarifications: remove ambiguity; correct grammatical and spelling errors; amend or update cross references; and insert improved graphics. A *clarification* must not cause any substantive semantic change to S-101.

Changes in a clarification are minor and ensure backward compatibility with the previous versions.

1.5.1.5 Version Numbers

The associated version control numbering to identify changes (n) to S-101 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 Scopes

Scope ID: Global

Level: 006- series

Level name: ENC Dataset

3 Dataset Identification

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

Title: Electronic Navigational Chart

Alternate Title: ENC

Abstract: S-101 ENCs must be produced in accordance with the rules defined in the S-101 Product Specification. The S-101 Product specification contains all the information necessary to enable Hydrographic Offices to produce a consistent ENC, and manufacturers to use that data efficiently within navigation systems.

Topic Category: Transportation (ISO 19115 Domain Code 018)

Geographic Description: Areas specific to marine navigation.

Spatial Resolution: An ENC dataset and **Data Coverage** must carry a value for maximum display scale. Each **Data Coverage** must also carry a value for minimum display scale. Values must be taken from the following table:

Scale
NULL (only allowed on minimum display scale where the maximum display scale = 10,000,000)
1:10,000,000
1:3,500,000
1:1,500,000

1:700,000
1:350,000
1:180,000
1:90,000
1:45,000
1:22,000
1:12,000
1:8,000
1:4,000
1:3,000
1:2,000
1:1,000

Table 1- ENC Minimum Display and Maximum Display Scales

Purpose: Electronic Navigational Chart for use in Electronic Chart Display and Information Systems

Language: English (Mandatory), other (Optional)

Classification: Data may be classified as one of the following:

Unclassified
Restricted
Confidential
Secret
Top Secret

Spatial Representation Type: Vector

Point of Contact: Producing Agency

Use Limitation: Not to be used for navigation on land.

4 Data Content and structure

4.1 Introduction

An S-101 ENC is a feature-based product. The content information is described in terms of a General Feature Model and a Feature Catalogue.

4.2 Application Schema

S-101 conforms to the General Feature Model (GFM) from S-100 Part 3. The GFM is the conceptual model and the implementation is defined in the Feature Catalogue. The S-101 Application Schema is realised in the feature catalogue and the product specification only contains specific examples.

4.3 Feature Catalogue

4.3.1 Introduction

The S-101 Feature Catalogue describes the feature types, information types, attributes, attribute values, associations and roles which may be used in an ENC.

The S-101 Feature Catalogue is available in an XML document which conforms to the S-100 XML Feature Catalogue Schema and can be downloaded from the IHO website. S-101 Annex A – Data Classification and Encoding Guide, constitutes a human readable interpretation of the Feature Catalogue.

4.3.2 Feature Types

4.3.2.1 Geographic

Geographic (geo) feature types form the principle content of the ENC and are fully defined by their associated attributes and information types.

4.3.2.1.1 Skin of the Earth

Each area covered by a meta-feature **Data Coverage** must be totally covered by a set of geo features of geometric primitive type surface that do not overlap each other (the Skin of the Earth). Feature types that comprise the Skin of the Earth are listed below:

Depth Area

Dredged Area

Land Area

Unsurveyed Area

Dock Area

Lock Basin

The geometry of coincident boundaries between Skin of the Earth features in a dataset must not be duplicated.

4.3.2.2 Meta

Meta features contain information about other features within a dataset. Information defined by meta features override the default metadata values defined by the dataset descriptive records. Meta attribution on individual features overrides attribution on meta features.

4.3.2.3 Cartographic

Cartographic features contain information about the cartographic representation (including text) of real world entities.

4.3.3 Feature Relationship

A feature relationship links instances of one feature type with instances of the same or a different feature type. There are four types of defined feature relationships in S-101 as described in the following sub clauses.

4.3.3.1 Information Association

An association is used to describe a relationship between a feature type, spatial object, or information type on one side and an information type on the other side.

EXAMPLE A **Nautical Information** information type provides additional information to any geo feature using an information association called **additional information**.

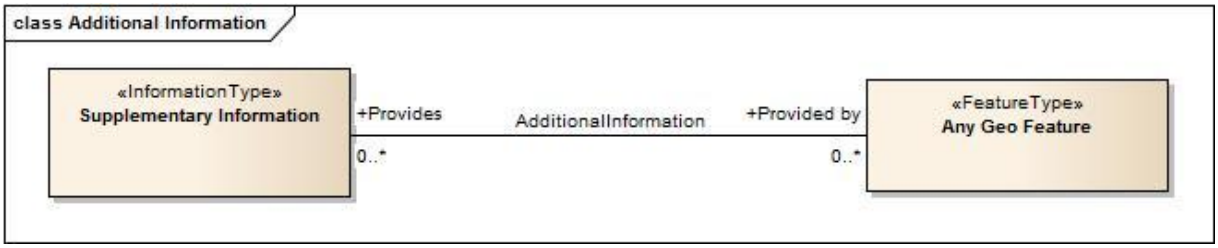

Figure 1 - Information Association

4.3.3.2 Feature Association

An association is used to describe a relationship between two feature types that involves connections between their instances.

EXAMPLE A **Caution Area** feature provides additional caution information to the **Archipelagic Sea Lane** feature. An association named **Caution Area Association** is used to relate the two features; roles are used to convey the meaning of the relationship.

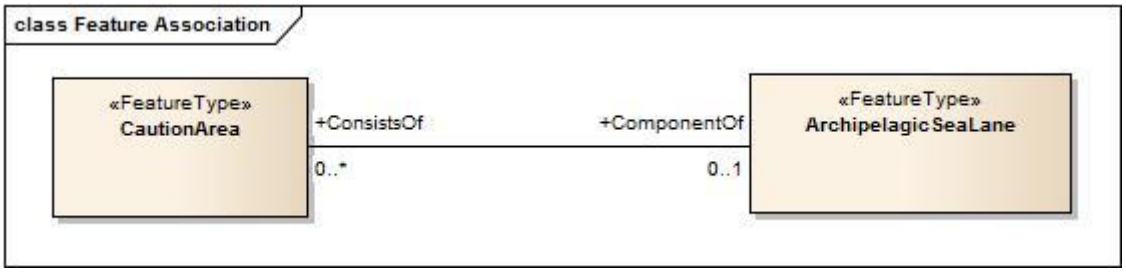

Figure 2 – Feature Association

4.3.3.3 Aggregation

An aggregation is a relationship between two or more feature types where the aggregation feature is made up of component features.

EXAMPLE An **Island Group** feature may be composed of multiple **Land Area** features to indicate the name of a group of island.

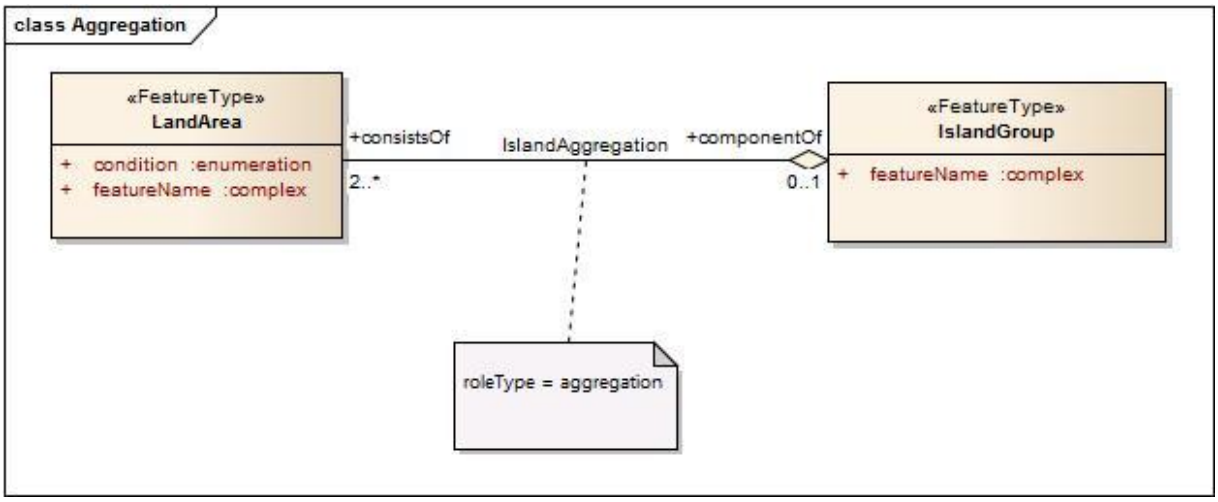

Figure 3 - Aggregation

4.3.3.4 Composition

A composition is a strong aggregation. In a composition, if a container feature is deleted then all of its containee features are deleted as well.

EXAMPLE If a feature type that is considered a structure feature, such as a beacon. is deleted, then all of its component feature types that make up the equipment composition, such as lights and fog signals must be deleted as they make up the **Structure/Equipment** Composition.

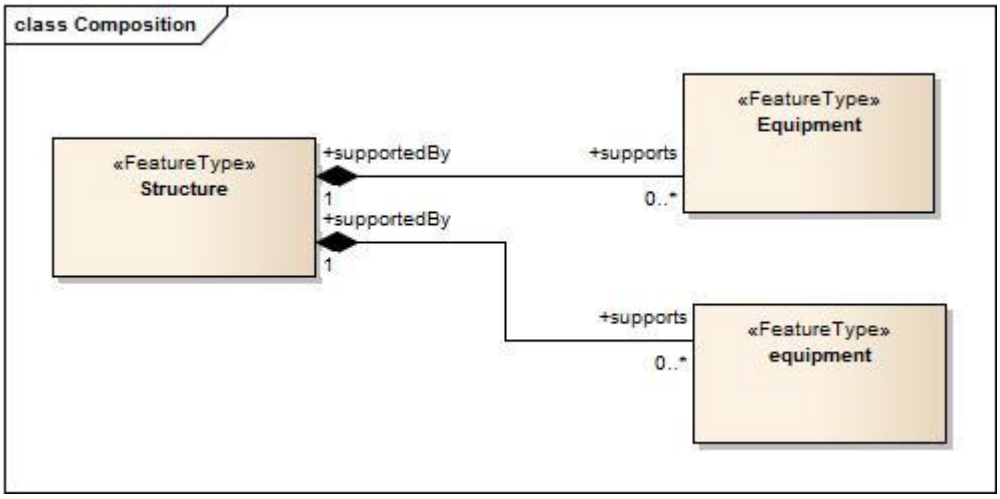

Figure 4 - Composition

4.3.4 Information Types

Information types define identifiable pieces of information in a dataset that can be shared between other objects such as feature types, spatial objects and other information types. They have attributes but have no relationship to any geometry.

4.3.4.1 Spatial Quality

Spatial quality attributes are carried in an information class called **Spatial Quality**. Only points, multipoints and curves can be associated with spatial quality. Currently no use case for associating surfaces with spatial quality attributes has been identified, therefore this is prohibited. Vertical uncertainty is prohibited for curves as this dimension is not supported by curves.

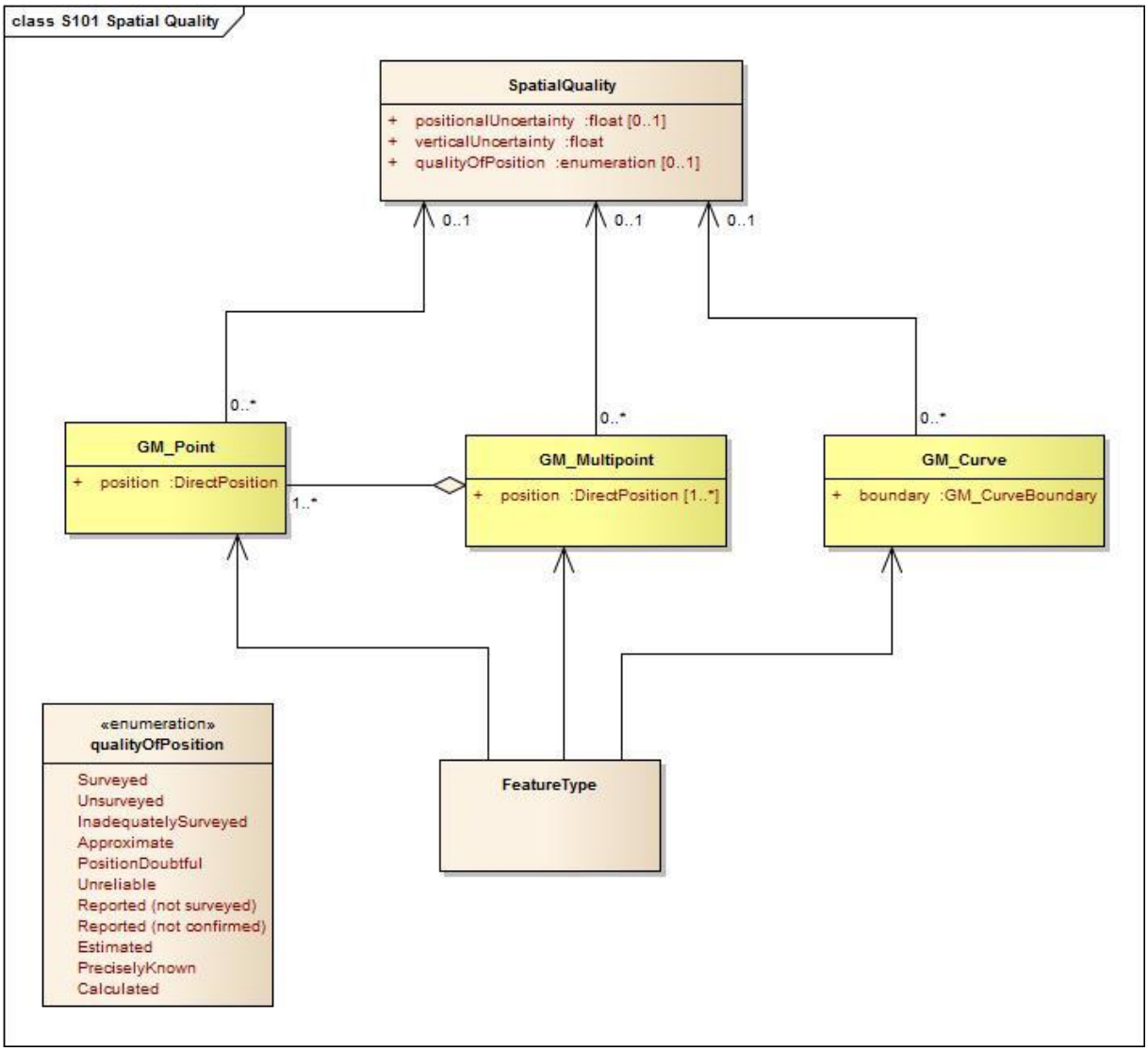

Figure 4 - Spatial Quality Information Type

4.3.5 Attributes

S-101 defines attributes as either simple or complex.

4.3.5.1 Simple Attributes

S-100 uses nine types of simple attributes; they are listed in the following table:

Type	Definition
Boolean	the value is a logical value either ‘True’ or ‘False’
Integer	the value is an integer number
Real	the value is a floating point number
Enumeration	the value is one of a list of predefined values
Codelist	the value is an open enumeration, or the identifier of a vocabulary (mapping between codes, labels and definitions) [Not currently used in S-101]

Text	the value is general text. This is also defined as CharacterString
Date and Time	the value marks a point in time, consisting of a date in the Gregorian calendar and a 24 hour time. The time may contain a time zone [Not currently used in S-101]
Truncated Date	the value is a date according to the Gregorian calendar, and allows for partial dates to be provided
Time	the value is a 24 hour time, it may contain a time zone

Table 2 - Simple Attribute Types

4.3.5.2 Complex Attributes

Complex attributes are aggregations of other attributes that are either simple or complex. The aggregation is defined by means of attribute bindings.

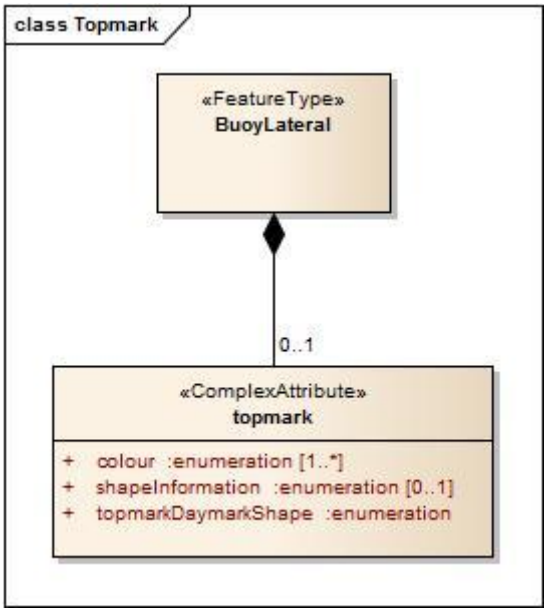

Figure 5 - Complex Attribute

EXAMPLE In this example the complex attribute **topmark** has three sub attributes. The **Buoy Lateral** feature may optionally include one instance of **topmark**.

4.4 Feature Object Identifier

Each real world feature within an ENC must have a unique universal Feature Object Identifier. This identifier is formed by the binary concatenation of the contents of the subfields of the “Feature Object Identifier” [FOID] field. Information types must not have a FOID.

The FOID may be used to identify that the same feature has instances in separate datasets. For example the same feature included in different maximum display scale datasets, or a feature being split by the ENC dataset limits within the same maximum display scale.

FOIDs must not be repeated in a dataset. Where a real-world feature has multiple parts within a single ENC dataset due to ENC dataset limit truncations, the feature will reference each spatial part of the feature within the dataset. This is accomplished in the ISO/IEC 8211 encoding by including a Spatial Association for each disjoint component. When a feature’s geometry is split each component must be represented by a separate spatial feature that the feature refers to.

Where a real-world feature is repeated in datasets of different maximum display scale, the FOID should be repeated for each instance of the feature across the maximum display scale range. Where

this occurs, all instances of the geo feature must be identical, that is same feature class and attribute values.

Feature Object Identifiers must not be reused by another feature, even when a feature has been deleted. The same feature can be deleted and added again later using the same FOID.

4.5 Dataset

4.5.1 Introduction

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

4.5.2 Dataset rules

In order to facilitate the efficient processing of ENC 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.

An ENC update dataset must not change the limit of a **Data Coverage** feature for the base ENC dataset. Where the limit of a **Data Coverage** feature for a base ENC dataset is to be changed, this must be done by issuing a new edition of the dataset.

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

4.5.3 Data Coverage rules

- All base datasets (new dataset, new edition and re-issue) must contain at least one **Data Coverage** feature, but must not contain more than three **Data Coverage** features.
- 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 a single **Data Coverage** feature then the **maximum display scale** of the dataset must be equal to the **maximum display scale** of the **Data Coverage** feature. When a dataset has multiple **Data Coverage** features then the **maximum display scale** of the dataset must be equal to the value corresponding to the largest scale **maximum display scale** value of the **Data Coverage** features.
- The **maximum display scale** is considered to be the equivalent of the compilation scale of the data.

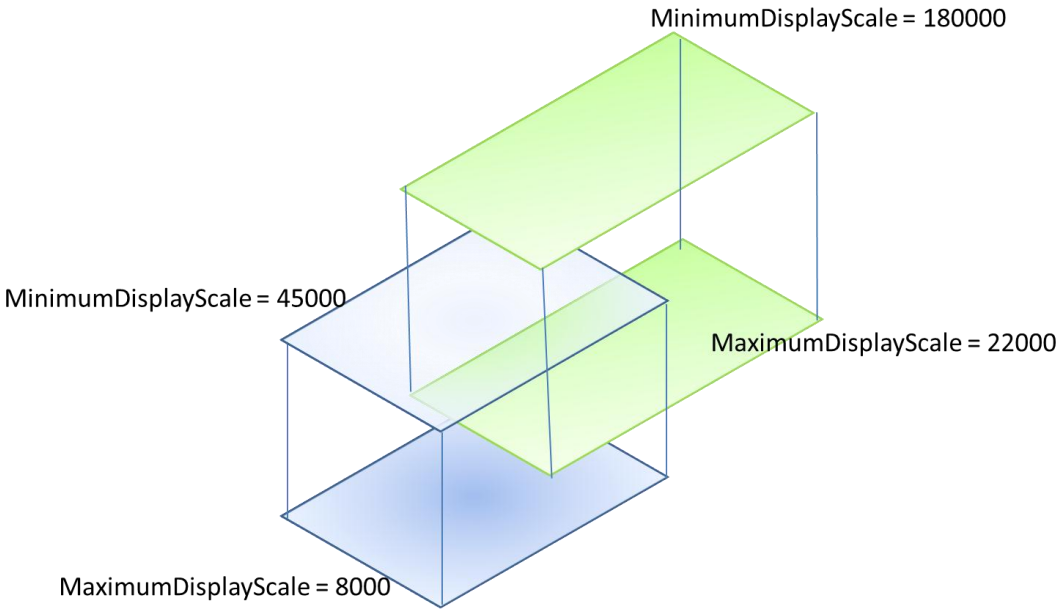

Figure 7 - Data Coverage Rules

4.5.4 Dataset size

Datasets must not exceed 10MB.

Update datasets should not normally be larger than 50kb and must not be larger than 200kb.

4.6 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. (See clause 4.7 for how datasets are to be loaded and unloaded within a navigation system.) 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 in clause 3 (spatial resolutions).

When the systems viewing scale is smaller than the value indicated by **minimum display scale**, features within the **Data Coverage** feature are not displayed, except where the SENC does not contain a dataset covering the area at a smaller scale, in which case the dataset will be displayed at all smaller scales. As required by the IMO Performance Standards for ECDIS, when the viewing scale is larger than the value indicated by **maximum display scale**, the overscale indication is shown.

4.7 Dataset Loading and Unloading

A new algorithm based on producer defined dataset display scales (minimum and maximum) for dataset loading and unloading within a navigation system is prescribed in S-101 in order for the appropriate ENC to be viewed at the mariner's selected viewing scale. This will simplify the process for navigation systems, giving clear and concise rules on how and when data is loaded and unloaded. The concept of navigation purpose is restricted for use in presenting ENCs in a visual catalogue and must not be used for determining which dataset should be displayed.

4.7.1 Dataset Loading and Unloading Algorithm

This clause defines the dataset loading and unloading algorithm for use within marine navigation systems.

In order for systems to properly load and unload data as the mariner is zooming in and out using the mariner's selected viewing scale (MSVS) the following algorithm must be used.

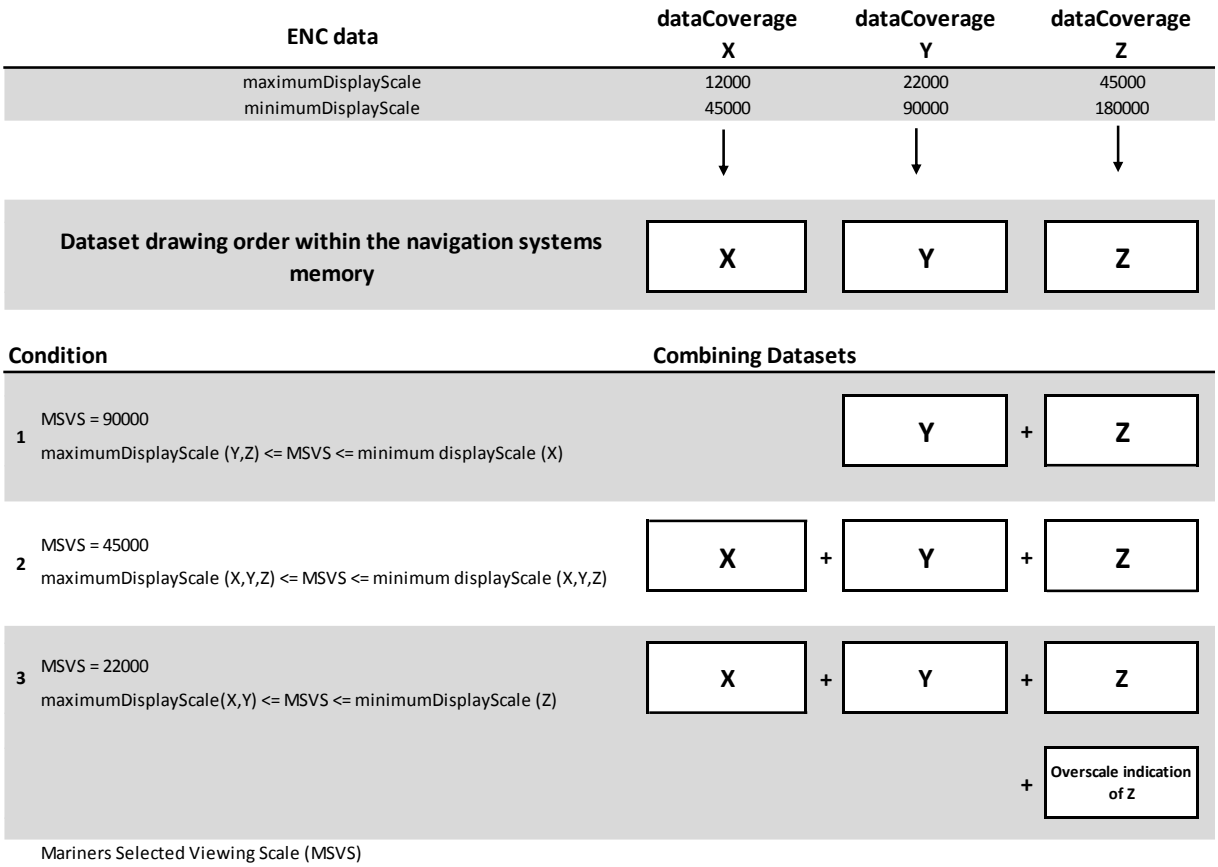

Figure 6 - Data Loading and Unloading Algorithm

1. Create selection List

   a. All **Data Coverage** areas within the graphics window within scale range (covered by the MSVS) are firstly ordered by **maximum display scale** and secondly by the largest percentage of coverage if **Data Coverage** areas have the same **maximum display scale**

   b. All other smaller scale **Data Coverage** areas within the graphics window are firstly ordered by **maximum display scale** and secondly by the largest percentage of coverage if **Data Coverage** areas have the same **maximum display scale**

   c. The display order is from the smallest **maximum display scale** to the largest **maximum display scale**, that is the **Data Coverage** area with largest **maximum display scale** will be displayed with the highest priority

   d. If adjacent data coverages have the same **maximum display scale** they should be drawn so that all objects of a given display priority from the adjacent data coverages are drawn prior to drawing objects of the next display priority

2. If the MSVS is larger than the **maximum display scale** of an area within the window, turn on overscale indication.

3. If the mariner selects an individual dataset to load it must be displayed at its **maximum display scale**, that is MSVS is set to the **maximum display scale** of the selected dataset, and then the algorithm is used to fill the graphics window.

The example below works through four scenarios and uses four different types of **Data Coverage** with different **maximum display scale** and **minimum display scale**. They are denoted as areas A, B, C and D.

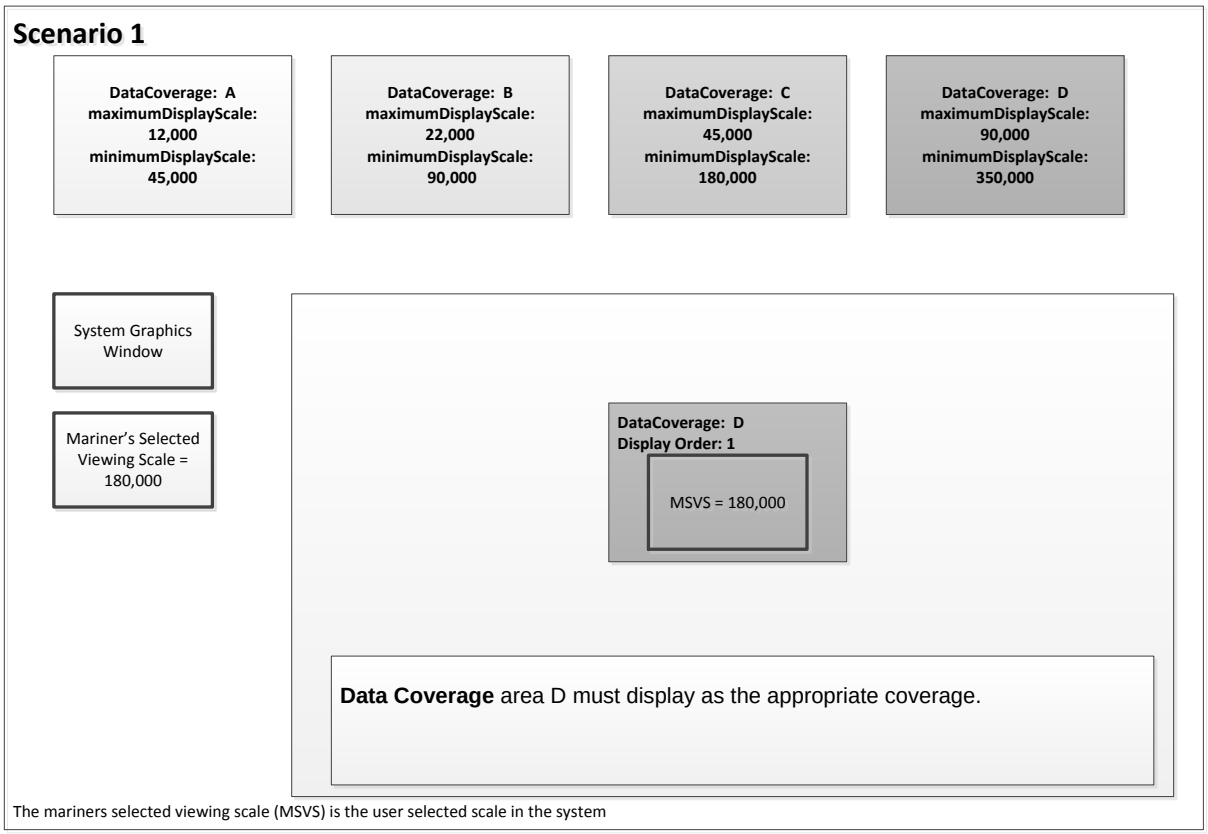

Figure 7 – Scenario 1: Simple Data Coverage Display

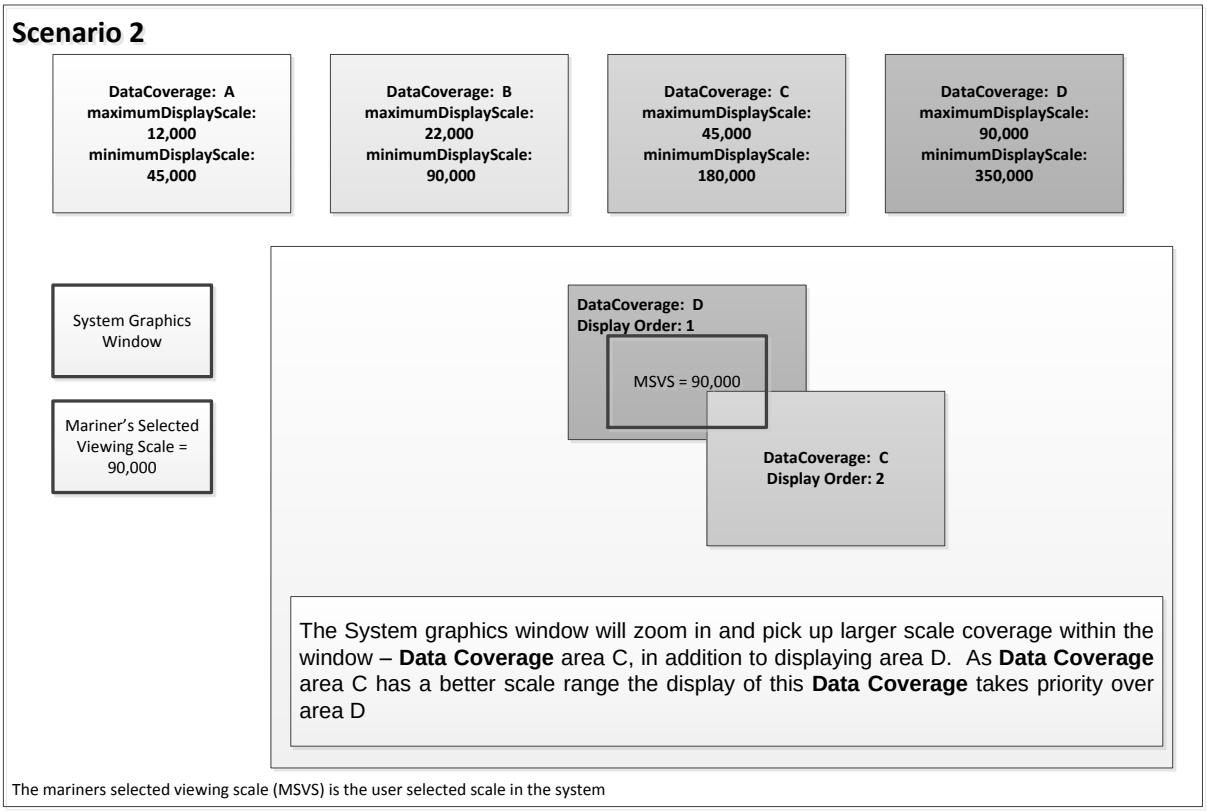

Figure 8 - Scenario 2: Display of two different overlapping Data Coverages

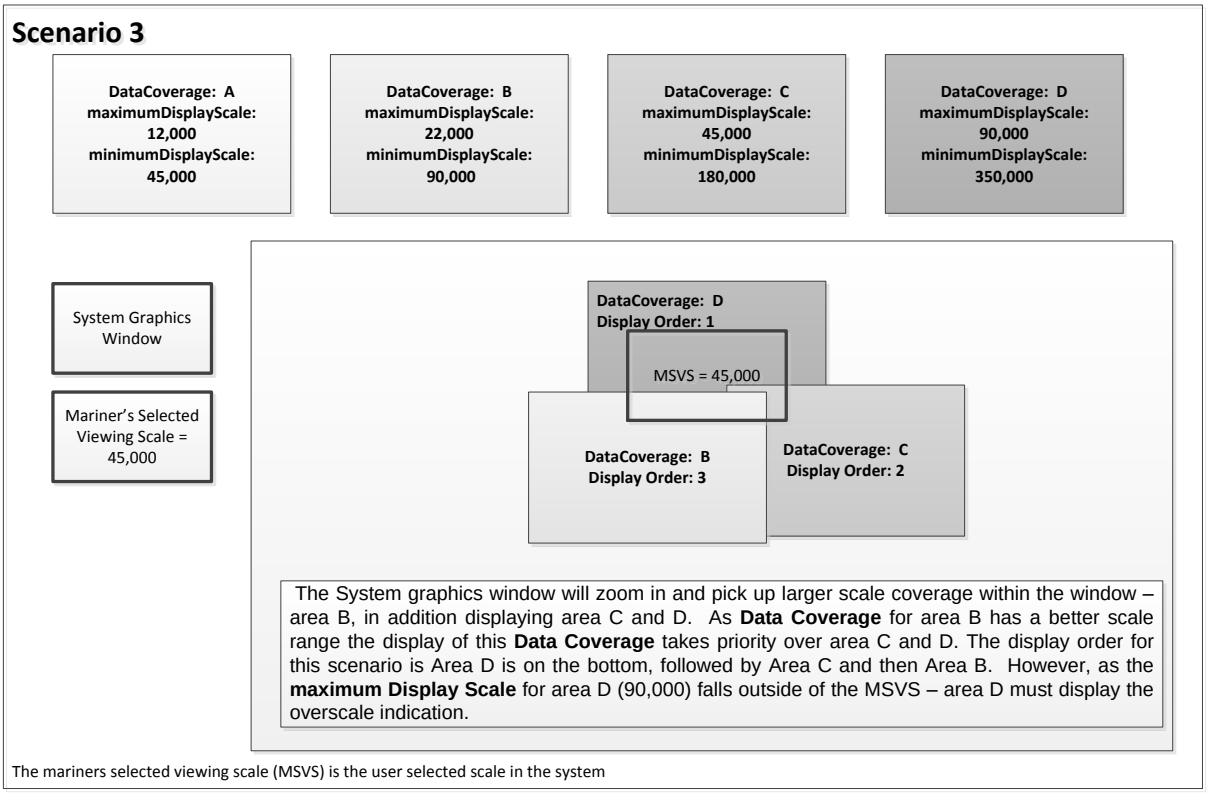

Figure 9 - Scenario 3: Display of three different overlapping Data Coverages

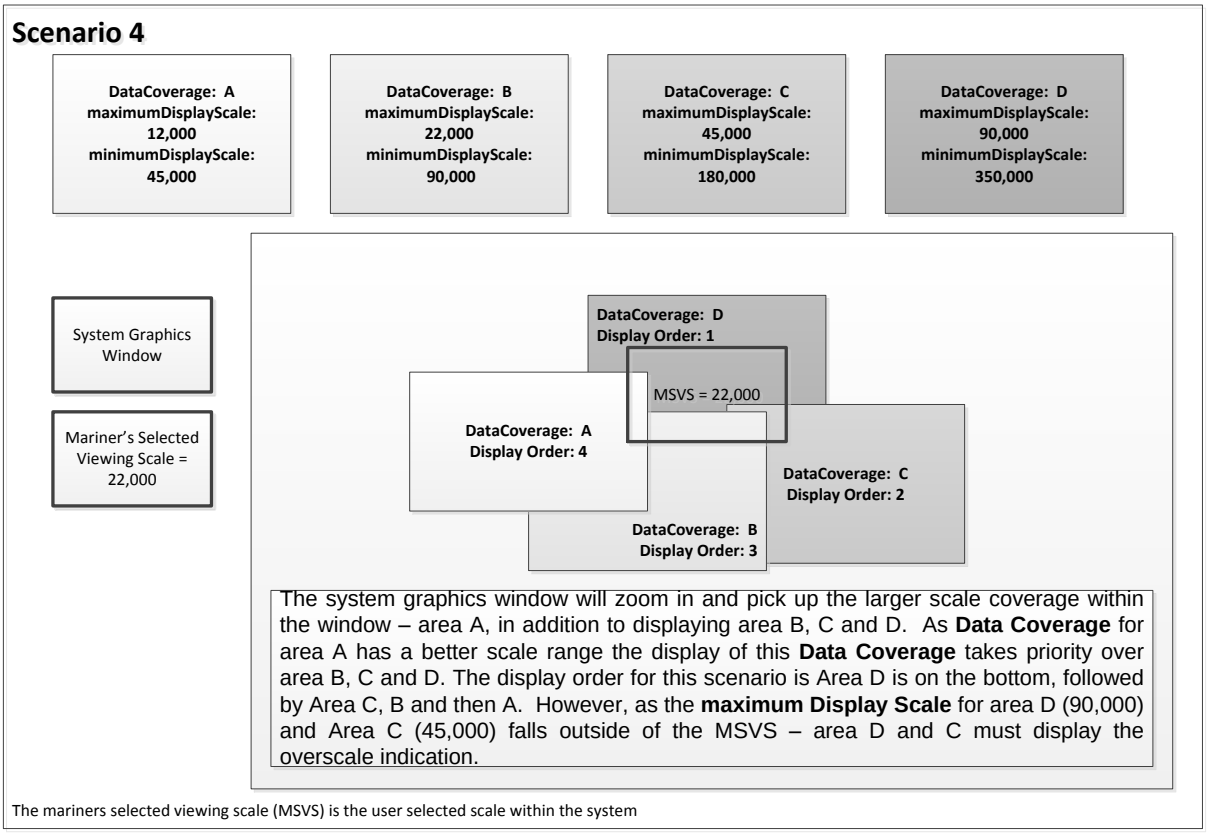

Figure 10 - Scenario 4: Display of four different overlapping coverages

4.8 Geometry

4.8.1 S-100 Level 3a Geometry

The underlying geometry of an ENC is constrained to level 3a which supports 0, 1 and 2 dimensional features (points, curves and surfaces) as defined by S-100 Part 7 – Spatial Schema.

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 Figure 13.
- 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 Figure 14.
- 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 Figure 15.

S-101 further constrains Level 3a with the following:

- Coincident linear geometry must be avoided when there is a dependency between features.
- The interpolation of GM_CurveSegment must be loxodromic.
- Linear geometry is defined by curves which are made of curve segments. Each curve segment contains the geographic coordinates as control points and defines an

interpolation method between them. The distance between two consecutive control points must not be less than 0.3 mm at the maximum display scale.

The following exception applies to S-101:

- The use of coordinates is restricted to two dimensions, except in the case of features **Depth – No Bottom Found** and **Sounding** which use GM_Point or GM_Multipoint with three dimensional coordinates.

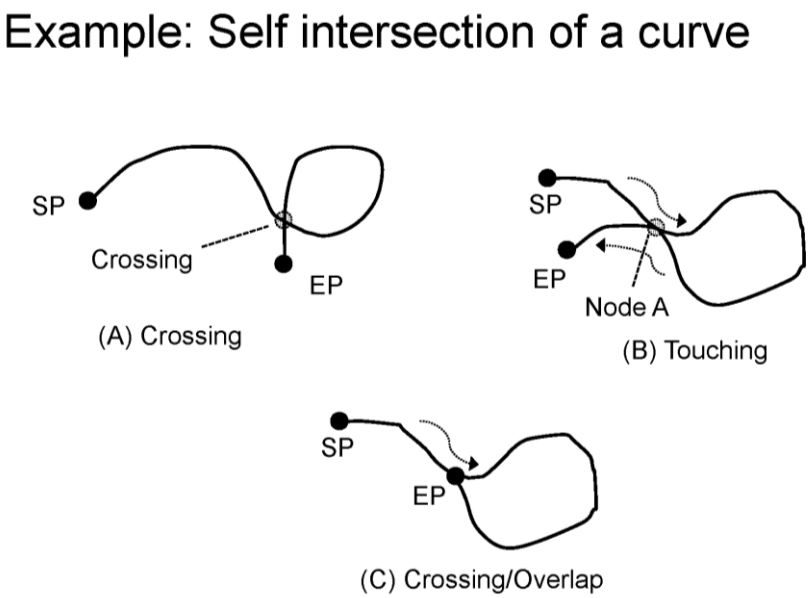

Figure 11 - Self Intersect Example

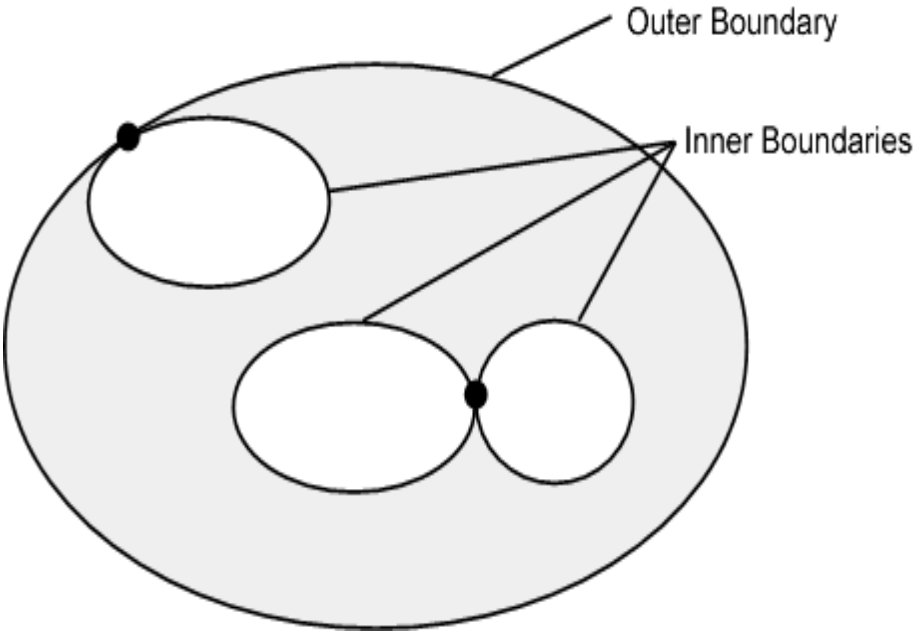

Figure 14 - Area Holes

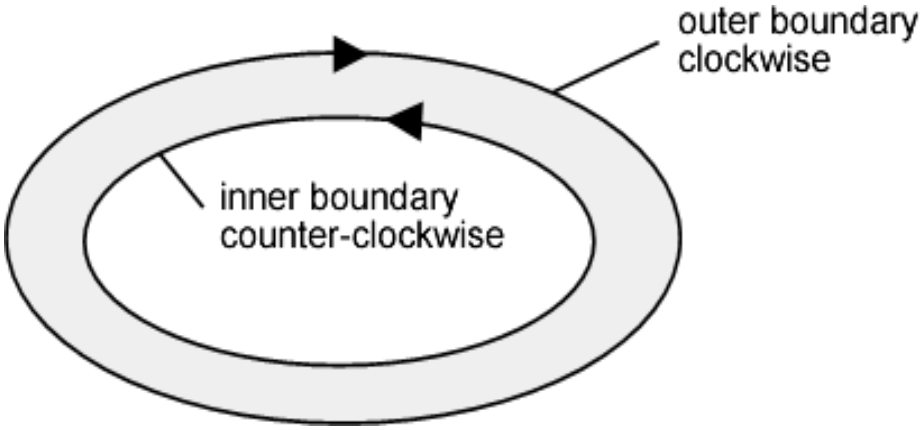

Figure 15 - Boundary Direction

4.8.2 Masking

In certain circumstances, the symbolisation of a curve may need to be suppressed. This is done using the Masked Spatial Type [MASK] field of the Feature Type record. The Mask Update Instruction [MUIN] must be set to {1} and Referenced Record name [RRNM] and Referenced Record identifier [RRID] fields must be populated with the values of the referenced spatial record. The Mask Indicator [MIND] must be set to either {1} or {2} (see Annex B – clause B5.1.33).

Figure 16 is an example without masking and Figure 17 is an example of a masked edge between **River** and **Depth Area** features, where the seaward edge of the **River** should be masked. In this example MIND is set to {2} – suppress portrayal.

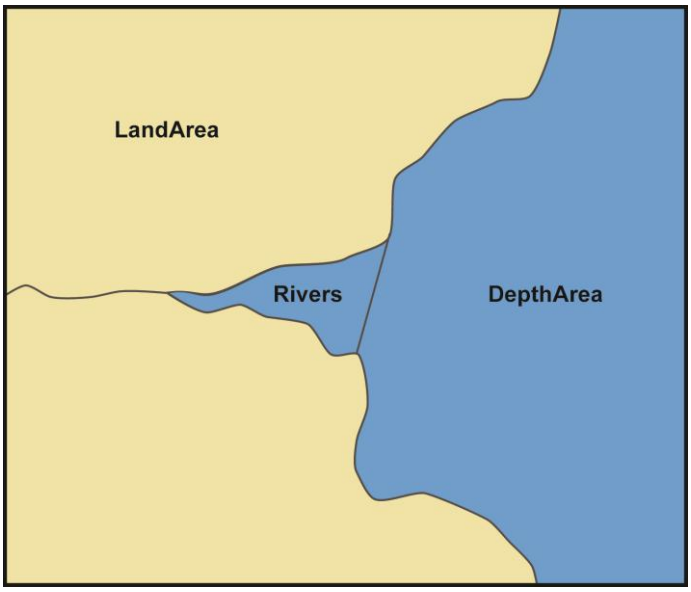

Figure 16 - Example without masking

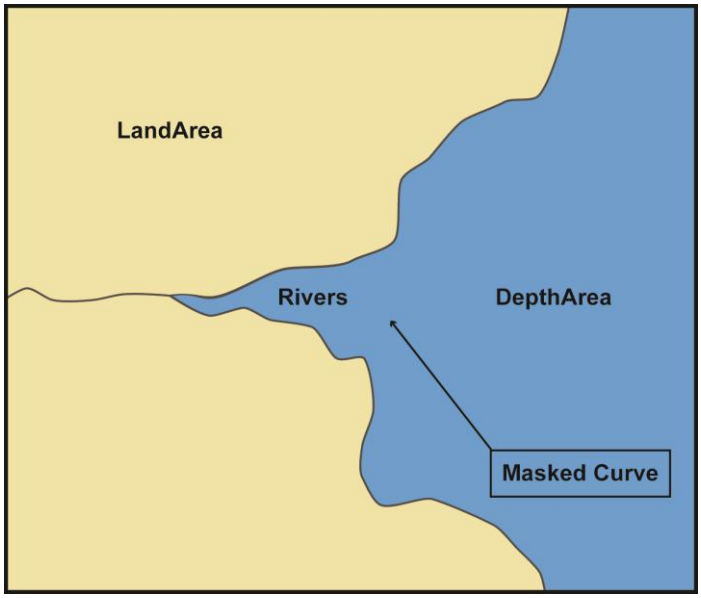

Figure 17 - Example with masking

5 Coordinate Reference Systems (CRS)

5.1 Introduction

An ENC dataset must define at least one compound CRS, which must be composed of one geodetic CRS and one vertical CRS. All compound CRSs within the same dataset must use the same geodetic CRS.

5.2 Horizontal Coordinate Reference System

For ENC the horizontal CRS must be EPSG:4326 (WGS84). The full reference to EPSG: 4326 can be found at www.epsg-registry.org.

Horizontal coordinate reference system:	EPSG:4326 (WGS84)
Projection:	None
Temporal reference system:	Gregorian calendar
Coordinate reference system registry:	EPSG Geodetic Parameter Registry
Date type (according to ISO 19115):	002- publication
Responsible party:	International Organisation of Oil and Gas Producers (IOGP)
URL:	http://www.iogp.org

5.3 Vertical CRS for Soundings

For ENC the vertical CRS must be in metres. Depths are represented by positive values, while negative values indicate intertidal (drying) soundings.

Although all coordinates in a dataset must refer to the same geodetic CRS, different Vertical Datums can be used for the depth component of a coordinate tuple. Therefore the vertical CRS can be repeated. For each vertical CRS a unique identifier is defined. Those identifiers will be used to indicate which Vertical CRS is used.

The encoding of the Coordinate Reference System record will be demonstrated with the following

examples. The example at Table 3 specifies a compound CRS. The first component is a 2D Geographic CRS (WGS84). The second component is a Vertical CRS for depth using the Vertical Datum: Lowest Astronomical Tide.

Field	Subfield	Value	Description
CSID			**Coordinate Reference System Record Identifier**
	RCNM	15	Record Name (15 = Coordinate Reference System Identifier)
	RCID	1	Record Identification Number
	NCRC	2	Number of CRS Components
CRSH			**Coordinate Reference System Header**
	CRIX	1	CRS Index
	CRST	1	CRS Type (1 = 2D Geographic)
	CSTY	1	Coordinate System Type (1 = Ellipsoidal CS)
	CRNM	WGS84	CRS Name
	CRSI	4326	CRS Identifier
	CRSS	2	CRS Source (2 = EPSG)
	SCRI		CRS Source Information (omitted)
CRSH			**Coordinate Reference System Header**
	CRIX	2	CRS Index
	CRST	5	CRS Type (5 = Vertical)
	CSTY	3	Coordinate System Type (3 = Vertical)
	CRNM	Depth - lowest astronomical tide	CRS Name
	CRSI		CRS Identifier (omitted)
	CRSS	255	CRS Source (255 = Not Applicable)
	SCRI		CRS Source Information (omitted)
CSAX			**Coordinate System Axes**
	AXTY	12	Axis Type (12 = Gravity Related Depth)
	AXUM	4	Axis Unit of Measure (4 = Metres)
VDAT			**Vertical Datum**
	DTNM	lowest astronomical tide	Datum Name
	DTID	23	Datum Identifier (23 = Lowest Astronomical Tide)
	DTSR	2	Datum Source (2 = Feature Catalogue)
	SCRI		Datum Source Information (omitted)

Table 3 – Compound CRS (WGS84 and Lowest Astronomical Tide)

The example at Table 4 is similar to the above except that its second component is encoded with the Vertical Datum: Mean Sea Level.

Field	Subfield	Value	Description
CSID			**Coordinate Reference System Record Identifier**
	RCNM	15	Record Name (15 = Coordinate Reference System Identifier)
	RCID	1	Record Identification Number
	NCRC	2	Number of CRS Components
CRSH			**Coordinate Reference System Header**
	CRIX	1	CRS Index
	CRST	1	CRS Type (1 = 2D Geographic)
	CSTY	1	Coordinate System Type (1 = Ellipsoidal CS)
	CRNM	WGS84	CRS Name
	CRSI	4326	CRS Identifier
	CRSS	2	CRS Source (2 = EPSG)
	SCRI		CRS Source Information (omitted)
CRSH			**Coordinate Reference System Header**
	CRIX	2	CRS Index
	CRST	5	CRS Type (5 = Vertical)
	CSTY	3	Coordinate System Type (3 = Vertical)

	CRNM	Depth - mean sea level	CRS Name
	CRSI		CRS Identifier (omitted)
	CRSS	255	CRS Source (255 = Not Applicabel)
	SCRI		CRS Source Information (omitted)
CSAX			**Coordinate System Axes**
	AXTY	12	Axis Type (12 = Gravity Related Depth)
	AXUM	4	Axis Unit of Measure (4 = Metres)
VDAT			**Vertical Datum**
	DTNM	mean sea level	Datum Name
	DTID	3	Datum Identifier (3 = Mean Sea Level)
	DTSR	2	Datum Source (2 = Feature Catalogue)
	SCRI		Datum Source Information (omitted)

Table 4 – Compound CRS (WGS84 and Mean Sea Level)

6 Data Quality

6.1 Introduction

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.

For S-101 the following data quality elements have been included;

- Conformance to this Product Specification;
- Intended purpose of the data product;
- Completeness of the data product in terms of coverage;
- Logical Consistency;
- Positional Uncertainty and Accuracy;
- Thematic Accuracy;
- Temporal Quality;
- Aggregation measures;
- Anything specifically required for S-101; and
- Validation checks or conformance checks including:
    - General tests for dataset integrity;
    - Specific tests for compliance against the S-101 data model.

For S-101 data quality is divided into two parts – data compliance and integrity against all requirements of S-101; and bathymetric data quality.

6.1.1 Data Compliance and Integrity

All S-101 datasets must be validated against the above data quality elements using conformance checks that are located in Annex C – ENC Validation Checks.

S-101 datasets must conform to all mandatory elements of Annex A – Data Classification and Encoding Guide, where the word ‘must’ is used.

6.1.2 Bathymetric Data Quality

Bathymetric data quality comprises the following:

completeness of data (for example, seafloor coverage);

currency of data (for example, temporal degradation);

uncertainty of data;

source of data.

Data quality can be encoded at three different metadata levels (dataset, feature, feature instance). All horizontal position (2D), vertical (1D), horizontal distance (1D) and orientation (1D) uncertainty attributes concern the 95% confidence level of the variation associated with all sources of measurement, processing and visualization error. Uncertainty due to temporal variation should not be included in these attributes.

The meta feature for Bathymetric data quality is **Quality Of Bathymetric Data**.

6.1.3 Non-bathymetric Data Quality

The meta feature **Quality Of Non-bathymetric Data** allows for data quality to be expressed for non-bathymetric items.

6.1.4 Survey Data Quality

The quality of the surveys from which charted features are derived can be further expressed using the meta feature **Quality of Survey**. **Quality of Survey** can apply to bathymetry (for example, underwater rocks), non-bathymetry (for example, navigational aids) and a combination of these (for example, LIDAR survey).

7 Data Capture and Classification

The S-101 ENC Data Classification and Encoding Guide (DCEG) describes how data describing the real world should be captured using the types defined in the S-101 Feature Catalogue. This Guide is located at Annex A.

8 Maintenance

8.1 Introduction

This clause describes the requirement to adequately maintain datasets; use of newly acquired source data; maintenance requirements within the overall production process; and how Feature and Portrayal Catalogues are to be managed within an S-100 based marine navigation system.

8.2 Maintenance and Update Frequency

Datasets must be maintained as needed; and the overall production process must include mechanisms for ENC updating designed to meet the needs of the mariner regarding safety of navigation.

8.3 Data Source

Data Producers must use all available and applicable sources, as evaluated against a robust data assessment process, to maintain and update ENC datasets as required.

8.4 Production Process

Data Producers should follow their established production processes for maintaining and updating datasets. Data must be maintained against S-101 Annex A – Data Classification and Encoding Guide, checked against S-101 Annex C – ENC Validation Checks, and encapsulated in ISO/IEC 8211.

Only maintained datasets that conform to the mandatory requirements outlined in S-101 will be considered to be an ENC satisfying the SOLAS chart carriage requirements for use in an ECDIS.

8.5 Feature and Portrayal Catalogue Management

For each new version of the S-101 Product Specification a new Feature and Portrayal Catalogue will be released. The end user system must be able to manage datasets and their corresponding catalogues that are created using different versions of the S-101 Product Specification.

9 Portrayal

9.1 Introduction

S-101 portrayal is intended to contribute to the safe operation of an S-100 based marine navigation system by:

- Ensuring base and supplementary levels of display for ENC data; standards of symbols, colours and their standardized assignment to features; scale limitations of data presentation; and appropriate compatibility with paper chart symbols as standardized in the Chart Specifications of the IHO (IHO Publication S-4);
- Ensuring the display is clear and unambiguous;
- Establishing an accepted pattern for presentation that becomes familiar to mariners and so can be recognized instantly without confusion; and
- Utilizing the S-100 portrayal model to ensure interoperability.

S-101 portrayal is covered by the portrayal model as defined in S-100. This model reflects how the Portrayal Catalogue is defined for use in marine navigation systems. The Portrayal Catalogue defines symbology and the portrayal rules for each feature/attribute combination contained in the Feature Catalogue.

S-101 uses the portrayal process defined in S-100 Part 9A.

9.2 Portrayal Catalogue

Item Name	Description	M/O	Card	Type
S101_PortrayalCatalogue	Catalogue containing the mechanisms to portray S-101 ENCs	M	1	CI_Citation (ISO 19115)

Table 5 – S-101 Portrayal Catalogue

The Portrayal Catalogue contains the mechanisms for the system to portray information found in S-101 ENCs. The S-101 Portrayal Catalogue contains the following types of mechanisms and structures:

- Set of portrayal rules;
- Set of pixmaps, symbols, complex line styles, area fills, fonts and colour profiles.

The portrayal catalogue model is defined in S-100 Part 9.

The S-101 Portrayal Catalogue will be available in an XML document which conforms to the S-100 XML Portrayal Catalogue Schema and is structured as follows:

Root ---- (contains the catalogue named "**portrayal_catalogue.xml"**)
|
|-- Pixmaps (contains XML files describing pixmaps)
|
|-- ColorProfiles (contains XML files with colour profiles and CSS2 style sheets)
|
|-- Symbols (contains SVG files with symbols)
|
|-- LineStyles (contains XML files with line styles)
|
|-- AreaFills (contains XML files area fills)
|
|-- Fonts (contains TrueType font files)
|
|-- Rules (contains files with rules which map features to drawing instructions)

10 Data Product format (encoding)

10.1 Introduction

This clause specifies the encoding for S-101 datasets. See Annex B for a complete description of the data records, fields and subfields defined in the encoding.

Format Name: ISO/IEC 8211

Character Set: ISO 10646 Base Multilingual Plane

Specification: S-100 profile of ISO/IEC 8211 (S-100 Part 10A)

10.1.1 Encoding of Latitude and Longitude

Coordinates are stored as integers. Latitude and longitude are converted to integers using a multiplication factor held in the Dataset Structure Information field under [CMFX] and [CMFY] (see Annex B – clause B5.1.2).

These coordinate multiplication factors must be set to {10000000} (10^7) for all datasets.

EXAMPLE A longitude = 42.0000 is converted into X = longitude * CMFX = 42.0000 * 10000000 = 420000000.

10.1.2 Encoding of Depths

Depths are converted from decimal metres to integers by means of the [CMFZ] (see Annex B – clause B5.1.2). This Product Specification limits the resolution to two decimal places and therefore the [CMFZ] must be set to {100}.

EXAMPLE: A depth = 4.2 is converted in Z = depth*CMFZ = 4.2*100 = 420

10.1.3 Numeric Attribute Encoding

Floating point and integer attribute values must not contain leading zeros. Floating point attribute values must not contain non-significant trailing zeros.

10.1.4 Text Attribute Values

Character strings must be encoded using the character set defined in ISO 10646-1, in Unicode Transformation Format-8 (UTF-8).

10.1.5 Mandatory Attribute Values

The following are reasons why attribute values may be considered mandatory:

- They are required to support correct portrayal by determining
  - whether a feature is in the display base
  - which symbol is to be displayed;
- Certain features make no logical sense without specific attributes;
- Some attributes are required for safety of navigation.

All mandatory attributes are identified in the Feature Catalogue and summarised in Annex A – Data Classification and Encoding Guide.

10.1.6 Unknown Attribute Values

In a Base dataset and an Update dataset, when an attribute code is present but the attribute value is missing, it means that the producer wishes to indicate that this attribute value is unknown.

In an Update dataset, when an attribute code is present but the attribute value is missing it means:

- that the value of this attribute is to be replaced by an empty (null) value if it was present in the original dataset; or
- that an empty (null) value is to be inserted if the attribute was not present in the original dataset.

11 Data Product Delivery

11.1 Introduction

This clause specifies the encoding and delivery mechanisms for an S-101 ENC. Data which conforms to this Product Specification must be delivered by means of an exchange set.

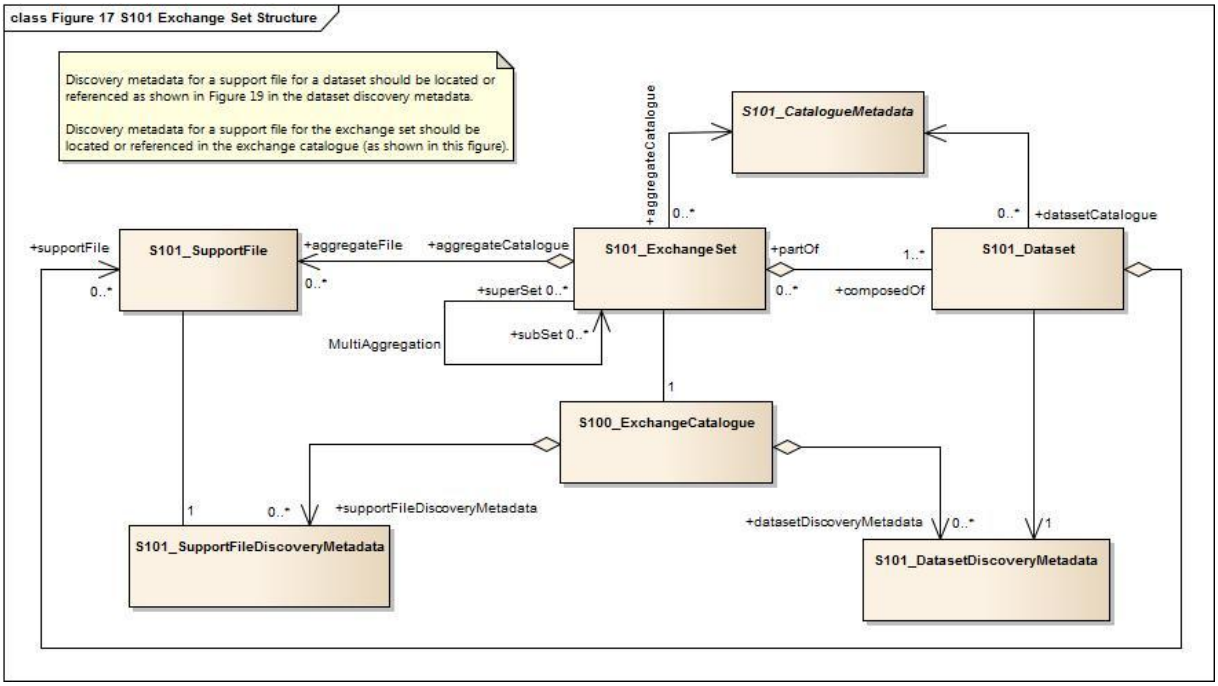

Figure 18 - Exchange Set Structure

11.2 Exchange Set

S-101 datasets are grouped into exchange sets. Each exchange set consists of one or more ENC datasets with an associated XML metadata file and a single Exchange Catalogue XML file containing metadata. It may also include one or more support files.

Units of Delivery: Exchange Set

Transfer Size: Unlimited

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 and references to any support files.

Support files are supplementary information which are linked to the features by the following simple attributes within the dataset:

- **file reference**
- **pictorial representation**.

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 also may define commercial constructs such as encryption and compression methods.

If the data is transformed in S-101 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:

11.2.1 Mandatory Elements

- ENC datasets – ISO/IEC 8211 encoding of features/attributes and their associated geometry and metadata.

- Exchange Catalogue – the XML encoded representation of exchange set catalogue features [discovery metadata].

11.2.2 Optional Elements

- Supplementary files – These are contained within the exchange set as files; and the mapping from the name included within the dataset and the physical location on the media is defined within the Exchange Catalogue.

- S-101 Feature Catalogue – If it is necessary to deliver the latest Feature Catalogue to the end user it may be done using the S-101 exchange set mechanism for datasets.

- S-101 Portrayal Catalogue - If it is necessary to deliver the latest Portrayal Catalogue to the end user it may be done using the S-101 exchange set mechanism for datasets.

11.3 Dataset

11.3.1 Datasets

Four types of dataset files may be produced and contained within an exchange set:

- New dataset and new edition of a dataset (Base dataset): Including new information which has not been previously distributed by updates. Each new edition of a dataset must have the same name as the dataset that it replaces. A new edition can also be ENC data that has previously been produced for this area and at the same maximum display scale. The encoding structure is located in Annex B – clause B5.
- Update: Changing some information in an existing dataset. The encoding structure for an Update is located in Annex B – clause B6.
- Re-issue of a dataset: Including all the updates applied to the original dataset up to the date of the reissue. A Re-issue is intended to avoid unnecessary loading of the Base cell and all applicable updates individually for new users of the dataset, therefore does not contain any new information additional to that previously issued by updates, and can be issued at any time. The encoding structure is located in Annex B – clause B5.
- Cancellation: The dataset is cancelled and is deleted from the system. The encoding structure for a Cancellation file is located in Annex B – clause B7.

11.3.2 Dataset file naming

101CCXXXXXXXXXX.EEE

The file name forms a unique S-101 identifier where:

- 101 - the first 3 characters identify the dataset as an S-101 dataset (mandatory).
- CC - the fourth and fifth characters identify the country code of the issuing agency, according to ISO 3166 (mandatory for S-101).
- the sixth to the maximum fifteenth 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).
- .EEE – new editions use 000, updates start at 001 and increment until a limit of 999 (mandatory). Re-issues use the same number as the last Update applied to the dataset.

11.3.3 New Editions, Re-issues, Updates and Cancellations

This section defines the sequencing of S-101 datasets for New Editions, Updates and Re-issues. In order to ensure that feature type updates are incorporated into an end user system in the correct sequence without any omission, a number of parameters encoded in the data are used in the following way:

Edition number When a dataset is initially created (Base dataset), the Edition number 1 is assigned to it. The Edition number is increased by 1 at each New Edition.

Update number Update number 0 is assigned to a new dataset and a New Edition. The first Update dataset file associated with this new dataset must have Update number 1. The Update number must be increased by one for each subsequent Update, until a New Edition is released.

A **Re-issue** of a dataset must have the Update number of the last Update applied to the dataset, and use the same Edition number.

Update comment Comment for describing the change introduced by an Update.

Issue date Date up to which the data producer has incorporated all applicable changes. The issue date must be greater than the previous issue date of the dataset.

In order to cancel a dataset, an Update dataset file is created for which the Edition number must be set to 0. This message is only used to cancel a Base dataset file. Where a dataset is cancelled and its name is reused at a later date, the issue date must be greater than the issue date of the cancelled dataset. When the dataset is cancelled it must be removed from the system.

An exchange set may contain Base dataset files and Update dataset files for the same datasets. Under these circumstances the Update dataset files must follow on in the correct sequential order from the last Update applied to the Base dataset file.

11.4 Support Files

Dataset support files offer supplementary information that can be included in an ENC exchange set.

- Text files must contain only general text as defined by this standard. (Extensible mark-up language (XML) supports UTF-8 character encoding.) **(TXT)**, **(XML)**, **(HTM)**.

- Picture files must be in TIFF (6.0 specification) or PDF format. **(TIFF)**, **(PDF)**.

File Types	Extensions	Comment
Text	TXT	
	HTM	HTML files must only include inline or embedded Cascading Style Sheet (CSS) information and must not contain embedded Javascript or other dynamic content, for example DHTML, Flash etc.
	XML	XML documents must only be included in accordance with guidance provided within the Data Classification and Encoding Guide (S-101 Annex A). This may include a schema for the validation of XML documents.
Picture	TIF	Baseline TIFF 6.0.
	PDF	

Table 6 - Support file extensions

11.4.1 Support File Naming

All support files must have unique universal file identifiers. The file identifier of support information should not be used to describe the physical content of the file. The support file metadata that accompanies the file will inform the user of the name and purpose of the file (that is new, replacement and deletion).

In this encoding the support files are named according to the specifications given below:

CCXXXXXXXX.EEE

The main part forms an identifier where:
- the first two characters identify the country code of the issuing agency, according to ISO 3166 (mandatory).
- the third to the maximum tenth characters are optional and can be used in any way by the producer to provide the unique file name. The following characters are allowed in the support file name: A to Z, 0 to 9 and the special character _ (underscore).
- .EEE – support file extension. (TXT, HTM, XML, TIF or PDF).

11.4.2 Support File Management

When a support file is created or a subsequent version is issued it must carry its own issue date and be supported with a digital signature which authenticates it against the producer's public key included in the exchange set metadata.

The type of support file is indicated in the “purpose” field of the discovery metadata. Support files carrying the “deletion” flag must be removed from the system. When a feature pointing to a text, picture or application file is deleted or updated so that it no longer references the file, the system software must check to see whether any other feature references the same file, before that file is deleted.

Each support file required must be included only once in the exchange set.

Support files should be stored in a separate folder within the exchange set.

Further information about support file management can be found in Annex A – Data Classification and Encoding Guide.

11.5 S-101 Exchange Catalogue

The S-101 exchange catalogue acts as the table of contents for the S-101 exchange set. The catalogue file of the exchange set must be named S101ed1.CAT. No other file in the exchange set may be named S101ed1.CAT. The contents of the S-101 exchange catalogue are described in Clause 12.

11.6 Data integrity and encryption

11.6.1 ENC data integrity measures

Where there is a high impact on the integrity of data as a result of data corruption, such as to ENC data, there is a need for a mechanism within the ENC data itself to ensure it has not changed during transmission/delivery. The mechanism chosen for this assurance is a Digital Signature. File integrity checks are based on the Digital Signature Algorithm (DSA) as defined in the United States Federal Information Processing Standard FIPS 186-4.

S-101 discovery metadata includes a mandatory field for each included dataset file’s digital signature (both data and auxiliary files are included) called “digitalSignature”. The digital signature uniquely authenticates the dataset content against the individual producer’s public key issued and authenticated by the IHO. The combination of the digital signature, the dataset file and the producer’s identity allows the end user to be assured of the origin of the ENC data.

11.6.2 Producer Identity and Authentication

In order to produce a digital signature a producing agency must first have a certified identity. This describes how to define a public/private keypair specific to the producer and how a data producer or distributor is able to have their identity (as embodied in the public/private keypair) certified by the IHO acting as the data protection scheme administrator.

11.6.3 Digital Signatures and metadata

In addition to the metadata included for each dataset file and its digital signature, an exchange set must also provide a public key for every dataset data producer included within the exchange set. The public key is termed “public” because its existence is not kept confidential. Each producer’s public key is included in a “publicKeys” field within the exchange set. These keys are referred to by the digital signature.

Authentication is done in two stages:

1. Verifying that the public key information included in the exchange set validates correctly against the IHOs root level certificate.

2. Verifying that the exchange set ENC data has not changed and the file based digital signatures are valid against the producer’s public key. The IHOs root certificate (certifying the IHOs identity) should be held externally on the implementing system and is not part of the dataset metadata.

11.6.4 ENC data encryption

If data encryption is required then it must be provided only by the mechanisms provided in S-100 Part [??] – it is not mandatory. If it is used then the entire dataset file is encrypted using the [????] algorithm (as defined in S-100) and is included in its encrypted form. IHO S-100 (Part [??]) also allows dataset files to be compressed using the zip algorithm prior to encryption.

12 Metadata

12.1 Introduction

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.

Figures 19 to 22 outline the overall concept of an S-101 exchange set for the interchange of geospatial data and its relevant metadata. Figure 19 depicts the realization of the ISO 19139 classes which form the foundation of the exchange set. The overall structure of S-101 metadata for exchange sets is modelled in Figures 20 and 21. More detailed information about the various classes is shown in Figure 22 and a textual description in the tables at clause 12.3.

The discovery metadata classes have numerous attributes which enable important information about the datasets and accompanying support files to be examined without the need to process the data, for example decrypt, decompress, load etc. Other catalogues can be included in the exchange set in support of the datasets such as feature and portrayal. The attribute “purpose” of the support file metadata provides a mechanism to update support files more easily.

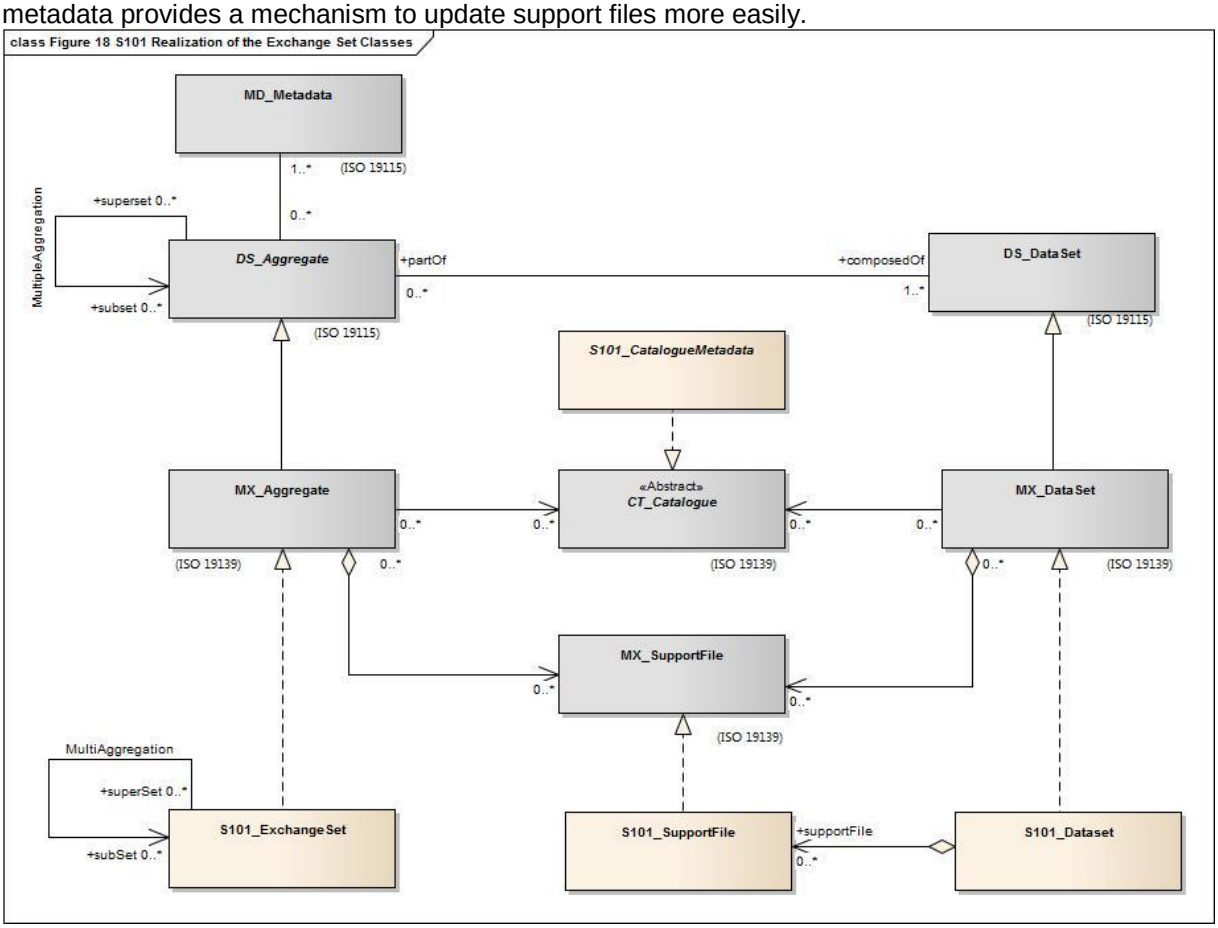

Figure 19 Realization of the Exchange Set Classes

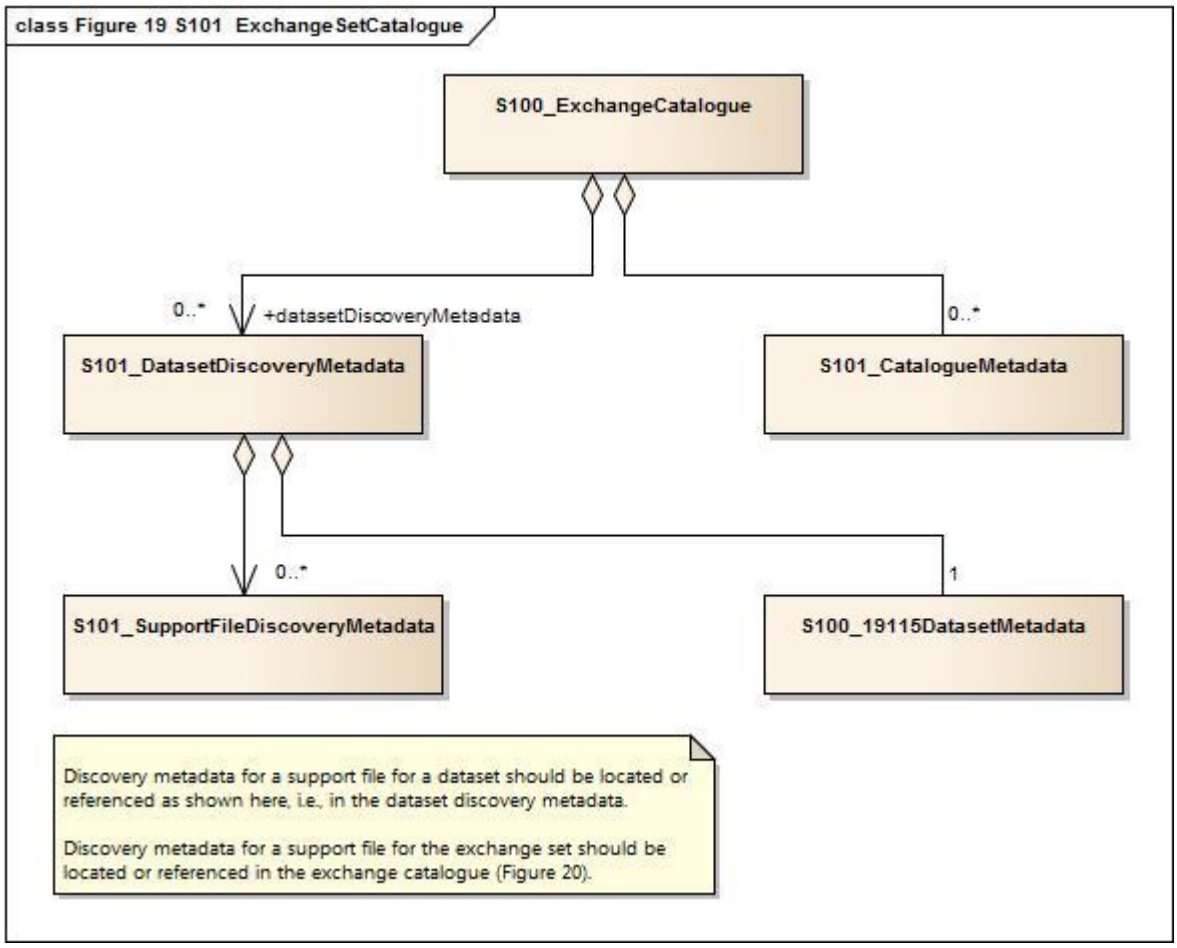

Figure 20 – S-101 Exchange Set Catalogue

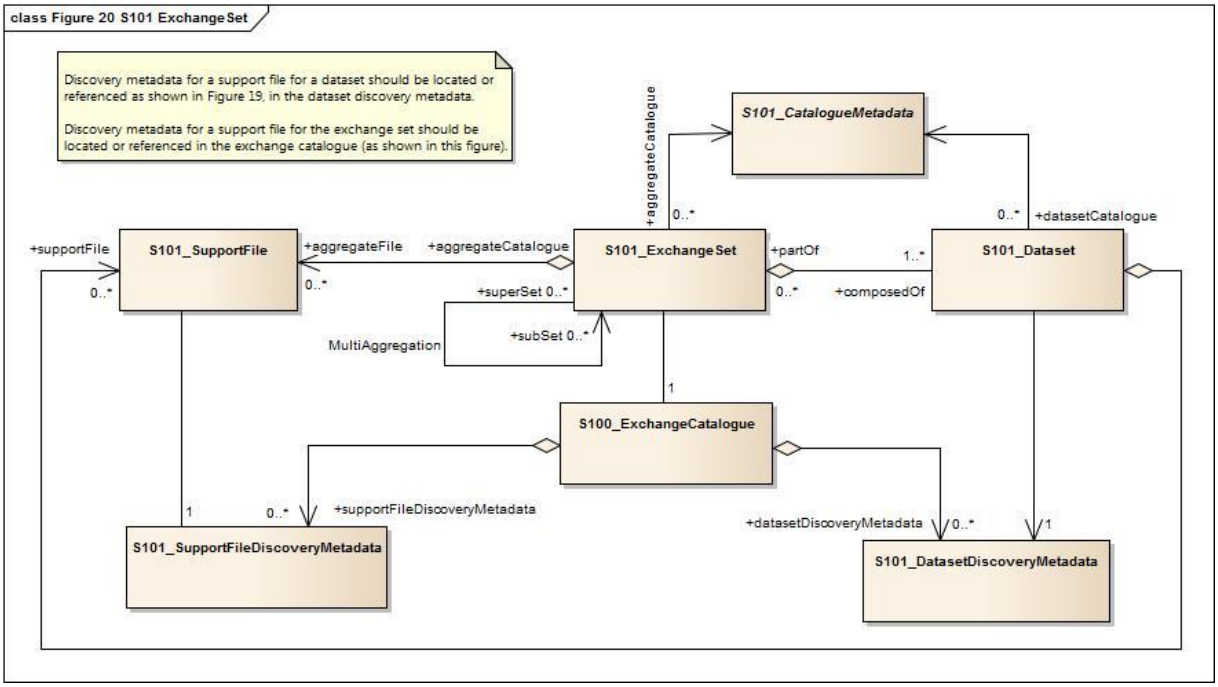

Figure 21 - S-101 Exchange Set

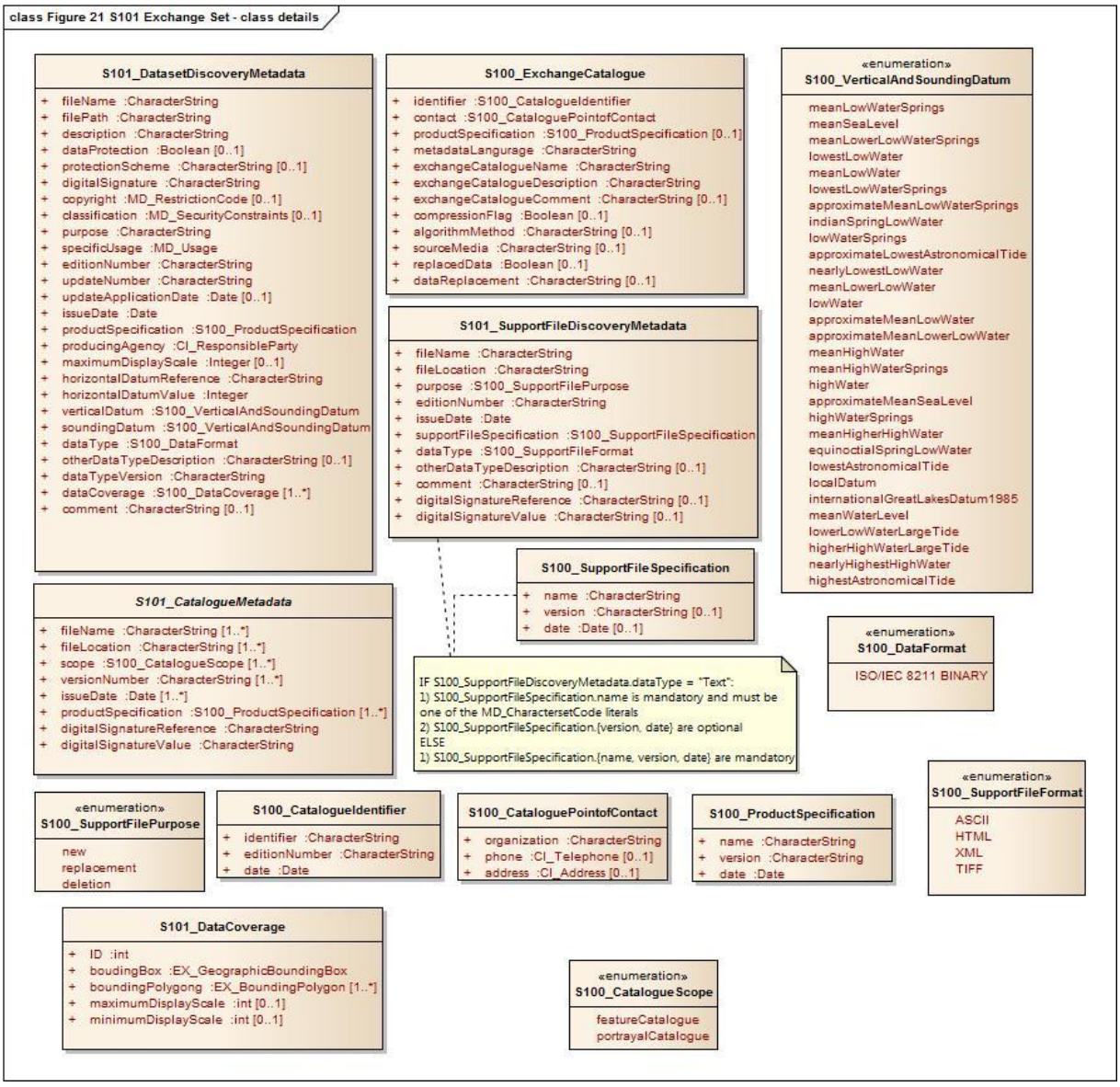

Figure 22 S-101 Exchange Set - Class Details

The following clauses define the mandatory and optional metadata needed for S-101. In some cases the metadata may be repeated in a national language. If this is the case it is noted in the Remarks column.

12.1.1 S101_ExchangeCatalogue

The catalogue file is defined in XML schema language. The Exchange catalogue inherits the dataset discovery metadata and support file discovery metadata.

Name	Multiplicity	Value	Type	Remarks
S101_ExchangeCatalogue	-			An exchange catalogue contains the discovery metadata about the exchange datasets and support files
identifier	1		CharacterString S100_CatalogueIdentifier	Uniquely identifies this exchange catalogue
contact	1		S100_CataloguePointofContact CI_ResponsibleParty	
productSpecification	1		S101_ProductSpecification	
metadataLanguage	1	English	CharacterString	All datasets conforming to S-101 PS must use English language
exchangeCatalogueName	1	S101ed1.CAT	CharacterString	Catalogue filename
exchangeCatalogueDescription	1		CharacterString	Description of what the exchange catalogue contains NATIONAL LANGUAGE enabled
exchangeCatalogueComment	0..1		CharacterString	Any additional Information NATIONAL LANGUAGE enabled
compressionFlag	0..1		Boolean	Yes or No
algorithmMethod	0..1		characterString	For Example, RAR or ZIP
sourceMedia	1		characterString	
replacedData	1		Boolean	If a data file is cancelled is it replaced by another data file
dataReplacement	0..1		characterString	Dataset name

12.1.1.1 S100_CatalogueIdentifier

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_CatalogueIdentifier	An exchange catalogue contains the discovery metadata about the exchange datasets and support files	-	-	-
Attribute	identifier	Uniquely identifies this exchange catalogue	1	CharacterString	The file name must be unique. Each file name must have a MD prefix added to the S-101 file name. Dataset: 101GB45678.000 Metadata: MD_101GB45678_000.xml Update 1: 101GB45678.001 Metadata: MD_101GB45678_001.xml
Attribute	editionNumber	The edition number of this exchange catalogue	1	CharacterString	
Attribute	date	Creation date of the exchange catalogue	1	Date	

12.1.1.2 S100_CataloguePointOfContact

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_CataloguePointOfContact	Contact details of the issuer of this exchange catalogue	-	-	-
Attribute	organization	The organization distributing this exchange catalogue	1	CharacterString	This could be an individual producer, value added reseller, etc
Attribute	phone	The edition number of this exchange catalogue	0..1	CI_Telephone	
Attribute	address	The address of the organization	0..1	CI_Address	

12.1.2 S101_DatasetDiscoveryMetadata

Name	Multiplity	Value	Type	Remarks
S101_DatasetDiscoveryMetadata	-		-	-
fileName	1		CharacterString	Dataset file name
filePath	1		CharacterString	Path to the dataset file, relative to the root directory of the exchange set. The location of the dataset file after the exchange set is unpacked into directory <EXCH_ROOT> will be: <EXCH_ROOT>/<filePath>/<fileName>
description	1		CharacterString	Short description of the area covered by dataset harbour or port name, between two named locations etc NATIONAL LANGUAGE enabled
dataProtection	1		Boolean	True = Encrypted False = Unencrypted A value of True indicates the presence of encryption. Otherwise, the value must be False
protectionScheme	0..1		CharacterString	For example, S-100
digitalSignature	1		CharacterString	
copyright	0..*		MD_LegalConstraints ->MD_RestrictionCode <copyright> (ISO 19115)	
classification	1	{1} to {5}	Class MD_SecurityConstraints>MD_ClassificationCode (codelist)	1. unclassified 2. restricted 3. confidential 4. secret 5. top secret
purpose	1	{1} to {5}	CharacterString MD_Identification>purpose (character string)	1. New Dataset 2. New Edition 3. Update 4. Re-issue 5.Cancellation

Name	Multiplity	Value	Type	Remarks
specificUsage	1	{1} to {3}	CharacterString MD_USAGE>specificUsage (character string) MD_USAGE>userContactInfo (CI_ResponsibleParty)	1. Port Entry – A dataset containing data required: for navigating the approaches to ports for navigating within ports, harbours, bays, rivers and canals for anchorages as an aid to berthing or any combination of the above. 2.Transit – A dataset containing data required: for navigating along the coastline either inshore or offshore for navigating oceans, approaching coasts for route planning or any combination of the above. 3.Overview – A dataset containing data required for: ocean crossing route planning
editionNumber	1		CharacterString	When a dataset 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 Update and Re-issue Characters forming the editionNumber must be integers.
updateNumber	1		CharacterString	Update number 0 is assigned to a new dataset. Characters forming the updateNumber must be integers.
updateApplicationDate	0..1		Date	This date is only used for the base dataset files (that is new dataset, re-issue and new edition), not update dataset files. All updates dated on or before this date must have been applied by the producer
issueDate	1		Date	Date on which the data was made available by the data producer
productSpecification	1		S101_ProductSpecification	This must be encoded as S-101.X.X.X – with the X representing the version number
producingAgency	1		CI_ResponsibleParty	Agency responsible for producing the data

Name	Multiplity	Value	Type	Remarks
maximumDisplayScale	1	{1} to {15}	Integer	1: 1,000 2: 2,000 3: 3,000 4: 4,000 5: 8,000 6: 12,000 7: 22,000 8: 45,000 9: 90,000 10: 180,000 11: 350,000 12: 700,000 13: 1,500,000 14: 3,500,000 15: 10,000,000
horizontalDatumReference	1	EPSG	CharacterString	
horizontalDatumValue	1	4326	Integer	WGS84
verticalDatum	1		S100_VerticalAndSoundingDatum	
soundingDatum	1		S100_VerticalAndSoundingDatum	
dataType	1	ISO 8211 BINARY	S100_DataFormat	
otherDataTypeDescription	0..1		CharacterString	
dataCoverage	1..3		S101_DataCoverage	Provides information about data coverages within the dataset
comment	0..1		CharacterString	

12.1.2.1 S101_DataCoverage

Name	Multiplicity	Value	Type	Remarks
S101_DataCoverage	-	-	-	-
ID	1		Integer	Uniquely identifies the coverage

Name	Multiplicity	Value	Type	Remarks
boundingBox	1		EX_GeographicBoundingBox	
boundingPolygon	1..*		EX_BoundingPolygon	
maximumDisplayScale	1	{1} to {15}	Integer	1: 1,000 2: 2,000 3: 3,000 4: 4,000 5: 8,000 6: 12,000 7: 22,000 8: 45,000 9: 90,000 10: 180,000 11: 350,000 12: 700,000 13: 1,500,000 14: 3,500,000 15: 10,000,000
minimumDisplayScale	1	{1} to {15}	Integer	1: 1,000 2: 2,000 3: 3,000 4: 4,000 5: 8,000 6: 12,000 7: 22,000 8: 45,000 9: 90,000 10: 180,000 11: 350,000 12: 700,000 13: 1,500,000 14: 3,500,000 15: 10,000,000

12.1.2.2 S100_VerticalAndSoundingDatum

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_VerticalAndSoundingDatum	Allowable vertical and sounding datums	-	-	-
Value	meanLowWaterSprings				
Value	meanSeaLevel				
Value	meanLowerLowWaterSprings				
Value	lowestLowWater				
Value	meanLowWater				
Value	lowestLowWaterSprings				
Value	approximateMeanLowWaterSprings				
Value	indianSpringLowWater				
Value	lowWaterSprings				
Value	approximateLowestAstronomicalTide				
Value	nearlyLowestLowWater				
Value	meanLowerLowWater				
Value	lowWater				
Value	approximateMeanLowWater				
Value	approximateMeanLowerLowWater				
Value	meanHighWater				
Value	meanHighWaterSprings				
Value	highWater				
Value	approximateMeanSeaLevel				
Value	highWaterSprings				
Value	meanHigherHighWater				
Value	equinoctialSpringLowWater				
Value	lowestAstronomicalTide				
Value	localDatum				

Role Name	Name	Description	Mult	Type	Remarks
Value	internationalGreatLakesDatum1985				
Value	meanWaterLevel				
Value	lowerLowWaterLargeTide				
Value	higherHighWaterLargeTide				
Value	nearlyHighestHighWater				
Value	highestAstronomicalTide				(HAT)

12.1.2.3 S101_DataFormat

Role Name	Name	Description	Mult	Type	Remarks
Class	S101_DataFormat	The encoding format	-	-	-
Value	ISO/IEC 8211 BINARY				

12.1.2.4 S100_ProductSpecification

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	S-101 Electronic Navigational Charts
Attribute	version	The version number of the product specification	1	CharacterString	X.X.X
Attribute	date	The version date of the product specification	1	Date	

12.1.3 S101_SupportFileDiscoveryMetadata

Name	Multiplicity	Value	Type	Remarks
S101_SupportFileDiscoveryMetadata	-		-	-
fileName	1		CharacterString	
fileLocation	1		CharacterString	Full location from the exchange set root directory
purpose	1	{1} to {3}	class S100_SupportFilePurpose	1: New – A file which is new 2: Replacement – A file which replaces an existing file 3: Deletion – deletes an existing file
editionNumber	1		CharacterString	When a support file is initially created, the edition number 1 is assigned to it. The edition number is increased by 1 at each new edition of the support file. Characters forming the editionNumber must be integers from 0 to 9
issueDate	1		Date	Date on which the data was made available by the data producer
productSpecification	1		S101_ProductSpecification	Version of S-101
dataType	1	{1} to {4}	class S101_SupportFileFormat	1: TXT =ASCII Text files 2: XML = Text files 3: HTM = Text files 4: TIFF = Picture files
dataTypeVersion	1		CharacterString	The version number of the dataType
comment	0..1		CharacterString	Any additional Information NATIONAL LANGUAGE enabled
digitalSignature	0..1		CharacterString	
digitalSignatureValue	1		CharacterString	

12.1.3.1 S101_SupportFormat

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_SupportFormat	The format used for the support file	-	-	-
Value	ASCII				Text
Value	HTML				
Value	XML				
Value	TIFF				
Value	PDF				

12.1.3.2 S100_SupportFilePurpose

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_SupportFilePurpose	The reason for inclusion of the support file in this exchange set	-	-	-
Value	new	A file which is new			Signifies a new file
Value	replacement	A file which replaces an existing file			Signifies a replacement for a file of the same name
Value	deletion	Deletes an existing file			Signifies deletion of a file of that name

12.1.4 S101_CatalogueMetadata

This is an optional element that allows for the delivery of S-101 feature and portrayal catalogues to be delivered within the exchange set.

Name	Multiplicity	Value	Type	Remarks
S101_CatalougeMetadata	-		-	-
filename	1..*		CharacterString	
fileLocation	1..*		CharacterString	Path relative to the root directory of the exchange set. The location of the file after the exchange set is unpacked into directory <EXCH_ROOT> will be <EXCH_ROOT>/<filePath>/<filename>

Name	Multiplicity	Value	Type	Remarks
scope	1..*		S100_CatalogueScope	
versionNumber	1..*		CharacterString	
issueDate	1..*		Date	
productSpecification	1..*		S100_ProductSpecification	
digitalSignatureReference	1		CharacterString	Reference to the appropriate digital signature algorithm
digitalSignatureValue	1		CharacterString	

12.1.4.1 S100_CatalogueScope

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_CatalogueScope		-	-	-
Value	featureCatalogue				
Value	portrayalCatalogue				

12.2 Language

The exchange language must be English. Other languages may be used as a supplementary option. National geographic names can be left in their original national language using the complex attribute Feature Name.

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

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ANNEX A - Data Classification and Encoding Guide

The “Data Classification and Encoding Guide” has been developed to provide consistent, standardized instructions for encoding S-100 compliant ENC data. This document has been laid out, as far as possible, along the lines of the IHO publication S-4, Part B “Chart Specifications of the IHO – Medium and Large-Scale National and International (INT) Charts”.

The purpose of the Data Classification and Encoding Guide is to facilitate S-101 encoding to meet IHO standards for the proper display of ENC in an S-100 based marine navigation system such as ECDIS. The document describes how to encode information that the cartographer considers relevant to an ENC. The content of an ENC is at the discretion of the producing authority provided that the conventions described within this document are followed. A “producing authority” is a Hydrographic Office (HO) or an organization authorized by a government, HO or other relevant government institution to produce ENCs.

The S-101 Data Classification and Encoding Guide can be found in the Standards and Publications page of the IHO web site, http://www.iho.int.

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ANNEX B - NORMATIVE

Data Product format (encoding)

Introduction

S-101 uses the S-100 profile of ISO/IEC 8211 (refer to S-100 Part 10A) to encapsulate data. This annex specifies the interchange format to facilitate the moving of files containing data records between computer systems. It defines a specific structure which can be used to transmit files containing data type and data structures specific to S-101.

B1 Dataset files

The order of data in each base or update dataset file is described below:

Dataset file
- Dataset general information record
- Dataset structure information field structure
- Dataset Coordinate Reference System record structure

Information records
- Information

Vector records
- Point
- Multi point
- Curve
- Composite Curve
- Surface

Feature records
- Meta features
- Geo features
- Aggregated features

This order of records will enable the import software to check that the child record exists each time the parent record references it (that is it will already have read the child record so it will know if it exists or not).

B2 Records

Records and fields that do not appear in the following tree structure diagrams are prohibited. The order of records in the files must be the same as that described in these tree structure diagrams.

The combination of the file name and the ‘‘Name’’ of the record must provide a unique world-wide identifier of the record. The “Name” of the record is the combination of the subfields RCNM and RCID in the appropriate Identifier field of the record.

B3 Fields

For base dataset files, some fields may be repeated (indicated by <0..*> or <1..*>) and all of their content may be repeated (indicated by *). In order to reduce the volume of data, the encoder should repeat the sequence of subfields, in preference to creating several fields.

B4 Subfields

Mandatory subfields must be filled by a non-null value.

Prohibited subfields must be encoded as missing subfields values. The exact meaning of missing attribute values is defined in Annex A.

In the tables following the tree structure diagrams, prescribed values are indicated in the “Values” column.

When encoding new base datasets the Record Update Instruction (RUIN) subfield must be set to “Insert”. When encoding updates RUIN may be set to “Insert”, “Modify” or “Delete”.

B5 Base dataset structure

NOTE: The number contained in parenthesis () is the number of subfields that are contained in the field.

```
Base dataset file
   |
   |--<1>- Dataset General Information record
   |   |
   |   |--<1>-DSID (13\\*1): Dataset Identification field
   |       |
   |       |--<1>-DSSI (13): Dataset Structure Information field
   |       |
   |       |--<0..1>-ATCS (*2): Attribute Codes field
   |       |
   |       |--<0..1>-ITCS (*2): Information Type Codes field
   |       |
   |       |--<0..1>-FTCS (*2): Feature Type Codes field
   |       |
   |       |--<0..1>-IACS (*2): Information Association Codes field
   |       |
   |       |-<0..1>-FACS (*2): Feature Association Codes field
   |       |
   |       |-<0..1>-ARCS (*2): Association Role Codes field
   |
   |
   |--<1>--Dataset Coordinate Reference System record
   |   |
   |   |--<1>-CSID (3): Coordinate Reference System Record Identifier field
   |       |
   |       |--<1..*>-CRSH (7): Coordinate Reference System Header field
   |          |
```

```
|          |--<0..1>-CSAX (*2): Coordinate System Axes field
|          |
|          |--<0..1>-VDAT (4): Vertical Datum field
|
|
|--<0..*>--Information record
|   |
|   |--<1>-IRID (5): Information Type Record Identifier field
|      |
|      |--<0..*>- ATTR (*5): Attribute field
|      |
|      |--<0..*>- INAS (5\\*5): Information Association field
|
|
|--<0..*>-- Point record
|   |
|   |--<1>-PRID (4): Point Record Identifier field
|      |
|      |-<0..*>-INAS (5\\*5): Information Association field
|      |
|      | alternate coordinate representations
|      |
|      *-<1>-C2IT (2): 2-D Integer Coordinate Tuple field
|      |
|      *-<1>-C3IT (4): 3-D Integer Coordinate Tuple field
|
|
|--<0..*>-- Multi Point record
|   |
|   |--<1>-MRID (4): Multi Point Record Identifier field
|      |
|      |-<0..*>-INAS (5\\*5): Information Association field
|      |
|      | alternate coordinate representations
|      |
|      *-<0..*>-C2IL (*2): 2-D Integer Coordinate List field
|      |
|      *-<0..*>-C3IL (1\\*3): 3-D Integer Coordinate List field
|
|
|--<0..*>-- Curve record
|   |
|   |--<1>-CRID (4): Curve Record Identifier field
|      |
|      |-<0..*>-INAS (5\\*5): Information Association field
|      |
|      |-<1>-PTAS (*3): Point Association field
|      |
|      |-<1>-SEGH (1): Segment Header field
|          |
|          |-<1..*>-C2IL (*2): 2-D Integer Coordinate List field
|
|
|--<0..*>-- Composite Curve record
|   |
|   |--<1>-CCID (4): Composite Curve Record Identifier field
|      |
|      |-<0..*>-INAS (5\\*5): Information Association field
|      |
|      |-<0..*>-CUCO (*3): Curve Component field
|
```

```
|
|--<0..*>-- Surface record
|    |
|    |--<1>-SRID (4): Surface Record Identifier field
|       |
|       |-<0..*>-INAS (5\\*5): Information Association field
|       |
|       |-<1..*>-RIAS (*5): Ring Association Field
|
|
|--<0..*>-- Feature Type record
     |
     |--<1>-FRID (5): Feature Type Record Identifier field
        |
        |-<1>-FOID (3): Feature Object Identifier field
        |
        |-<0..*>-ATTR (*5): Attribute field
        |
        |-<0..*>-INAS (5\\*5): Information Association field
        |
        |-<0..*>-SPAS (*6): Spatial Association field
        |
        |-<0..*>-FASC (5\\*5): Feature Association field
        |
        |-<0..*>-MASK (*4): Masked Spatial Type field
```

B5.1 Field Content

B5.1.1 Dataset Identification field - DSID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{10}	b11	{10} - Dataset Identification
Record Identification number	RCID	{1}	b14	Only one record
Encoding Specification	ENSP	'S-100 Part 10a'	A()	Encoding specification that defines the encoding
Encoding Specification Edition	ENED	"1.1"	A()	Edition of the encoding specification
Product Identifier	PRSP	"INT.IHO .S-101.1.0"	A()	Unique identifier for the data product as specified in the product specification
Product Edition	PRED	"1.0"	A()	Edition of the product specification
Application Profile	PROF	"1"	A()	"1" – EN Profile
Dataset File Identifier	DSNM		A()	The file name including the extension but excluding any path information
Dataset Title	DSTL		A()	The title of the dataset
Dataset Reference Date	DSRD		A(8)	The reference date of the dataset Format: YYYYMMDD according to ISO 8601
Dataset Language	DSLG	"EN"	A()	The (primary) language used in this dataset
Dataset Abstract	DSAB	omitted	A()	The abstract of the dataset
Dataset Edition	DSED		A()	See clause 11.3.3
Dataset Topic Category	*DSTC	{14}{18}	b11	A set of topic categories

B5.1.2 Dataset Structure Information field - DSSI

Subfield name	Label	Value	Format	Comment
Dataset Coordinate Origin X	DCOX	{0.0}	b48	Shift used to adjust x-coordinate before encoding
Dataset Coordinate Origin Y	DCOY	{0.0}	b48	Shift used to adjust y-coordinate before encoding
Dataset Coordinate Origin Z	DCOZ	{0.0}	b48	Shift used to adjust z-coordinate before encoding
Coordinate Multiplication Factor for X-coordinate	CMFX	$\{10^7\}$	b14	Floating point to integer multiplication factor for the x-coordinate or longitude
Coordinate Multiplication Factor for Y-coordinate	CMFY	$\{10^7\}$	b14	Floating point to integer multiplication factor for the y-coordinate or latitude
Coordinate Multiplication Factor for Z-coordinate	CMFZ	{100}	b14	Floating point to integer multiplication factor for the z-coordinate or depths or height
Number of Information Type records	NOIR		b14	Number of information records in the dataset
Number of Point records	NOPN		b14	Number of point records in the dataset
Number of Multi Point records	NOMN		b14	Number of multi point records in the dataset
Number of Curve records	NOCN		b14	Number of curve records in the dataset
Number of Composite Curve records	NOXN		b14	Number of composite curve records in the dataset
Number of Surface records	NOSN		b14	Number of surface records in the dataset
Number of Feature Type records	NOFR		b14	Number of feature records in the dataset

B5.1.3 Attribute Code field structure - ATCS

Subfield name	Label	Value	Format	Comment
Attribute Code	ATCD		A	The code as defined in the feature catalogue
Attribute Numeric Code	ANCD		b12	The code used within the NATC subfield

B5.1.4 Information Type Codes field structure - ITCS

Subfield name	Label	Value	Format	Comment
Information Type Code	ITCD		A	The code as defined in the feature catalogue
Information Type Numeric Code	ITNC		b12	The code used within the NITC subfield

B5.1.5 Feature Type Codes field structure - FTCS

Subfield name	Label	Value	Format	Comment
Feature Type Code	FTCD		A	The code as defined in the feature catalogue
Feature Type Numeric Code	FTNC		b12	The code used within the NFTC subfield

B5.1.6 Information Association Codes field structure - IACS

Subfield name	Label	Value	Format	Comment
Information Association Code	IACD		A	The code as defined in the feature catalogue
Information Association Numeric Code	IANC		b12	The code used within the NIAC subfield

B5.1.7 Feature Association Codes field structure - FACS

Subfield name	Label	Value	Format	Comment
Feature Association Code	FACD		A	The code as defined in the feature catalogue
Feature Association Numeric Code	FANC		b12	The code used within the NFAC subfield

B5.1.8 Association Role Codes field structure - ARCS

Subfield name	Label	Value	Format	Comment
Association Role Code	ARCD		A	The code as defined in the feature catalogue
Association Role Numeric Code	ARNC		b12	The code used within the NARC subfield

B5.1.9 Attribute field - ATTR

Subfield name	Label	Value	Format	Comment
Numeric Attribute Code	*NATC		b12	A valid attribute code as defined in the ATCS field of the Dataset General Information Record
Attribute Index	ATIX		b12	Index (position) of the attribute in the sequence of attributes with the same code and the same parent (starting with 1)
Parent Index	PAIX		b12	Index (position) of the parent complex attribute within this ATTR field (starting with 1). If the attribute has no parent (top level attribute) the value is 0
Attribute Instruction	ATIN	{1}	b11	{1} - Insert
Attribute Value	ATVL		A()	A string containing a valid value for the domain of the attribute specified by the subfields above

B5.1.10 Information Association field - INAS

Subfield name	Label	Value	Format	Subfield content and specification
Referenced Record Name	RRNM	150	b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Numeric Information Association Code	NIAC		b12	A valid code for the information association as defined in the IACS field of the Dataset General Information Record
Numeric Association Role Code	NARC			A valid code for the role as defined in the ARCS field of the Dataset General Information Record
Information Association Update Instruction	IUIN		b11	{1} - Insert {2} – Delete {3} - Modify
Numeric Attribute Code	*NATC		b12	A valid attribute code as defined in the ATCS field of the Dataset General Information Record
Attribute Index	ATIX		b12	Index (position) of the attribute in the sequence of attributes with the same code and the same parent (starting with 1)
Parent Index	PAIX		b12	Index (position) of the parent complex attribute within this INAS field (starting with 1). If the attribute has no parent (top level attribute) the value is 0
Attribute Instruction	ATIN		b11	{1} - Insert {2} - Delete {3} - Modify
Attribute Value	ATVL		A()	A string containing a valid value for the domain of the attribute specified by the subfields above

B5.1.11 Coordinate Reference System Record Identifier field - CSID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{15}	b11	{15} - Coordinate Reference System Identifier
Record Identification number	RCID	{1}	b14	Only one record
Number of CRS Components	NCRC		b11	{1} - Single CRS (No C3IT or C3IL fields in the dataset) >{1} - Compound CRS

B5.1.12 Coordinate Reference System Header field - CRSH

Subfield name	Label	Value	Format	Comment
CRS Index	CRIX		b11	1 – for the horizontal CRS >1 – for the vertical CRSs
CRS Type	CRST	{1} or {5}	b11	{1} – 2D Geographic {5} - Vertical
Coordinate System Type	CSTY	{1} or {3}	b11	{1} - Ellipsoidal CS {3} - Vertical CS
CRS Name	CRNM	"WGS84" for horizontal CRS "Depth - *" for vertical CRS where * is the name of the vertical datum	A()	
CRS Identifier	CRSI	"4326" – for horizontal CRS "omitted for vertical CRS	A()	
CRS Source	CRSS	{2} for horizontal CRS {255} for vertical CRS	b11	{2} - EPSG {255} - Not Applicable
CRS Source Information	SCRI	omitted	A()	

B5.1.13 Coordinate System Axes field - CSAX

This field is only used for vertical CRS.

Subfield name	Label	Value	Format	Comment
Axis Type	*AXTY	{12}	b11	{12} – Gravity related depth (orientation down)
Axis Unit of Measure	AXUM	{4}	b11	{4} - Metre

B5.1.14 Vertical Datum field - VDAT

This field is only used for vertical CRS.

Subfield name	Label	Value	Format	Comment
Datum Name	DTNM		A()	Name of the enumeration value of the attribute **vertical datum**
Datum Identifier	DTID		A()	Enumeration value of the attribute **vertical datum**
Datum Source	DTSR	{2}	b11	{2} - Feature Catalogue
Datum Source Information	SCRI	omitted	A()	

B5.1.15 Information Type Identifier field - IRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{150}	b11	{150} - Information Type
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Numeric Information Type Code	NITC		b12	A valid information type code as defined in the ITCS field of the Dataset General Information Record
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1}	b11	{1} - Insert

B5.1.16 Point Record Identifier field - PRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{110}	b11	{110} - Point
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1}	b11	{1} – Insert

B5.1.17 2-D Integer Coordinate Tuple field structure - C2IT

Subfield name	Label	Value	Format	Comment
Coordinate in Y axis	YCOO		b24	Y-coordinate or latitude
Coordinate in X axis	XCOO		b24	X-coordinate or longitude

B5.1.18 3-D Integer Coordinate Tuple field structure - C3IT

Subfield name	Label	Value	Format	Comment
Vertical CRS Id	VCID		b11	Internal identifier of the Vertical CRS
Coordinate in Y axis	YCOO		b24	Y- coordinate or latitude
Coordinate in X axis	XCOO		b24	X- coordinate or longitude
Coordinate in Z axis	ZCOO		b24	Z - coordinate (depth)

B5.1.19 Multi Point Record Identifier field - MRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{115}	b11	{115} - Multi Point
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1}	b11	{1} - Insert

B5.1.20 2-D Integer Coordinate List field structure - C2IL

Subfield name	Label	Format	Subfield content and specification
Coordinate in Y axis	*YCOO	b24	Y-coordinate or latitude
Coordinate in X axis	XCOO	b24	X-coordinate or longitude

B5.1.21 3-D Integer Coordinate List field structure - C3IL

Subfield name	Label	Format	Subfield content and specification
Vertical CRS Id	VCID	b11	Internal identifier of the Vertical CRS
Coordinate in Y axis	*YCOO	b24	Y- coordinate or latitude
Coordinate in X axis	XCOO	b24	X- coordinate or longitude
Coordinate in Z axis	ZCOO	b24	Z - coordinate (depth or height)

B5.1.22 Curve Record Identifier field - CRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{120}	b11	{120} - Curve
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1}	b11	{1} - Insert

B5.1.23 Point Association field - PTAS

Subfield name	Label	Value	Format	Comment
Referenced Record Name	*RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Topology Indicator	TOPI		b11	{1} - Beginning point {2} - End point {3} - Beginning & End point

B5.1.24 Segment Header field - SEGH

Subfield name	Label	Value	Format	Comment
Interpolation	INTP	{4}	b11	{4} - Loxodromic

B5.1.25 Composite Curve Record Identifier field - CCID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{125}	b11	{125} - Composite Curve
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1}	b11	{1} - Insert

B5.1.26 Curve Component field - CUCO

Subfield name	Label	Value	Format	Comment
Referenced Record Name	*RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Orientation	ORNT		b11	{1} - Forward {2} - Reverse

B5.1.27 Surface Record Identifier field - SRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{130}	b11	{130} - Surface
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1}	b11	{1} – Insert

B5.1.28 Ring Association field - RIAS

Subfield name	Label	Value	Format	Comment
Referenced Record Name	RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Orientation	ORNT		b11	{1} - Forward {2} - Reverse
Usage indicator	USAG		b11	{1} - Exterior {2} - Interior
Ring Association Update Instruction	RAUI	{1}	b11	{1} – Insert

B5.1.29 Feature Type Record Identifier field - FRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{100}	b11	{100} - Feature type
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Numeric Feature Type Code	NFTC		b12	A valid feature type code as defined in the FTCS field of the Dataset General Information Record
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1}	b11	{1} - Insert

B5.1.30 Feature Object Identifier field - FOID

Subfield name	Label	Value	Format	Comment
Producing Agency	AGEN		b12	Agency code
Feature Identification Number	FIDN		b14	Range: 1 to 2^{32}-2
Feature Identification Subdivision	FIDS		b12	Range: 1 to 2^{16}-2

B5.1.31 Spatial Association field - SPAS

Subfield name	Label	Value	Format	Comment
Referenced Record Name	*RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Orientation	ORNT		b11	{1} Forward {2} Reverse {255} NULL (Not Applicable)
Scale Minimum	SMIN		b14	Denominator of the largest scale for which the feature type can be depicted by the referenced spatial feature. If the value is 0 it does not apply
Scale Maximum	SMAX		b14	Denominator of the smallest scale for which the feature type can be depicted by the referenced spatial feature. If the value is 2^{32}-1 it does not apply
Spatial Association Update Instruction	SAUI	{1}	b11	{1} - Insert

B5.1.32 Feature Association field – FASC

Subfield name	Label	Value	Format	Comment
Referenced Record Name	RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Numeric Feature Association Code	NFAC		b12	A valid code for the feature association as defined in the FACS field of the Dataset General Information Record
Numeric Association Role Code	NARC		b12	A valid code for the role as defined in the ARCS field of the Dataset General Information Record
Feature Association Update Instruction	FAUI	{1}	b11	{1} - Insert
Numeric Attribute Code	*NATC		b12	A valid attribute code as defined in the ATCS field of the Dataset General Information Record
Attribute Index	ATIX		b12	Index (position) of the attribute in the sequence of attributes with the same code and the same parent (starting with 1)
Parent Index	PAIX		b12	Index (position) of the parent complex attribute within this FASC field (starting with 1). If the attribute has no parent (top level attribute) the value is 0
Attribute Instruction	ATIN		b11	{1} - Insert {2} - Delete {3} - Modify
Attribute Value	ATVL		A()	A string containing a valid value for the domain of the attribute specified by the subfields above

B5.1.33 Masked Spatial Type field - MASK

Subfield name	Label	Value	Format	Comment
Referenced Record Name	*RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Mask Indicator	MIND	{1} or {2}	b11	{1} – Truncated by the dataset limit {2} – Supress portrayal
Mask Update Instruction	MUIN	{1}	b11	{1} - Insert

B6 Update dataset structure

```
Update dataset file
   |
   |--<1>- Dataset General Information record
   |   |
   |   |--<1>-DSID (13\\*1): Dataset Identification field
   |       |
   |       |--<1>-DSSI (13): Dataset Structure Information field
   |       |
   |       |--<0..1>-ATCS (*2): Attribute Codes field
   |       |
   |       |--<0..1>-ITCS (*2): Information Type Codes field
   |       |
   |       |--<0..1>-FTCS (*2): Feature Type Codes field
   |       |
   |       |--<0..1>-IACS (*2): Information Association Codes field
   |       |
   |       |-<0..1>-FACS (*2): Feature Association Codes field
   |       |
   |       |-<0..1>-ARCS (*2): Association Role Codes field
   |
   |
   |--<0..*>--Information record
   |   |
   |   |--<1>-IRID (5): Information Type Record Identifier field
   |      |
   |      |--<0..*>- ATTR (*5): Attribute field
   |      |
   |      |--<0..*>- INAS (5\\*5): Information Association field
   |
   |
   |--<0..*>-- Point record
   |   |
   |   |--<1>-PRID (4): Point Record Identifier field
   |      |
   |      |-<0..*>-INAS (5\\*5): Information Association field
   |      |
   |      | alternate coordinate representations
   |      |
   |      *-<1>-C2IT (2): 2-D Integer Coordinate Tuple field
   |      |
   |      *-<1>-C3IT (4): 3-D Integer Coordinate Tuple field
   |
   |
   |--<0..*>-- Multi Point record
   |   |
```

```
|   |--<1>-MRID (4): Multi Point Record Identifier field
|       |
|       |-<0..*>-INAS (5\\*5): Information Association field
|       |
|       |-<0..1>-COCC (3): Coordinate Control field
|       |
|       | alternate coordinate representations
|       |
|       *-<0..*>-C2IL (*2): 2-D Integer Coordinate List field
|       |
|       *-<0..*>-C3IL (1\\*3): 3-D Integer Coordinate List field
|
|
|--<0..*>-- Curve record
|   |
|   |--<1>-CRID (4): Curve Record Identifier field
|       |
|       |-<0..*>-INAS (5\\*5): Information Association field
|       |
|       |-<1>-PTAS (*3): Point Association field
|       |
|       |-<0..1>-SECC (3): Segment Control field
|       |
|       |-<1>-SEGH (1): Segment Header field
|           |
|           |-<0..1>-COCC (3): Coordinate Control Field
|           |
|           |-<1..*>-C2IL (*2): 2-D Integer Coordinate List field
|
|
|--<0..*>-- Composite Curve record
|   |
|   |--<1>-CCID (4): Composite Curve Record Identifier field
|       |
|       |-<0..*>-INAS (5\\*5): Information Association field
|       |
|       |-<0..1>-CCOC (3): Curve Component Control field
|       |
|       |-<0..*>-CUCO (*3): Curve Component field
|
|
|--<0..*>-- Surface record
|   |
|   |--<1>-SRID (4): Surface Record Identifier field
|       |
|       |-<0..*>-INAS (5\\*5): Information Association field
|       |
|       |-<1..*>-RIAS (*5): Ring Association Field
|
|
|--<0..*>-- Feature Type record
    |
    |--<1>-FRID (5): Feature Type Record Identifier field
       |
       |-<1>-FOID (3): Feature Object Identifier field
       |
       |-<0..*>-ATTR (*5): Attribute field
       |
       |-<0..*>-INAS (5\\*5): Information Association field
       |
       |-<0..*>-SPAS (*6): Spatial Association field
```

```
|
|-<0..*>-FASC (*5): Feature Association field
|
|-<0..*>-MASK (*4): Masked Spatial Type field
```

B6.1 Field Content

B6.1.1 Dataset Identification field - DSID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{10}	b11	{10} - Dataset Identification
Record Identification number	RCID	{1}	b14	Only one record
Encoding Specification	ENSP	'S-100 Part 10a'	A()	Encoding specification that defines the encoding
Encoding Specification Edition	ENED	"1.1"	A()	Edition of the encoding specification
Product Identifier	PRSP	"INT.IHO.S-101.1.0"	A()	Unique identifier for the data product as specified in the product specification
Product Edition	PRED	"1.0"	A()	Edition of the product specification
Application Profile	PROF	"2"	A()	"2" – ER Profile
Dataset File Identifier	DSNM		A()	The file name including the extension but excluding any path information
Dataset Title	DSTL		A()	The title of the dataset
Dataset Reference Date	DSRD		A(8)	The reference date of the dataset Format: YYYYMMDD according to ISO 8601
Dataset Language	DSLG	"EN"	A()	The (primary) language used in this dataset
Dataset Abstract	DSAB	omitted	A()	The abstract of the dataset
Dataset Edition	DSED		A()	[edition number].[update number] for example 4.20
Dataset Topic Category	*DSTC	{14}{18}	b11	A set of topic categories

B6.1.2 Dataset Structure Information field - DSSI

Subfield name	Label	Value	Format	Comment
Dataset Coordinate Origin X	DCOX	{0.0}	b48	Shift used to adjust x-coordinate before encoding
Dataset Coordinate Origin Y	DCOY	{0.0}	b48	Shift used to adjust y-coordinate before encoding
Dataset Coordinate Origin Z	DCOZ	{0.0}	b48	Shift used to adjust z-coordinate before encoding
Coordinate Multiplication Factor for X-coordinate	CMFX	$\{10^7\}$	b14	Floating point to integer multiplication factor for the x-coordinate or longitude
Coordinate Multiplication Factor for Y-coordinate	CMFY	$\{10^7\}$	b14	Floating point to integer multiplication factor for the y-coordinate or latitude
Coordinate Multiplication Factor for Z-coordinate	CMFZ	{100}	b14	Floating point to integer multiplication factor for the z-coordinate or depths or height
Number of Information Type Records	NOIR		b14	Number of information records in the dataset
Number of Point records	NOPN		b14	Number of point records in the dataset
Number of Multi Point records	NOMN		b14	Number of multi point records in the dataset
Number of Curve records	NOCN		b14	Number of curve records in the dataset
Number of Composite Curve records	NOXN		b14	Number of composite curve records in the dataset
Number of Surface records	NOSN		b14	Number of surface records in the dataset
Number of Feature Type Records	NOFR		b14	Number of feature records in the dataset

B6.1.3 Attribute Code field structure - ATCS

Subfield name	Label	Value	Format	Comment
Attribute Code	ATCD		A	The code as defined in the feature catalogue
Attribute Numeric Code	ANCD		b12	The code used within the NATC subfield

B6.1.4 Information Type Codes field structure - ITCS

Subfield name	Label	Value	Format	Comment
Information Type Code	ITCD		A	The code as defined in the feature catalogue
Information Type Numeric Code	ITNC		b12	The code used within the NITC subfield

B6.1.5 Feature Type Codes field structure - FTCS

Subfield name	Label	Value	Format	Comment
Feature Type Code	FTCD		A	The code as defined in the feature catalogue
Feature Type Numeric Code	FTNC		b12	The code used within the NFTC subfield

B6.1.6 Information Association Codes field structure - IACS

Subfield name	Label	Value	Format	Comment
Information Association Code	IACD		A	The code as defined in the feature catalogue
Information Association Numeric Code	IANC		b12	The code used within the NIAC subfield

B6.1.7 Feature Association Codes field structure - FACS

Subfield name	Label	Value	Format	Comment
Feature Association Code	FACD		A	The code as defined in the feature catalogue
Feature Association Numeric Code	FANC		b12	The code used within the NFAC subfield

B5.1.8 Association Role Codes field structure - ARCS

Subfield name	Label	Value	Format	Comment
Association Role Code	ARCD		A	The code as defined in the feature catalogue
Association Role Numeric Code	ARNC		b12	The code used within the NARC subfield

B6.1.9 Attribute field - ATTR

Subfield name	Label	Value	Format	Comment
Numeric Attribute Code	*NATC		b12	A valid attribute code as defined in the ATCS field of the Dataset General Information Record
Attribute Index	ATIX		b12	Index (position) of the attribute in the sequence of attributes with the same code and the same parent (starting with 1)
Parent Index	PAIX		b12	Index (position) of the parent complex attribute within this ATTR field (starting with 1). If the attribute has no parent (top level attribute) the value is 0
Attribute Instruction	ATIN	{1}, {2} or {3}	b11	{1} - Insert {2} - Delete {3} - Modify
Attribute Value	ATVL		A()	A string containing a valid value for the domain of the attribute specified by the subfields above

B6.1.10 Information Association field - INAS

Subfield name	Label	Value	Format	Subfield content and specification
Referenced Record Name	RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Numeric Information Association Code	NIAC		b12	A valid code for the information association as defined in the IACS field of the Dataset General Information Record
Numeric Association Role Code	NARC		b12	A valid code for the role as defined in the ARCS field of the Dataset General Information Record
Information Association Update Instruction	IUIN		b11	{1} - Insert {2} – Delete {3} - Modify
Numeric Attribute Code	*NATC		b12	A valid attribute code as defined in the ATCS field of the Dataset General Information Record
Attribute Index	ATIX		b12	Index (position) of the attribute in the sequence of attributes with the same code and the same parent (starting with 1)
Parent Index	PAIX		b12	Index (position) of the parent complex attribute within this ATTR field (starting with 1). If the attribute has no parent (top level attribute) the value is 0
Attribute Instruction	ATIN		b11	{1} - Insert {2} - Delete {3} - Modify
Attribute Value	ATVL		A()	A string containing a valid value for the domain of the attribute specified by the subfields above

B6.1.11 Information Type Identifier field - IRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{150}	b11	{150} - Information Type
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Numeric Information Type Code	NITC		b12	A valid information type code as defined in the ITCS field of the Dataset General Information Record
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1},{2} or {3}	b11	{1} – Insert {2} - Delete {3} - Modify

B6.1.12 Point Record Identifier field - PRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{110}	b11	{110} - Point
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1},{2} or {3}	b11	{1} – Insert {2} - Delete {3} - Modify

B6.1.13 2-D Integer Coordinate Tuple field structure - C2IT

Subfield name	**Label**	**Value**	**Format**	**Comment**
Coordinate in Y axis	YCOO		b24	Y-coordinate or latitude
Coordinate in X axis	XCOO		b24	X-coordinate or longitude

B6.1.14 3-D Integer Coordinate Tuple field structure - C3DI

Subfield name	**Label**	**Value**	**Format**	**Comment**
Vertical CRS Id	VCID		b11	Internal identifier of the Vertical CRS
Coordinate in Y axis	YCOO		b24	Y- coordinate or latitude
Coordinate in X axis	XCOO		b24	X- coordinate or longitude
Coordinate in Z axis	ZCOO		b24	Z - coordinate (depth)

B6.1.15 Multi Point Record Identifier field - MRID

Subfield name	**Label**	**Value**	**Format**	**Comment**
Record Name	RCNM	{115}	b11	{115} - Multi Point
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1},{2} or {3}	b11	{1} – Insert {2} - Delete {3} - Modify

B6.1.16 2-D Integer Coordinate List field structure - C2IL

Subfield name	**Label**	**Format**	**Subfield content and specification**
Coordinate in Y axis	*YCOO	b24	Y-coordinate or latitude
Coordinate in X axis	XCOO	b24	X-coordinate or longitude

B6.1.17 3-D Integer Coordinate List field structure - C3IL

Subfield name	**Label**	**Format**	**Subfield content and specification**
Vertical CRS Id	VCID	b11	Internal identifier of the Vertical CRS
Coordinate in Y axis	*YCOO	b24	Y- coordinate or latitude
Coordinate in X axis	XCOO	b24	X- coordinate or longitude
Coordinate in Z axis	ZCOO	b24	Z - coordinate (depth or height)

B6.1.18 Coordinate Control field - COCC

Subfield name	Label	Value	Format	Comment
Coordinate Update Instruction	COUI	{1},{2} or {3}	b11	{1} - Insert {2} - Delete {3} - Modify
Coordinate Index	COIX		b12	Index (position) of the addressed coordinate tuple within the coordinate field(s) of the target record
Number of Coordinates	NCOR		b12	Number of coordinate tuples in the coordinate field(s) of the update record

B6.1.19 Curve Record Identifier field - CRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{120}	b11	{120} - Curve
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1},{2} or {3}	b11	{1} - Insert {2} - Delete {3} - Modify

B6.1.20 Point Association field - PTAS

Subfield name	Label	Value	Format	Comment
Referenced Record Name	*RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Topology Indicator	TOPI		b11	{1} - Beginning point {2} - End point {3} - Beginning & End point

B6.1.21 Segment Control field - SECC

Subfield name	Label	Value	Format	Comment
Segment Update Instruction	SEUI	{1},{2} or {3}	b11	{1} - Insert {2} - Delete {3} - Modify
Segment Index	SEIX		b12	Index (position) of the addressed segment in the target record
Number of Segments	NSEG		b12	Number of segments in the update record

B6.1.22 Segment Header field - SEGH

Subfield name	Label	Value	Format	Comment
Interpolation	INTP	{4}	b11	{4} - Loxodromic

B6.1.23 Composite Curve Record Identifier field - CCID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{125}	b11	{125} - Composite Curve
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1},{2} or {3}	b11	{1} - Insert {2} - Delete {3} - Modify

B6.1.24 Curve Component Control field - CCOC

Subfield name	Label	Value	Format	Comment
Curve Component Update Instruction	CCUI		b11	{1} - Insert {2} - Delete {3} - Modify
Curve Component Index	CCIX		b12	Index (position) of the addressed Curve record pointer within the CUCO field(s) of the target record
Number of Curve Components	NCCO		b12	Number of Curve record pointer in the CUCO field(s) of the update record

B6.1.25 Curve Component field - CUCO

Subfield name	Label	Value	Format	Comment
Referenced Record Name	*RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Orientation	ORNT		b11	{1} - Forward {2} - Reverse

B6.1.26 Surface Record Identifier field - SRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{130}	b11	{130} - Surface
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1},{2} or {3}	b11	{1} - Insert {2} - Delete {3} - Modify

B6.1.27 Ring Association field - RIAS

Subfield name	Label	Value	Format	Comment
Referenced Record Name	RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Orientation	ORNT		b11	{1} - Forward {2} - Reverse
Usage indicator	USAG		b11	{1} - Exterior {2} - Interior
Ring Association Update Instruction	RAUI	{1} or {2}	b11	{1} - Insert {2} - Delete

B6.1.28 Feature Type Record Identifier field - FRID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{100}	b11	{100} - Feature type
Record Identification number	RCID		b14	Range: 1 to 2^{32}-2
Numeric Feature Type Code	NFTC		b12	A valid feature type code as defined in the FTCS field of the Dataset General Information Record
Record Version	RVER		b12	RVER contains the serial number of the record edition
Record Update Instruction	RUIN	{1},{2} or {3}	b11	{1} - Insert {2} - Delete {3} - Modify

B6.1.29 Feature Object Identifier field - FOID

Subfield name	Label	Value	Format	Comment
Producing Agency	AGEN		b12	Agency code
Feature Identification Number	FIDN		b14	Range: 1 to 2^{32}-2
Feature Identification Subdivision	FIDS		b12	Range: 1 to 2^{16}-2

B6.1.30 Spatial Association field - SPAS

Subfield name	Label	Value	Format	Comment
Referenced Record Name	*RRNM	{1} to {5}	b11	Record name of the referenced record {1} - 110 {2} - 115 {3} - 120 {4} - 125 {5} - 130
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Orientation	ORNT		b11	{1} Forward {2} Reverse {255} NULL (Not Applicable)
Scale Minimum	SMIN		b14	Denominator of the largest scale for which the feature type can be depicted by the referenced spatial feature. If the value is 0 it does not apply
Scale Maximum	SMAX		b14	Denominator of the smallest scale for which the feature type can be depicted by the referenced spatial feature. If the value is 2^{32}-1 it does not apply
Spatial Association Update Instruction	SAUI	{1} or {2}	b11	{1} - Insert {2} - Delete

B6.1.31 Feature Association field – FASC

Subfield name	Label	Value	Format	Comment
Referenced Record Name	RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Numeric Feature Association Code	NFAC		b12	A valid code for the feature association as defined in the FACS field of the Dataset General Information Record
Numeric Association Role Code	NARC		b12	A valid code for the role as defined in the ARCS field of the Dataset General Information Record
Feature Association Update Instruction	FAUI	{1} ,{2} or {3}	b11	{1} - Insert {2} – Delete {3} - Modify
Numeric Attribute Code	*NATC		b12	A valid attribute code as defined in the ATCS field of the Dataset General Information Record
Attribute Index	ATIX		b12	Index (position) of the attribute in the sequence of attributes with the same code and the same parent (starting with 1)
Parent Index	PAIX		b12	Index (position) of the parent complex attribute within this ATTR field (starting with 1). If the attribute has no parent (top level attribute) the value is 0
Attribute Instruction	ATIN	{1},{2} or {3}	b11	{1} - Insert {2} - Delete {3} - Modify
Attribute Value	ATVL		A()	A string containing a valid value for the domain of the attribute specified by the subfields above

B6.1.32 Masked Spatial Type field - MASK

Subfield name	Label	Value	Format	Comment
Referenced Record Name	*RRNM		b11	Record name of the referenced record
Referenced Record Identifier	RRID		b14	Record identifier of the referenced record
Mask Indicator	MIND	{1} or {2}	b11	{1} - Truncated by the dataset limit {2} - Supress portrayal
Mask Update Instruction	MUIN	{1} or {2}	b11	{1} - Insert {2} - Delete

B7 Dataset cancellation structure

```
Dataset cancelation file
   |
   |--<1>- Dataset General Information record

       |

       |--<1>-DSID (13\\*1): Dataset Identification field
```

B7.1 Field Content

B7.1.1 Dataset Identification field - DSID

Subfield name	Label	Value	Format	Comment
Record Name	RCNM	{10}	b11	{10} - Dataset Identification
Record Identification number	RCID	{1}	b14	Only one record
Encoding Specification	ENSP	'S-100 Part 10a'	A()	Encoding specification that defines the encoding
Encoding Specification Edition	ENED	"1.1"	A()	Edition of the encoding specification
Product identifier	PRSP	"INT.IHO.S-101.1.0"	A()	Unique identifier for the data product as specified in the product specification
Product Edition	PRED	"1.0"	A()	Edition of the product specification
Application Profile	PROF	"2"	A()	"2" - ER Profile
Dataset File Identifier	DSNM		A()	The file name including the extension but excluding any path information
Dataset Title	DSTL		A()	The title of the dataset
Dataset Reference Date	DSRD		A(8)	The reference date of the dataset Format: YYYYMMDD according to ISO 8601
Dataset Language	DSLG	"EN"	A()	The (primary) language used in this dataset
Dataset Abstract	DSAB	omitted	A()	The abstract of the dataset
Dataset Edition	DSED	"0"	A()	0 - indicates the cancelation
Dataset Topic Category	*DSTC	{14}{18}	b11	A set of topic categories

ANNEX C - S-101 Validation Checks

This Annex specifies the minimum checks that producers of S-101 ENC validation tools should include in their validation software. This software must be used by hydrographic offices to help ensure that their ENC data are compliant with the S-101 ENC Product Specification. The checklist has been compiled for the IHO from lists of checks provided by a number of hydrographic offices and software companies. The Annex provides checks for individual ENC cells however additional checks applicable to ENC Exchange Sets are included in part X.X.

The S-101 Validation Checks can be found in the Standards and Publications page of the IHO web site,.

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