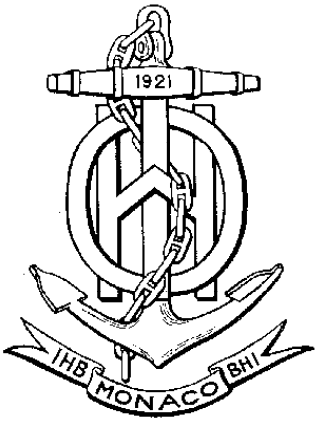
**INTERNATIONAL HYDROGRAPHIC ORGANIZATION**




# IHO GEOSPATIAL STANDARD FOR HYDROGRAPHIC DATA

**Version 0.0.0 – January 2008**

Special Publication No. 101
Electronic Navigational Chart Product Specification

**Published by the**
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# Contents

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# 1 Overview

## 1.1 S-101 General Product Specification Metadata

Note: This information uniquely identifies this product specification and provides information about its creation and maintenance.

**Title:** The International Hydrographic Organization Electronic Navigational Chart Product Specification

**Version:** 0.0.0

**Date:**

**Language:** English

**Classification:** Unclassified

**Contact:** International Hydrographic Bureau (IHB)

4 Quai Antoine 1er
B.P. 445
MC 98011 MONACO CEDEX
Telephone: +377 93 10 81 00
Fax: + 377 93 10 81 40

**URL:** www.iho.int

**Identifier:** S-101

**Maintenance:** Changes to the product specification S-101 are coordinated by Transfer Standards Maintenance and Applications Development Working Group (TSMAD) of the IHO and shall be made available via the IHO web site. For further details see annex ?

## 1.2 Terms, definitions and abbreviations

### 1.2.1 Terms and Definitions

**point**
0-dimensional **geometric primitive**, representing a position

**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”

**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**

### 1.2.2 Abbreviations

IHO International Hydrographic Organization

ENC Electronic Navigational Chart

SENC System Electronic Navigational Chart

## 1.3 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. Its primary function is for use within an Electronic Chart Display and Information Systems (ECDIS) to meet International Maritime Organisation (IMO) and Safety Of Life At Sea (SOLAS) chart carriage requirements. The ENC contains an extraction of real world information necessary for the safe navigation of vessels.

**Content:** This product specification is a complete description of all the appropriate features, attributes and their relationships necessary to define an ENC data product. The precise content is documented within the Feature Catalogue and the relationships defined the Application Schema. Details of how these features should be symbolised are contained in the associated portrayal catalogue.

**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 data set is to provide official navigational data to an Electronic Chart Display and Information System (ECDIS) for the safe passage of vessels between destinations.

## 2 Specification Scopes

**Scope ID:** Root scope

**Level:** 001

**Level name:** ENC general scope

**Extent:** Global, marine areas only

**Scope ID:** Scale Dependant

**Level:** 002

**Level name:** Scale Dependant Scope

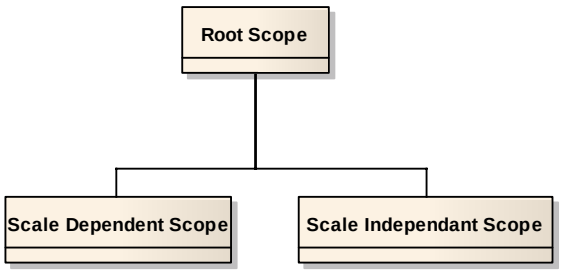
**Extent:** Global, marine areas only

**Scope ID:** Scale Independent

**Level:** 003

**Level name:** Scale Independent Scope

**Extent:** Global, marine areas only



# 3 Datasets Product Identification

A data set that conforms to this product specification will be identifiable by the discovery metadata that supports it.

| | |
|---|---|
| **Title:** | Electronic Navigation Chart |
| **Alternate Title:** | ENC |
| **Abstract:** | When an S-101 ENC is produced it must be in accordance with the rules defined in the S-101 product specification. S-101 details specifications intended to enable Hydrographic Offices to produce a consistent ENC, and manufacturers to use that data efficiently in an ECDIS to satisfy IMO Performance Standards for ECDIS. |
| **Topic Category:** | Transportation |
| **Geographic Description:** | Areas specific to marine navigation. |
| **Spatial Resolution:** | Display Scale |
| **Purpose:** | Electronic Navigational Chart for use in Electronic Chart Display Systems |
| **Language:** | English |
| **Classification:** | Unclassified |
| **Spatial Representation Type:** | Vector |
| **Point of Contact:** | Producing Hydrographic Office |
| **Use Limitation:** | Not to be used for navigation on land. |

# 4 Data Content and structure

An S-101 ENC is a feature-based product. This section contains the product application schema expressed in UML and an associated feature catalogue. The feature catalogue provides a full description of each feature type including its attributes, attribute values and relationships in the data product.

## 4.1 Application Schema

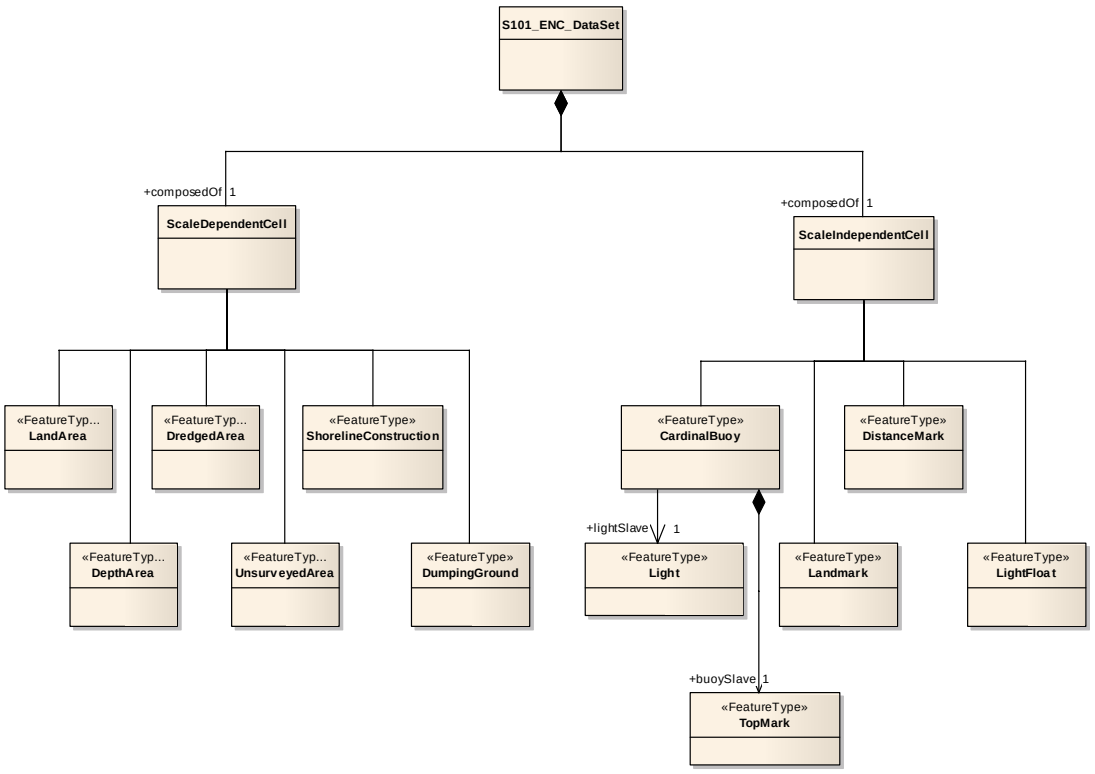



Figure ?? Datasets

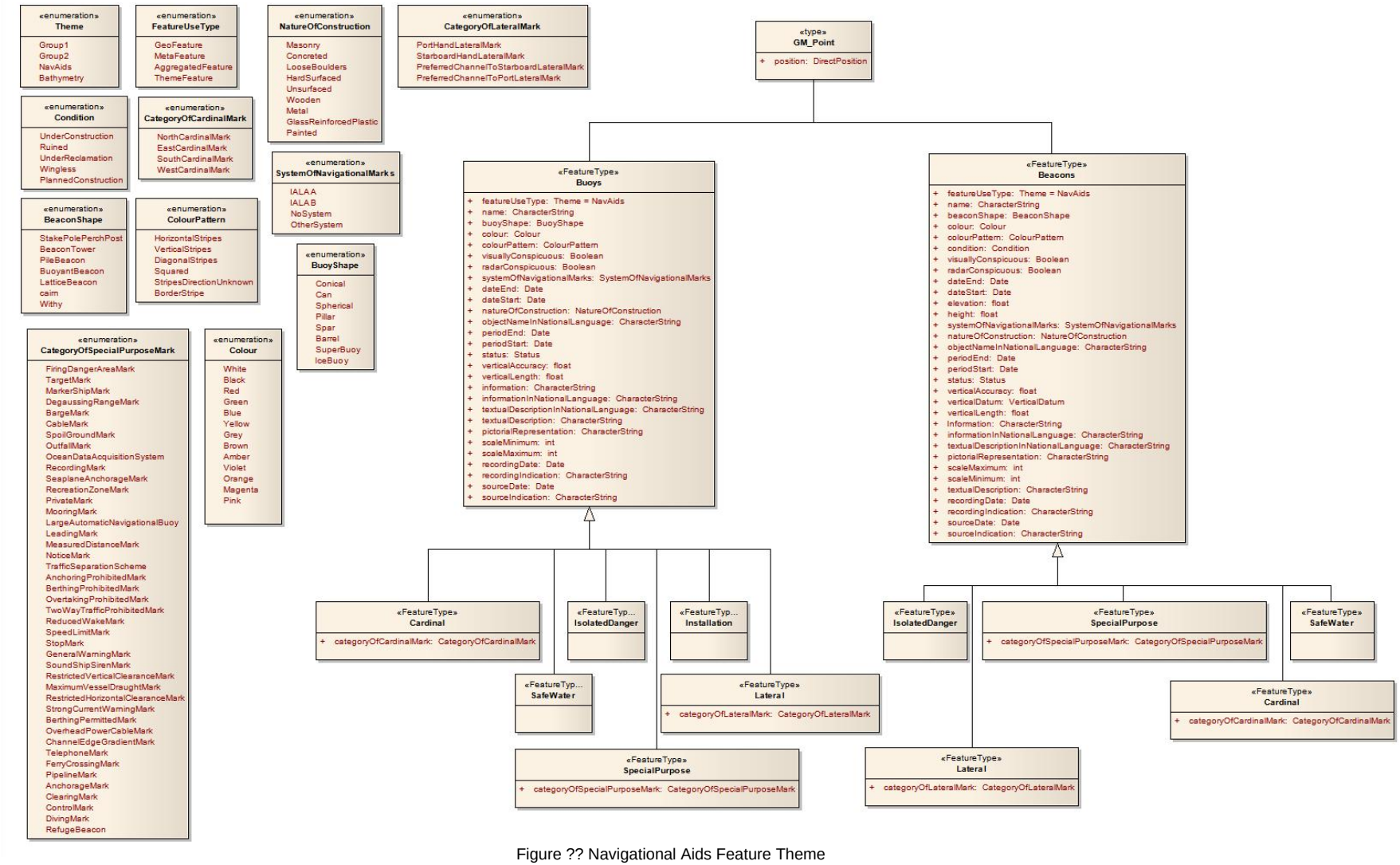



Figure ?? Navigational Aids Feature Theme

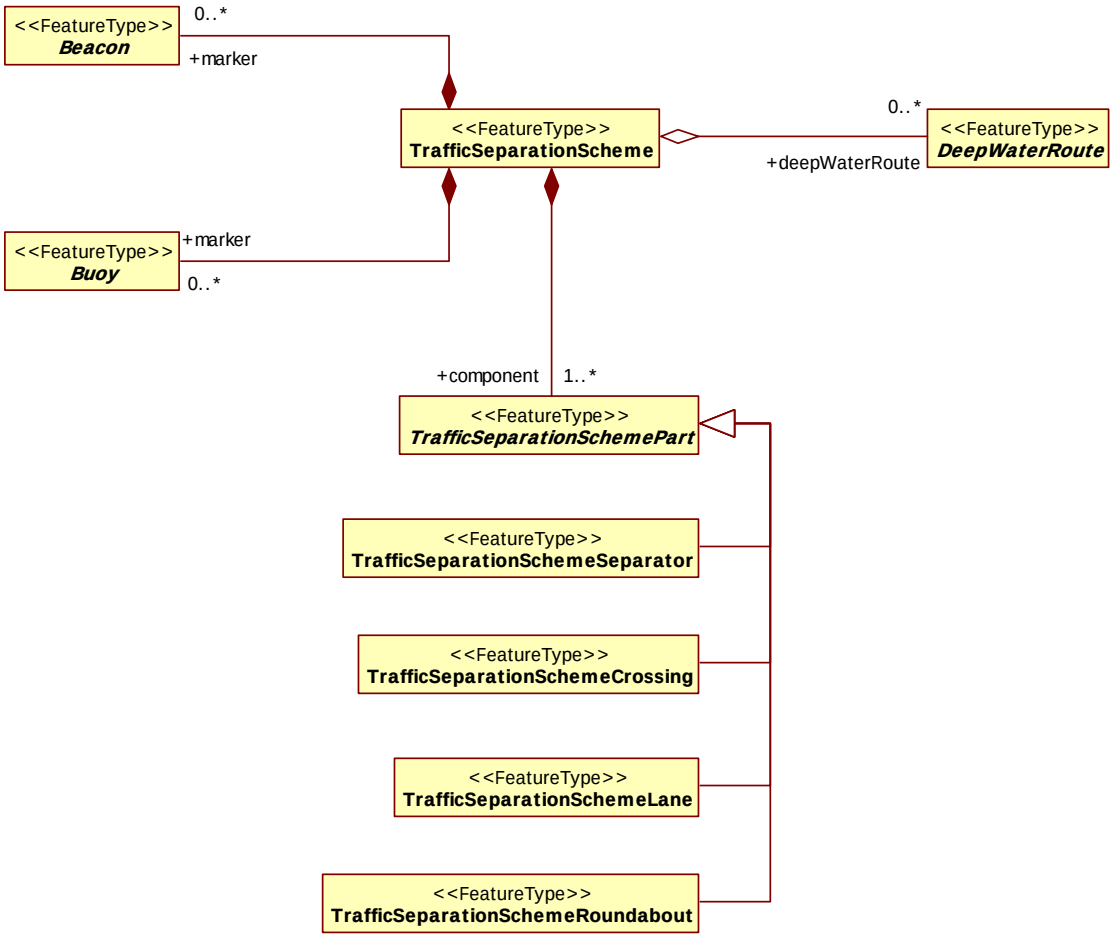



Figure ?? Feature Aggregation

Note: UML diagrams detailing all new S-101 concepts, the application schema will form the backbone of the document. This is just a start it is not the complete application schema. The next section of this chapter will discuss each of the parts of the application schema in detail. It will be generic and will not tie us down to a specific encoding. The content of this section needs some work….

## 4.2 Feature Catalogue

Only feature types, information types, attributes, attribute values, associations and roles which are defined in the IHO Feature Catalogue may be used in an ENC.

The feature catalogue will only be available in XML format with an accompanying style sheet.

## 4.3 Feature Types

### 4.3.1 Meta Feature Types

Meta features contain information about other features within a data set. Information defined by meta features override the default metadata values defined by the data set descriptive records. All meta objects are defined in the S-101 Feature Catalogue (Annex ?)

Maximum use must be made of meta features within a scale dependant cell to reduce the attribution on individual features. In a base data set, the meta feature M_QUAL is mandatory. This meta feature class must provide exhaustive coverage of the part of the cell containing depth data.

The meta feature M_NSYS with the attribute MARSYS (to indicate the system of navigational marks) must also provide an exhaustive non-overlapping coverage of the part of the cell containing data. However, other M_NSYS features with the attribute ORIENT (to indicate a local direction of buoyage) may overlap these features.

### 4.3.2 Geographic Feature Types

Geo feature types form the principle content of the navigational product and are fully defined by their associated attributes and information types.

### 4.3.3 Theme Feature Types

Theme features are a special kind of collection object. They do not define a feature itself but group other features together. The reasons for the grouping are mostly thematic, other reasons are possible. Each feature object may belong to more than one theme. Themes are therefore not mutually exclusive. Since the kind of association from a theme object to its members (and vice versa) is not variable, the encoding of this type of association is different from the other feature associations.

#### 4.3.3.1 Skin of the Earth Theme

Themes are normally defined in the feature catalogue however in this case there are constraints which have to be observed. Skin of the Earth features are a set of geo features of geometric type area that do not overlap each other and form a continuous surface named “skin of the earth”. The geometry of coincident boundaries between Skin of the Earth features must not be duplicated. The features listed below represent the only allowable features in this theme.

DEPARE DRGARE LNDARE UNSARE

### 4.3.4 Aggregated Feature Types

Feature with a use type of aggregated can have multiple associations to other feature types.

## 4.4 Time Varying Features

The ENC may contain information about magnetic variation, tides, tidal streams and currents.

### 4.4.1 TIDES

Depth information should normally be displayed as it has been provided in the ENC. However, where a producer has issued a supplementary layer of a higher resolution this information will take priority.
The layer will contain additional contour intervals which will increase the number of depth areas. There will also be an increase in the number of depth soundings.

To allow viewing of the new layer the scale dependent portion of an ENC can suppress its bathymetric data theme. This permits the superior layer to have its associated depths adjusted for tidal height. In this case, it must be made clear to the user that such adjustments are being made.

## 4.5 Information Types

Information types are identifiable pieces of information in a cell that can be shared between other features. They have attributes like all feature types but have no relationship to any geometry. Information types may reference other information types.

## 4.6 Feature integrity

### 4.6.1 ENC data integrity measures

Where there is a high impact of data corruption such as ENC data there is a need for a mechanism within the ENC data itself to ensure it has not changed. The mechanism chosen for this assurance is a cyclic redundancy check.

### 4.6.2 Feature level CRC values

Each Feature record may have a CRC value associated with it. This encapsulates the entire state of that feature and is calculated on all the cell data associated with that feature. It is defined as a CRC32 value calculated from an XML rendering of a feature's state at the time of publication. These feature level CRC values are described further in Appendix XX. Encodings may additionally define other data integrity mechanisms at a file level as well as stronger data authentication mechanisms such as digital signatures but the standard encoding defined in the standard contains only feature and file level CRC32 values.

## 4.7 Attributes

### 4.7.1 Complex Attributes

A complex attribute is a concatenation of two or more, simple or complex attribute types. Complex attributes do not carry the physical values, these will be held by its sub attributes.

### 4.7.2 Numeric Attribute Values

Floating point or integer attribute values must not be padded by non-significant zeroes.

### 4.7.3 Text Attribute Values

Character strings must be encoded using the character set specified in Unicode Transformation Format-8 (UTF-8).

#### 4.7.4 Text Placement

The text encoded in the object name attribute of a feature can be given an anchor point that specifies the placement of the text within an ECDIS. When a feature is encoded with an object name and the compiler wishes the text to appear in a specific place a text placement complex attribute must be encoded detailing the true bearing in degrees and the distance value from the feature

#### 4.7.5 Mandatory Attribute Values

There are four reasons why attribute values may be considered mandatory:

- They determine whether a feature is in the display base,
- Certain features make no logical sense without specific attributes,
- Some attributes are necessary to determine which symbol is to be displayed,
- Some attributes are required for safety of navigation.

All mandatory attributes are identified in the feature catalogue.

##### 4.7.5.1 Unknown Mandatory Attribute Values

In a base data set, 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 a revision data set, 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 unknown value if it was present in the original data set,
- that an unknown value is to be inserted if the attribute was not present in the original data set.

### 4.8 Associations

### 4.9 Roles

## 4.10 ENC Data Set

An ENC data set is a collection of geo-referenced cells containing geographic features that are used to fully describe the physical marine environment for the safe passage of vessels.

## 4.11 Cells

A cell is a grouping of features, attributes, geometry and metadata which form a data surface with a specific coverage.

Cells must be rectangular (i.e. defined by 2 meridians and 2 parallels). However the data contained within a cell does not have to be equal to the cell boundary.

Features with the geometric properties of point or line coincident with the border of two cells within the same layer and with the same display scale must be part of only one cell.

When a feature extends across cells at the same display scale its geometry must be split at the cell boundaries and its complete attribute description must be repeated in each cell.

## 4.12 Unique Universal Identifier

Each feature and Information type within an ENC must have a unique universal identifier [UUID].

For ENC the UUID may be used to identify multiple instances of the same feature. For example, the same feature may appear in different display scales, or a feature may be split by the cell structure. In these circumstances each instance of this feature may have the same identifier.

UUIDs must not be reused, even when a feature has been deleted.

## 4.13 Scale Independent and Scale Dependant

ENC producers can make the decision to partition a set of navigational data into two separate cells based on the scale dependent and scale independent geometric properties of features. This concept splits a collection of data into two groups. The primary advantage of this structure is that receiving systems only hold the scale independent features once, instead of multiple occurrences at different display scales. This in turn effectively reduces the file size of an ENC exchange set and increases the speed at which updates can be applied to cells.

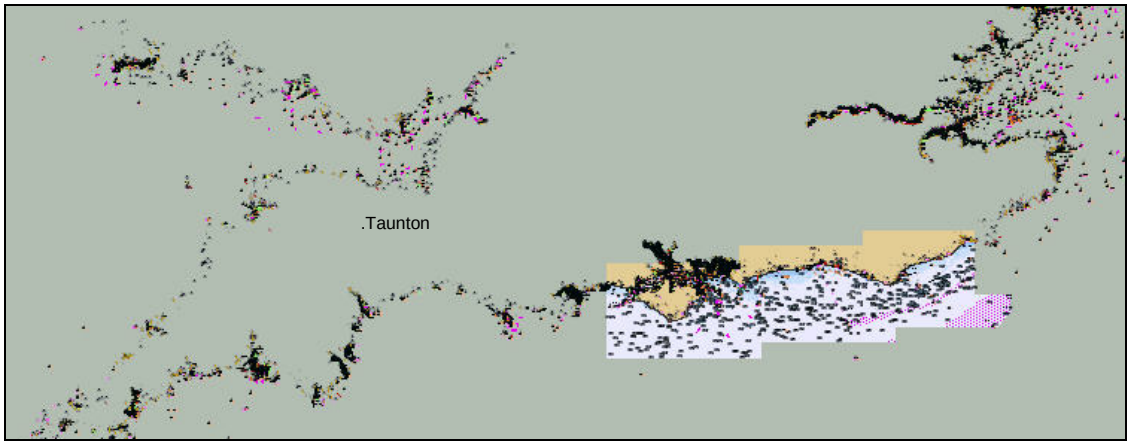



Figure ?? A scale independent cell overlaid with three scale dependant cells.

### 4.13.1 Scale Independent Cell

There can be more than one scale independent cell contained within an exchange set. To view scale independent data in a receiving system there must be an accompanying cell containing the scale dependent data for that area. A scale independent cell will not contain any meta features. A nation responsible for the population of a scale independent data set will be obligated to produce scale dependent data sets of the same area. The display scale of the cell must be set to 0. All features within a scale independent cell must have the attribute, scale minimum and (scale max?) encoded.

### 4.13.2 Scale Independent Cell Content

Listed in Table 2 are the allowable features and their geometric primitive types which make up the content of a scale independent cell.

| ACROYNM | NAMES | GEOMETRIC TYPE | UKHO FODB |
|---|---|---|---|
| BCNCAR | Beacon, cardinal | P | P |
| BCNISD | Beacon, isolated danger | P | P |
| BCNLAT | Beacon, lateral | P | P |
| BCNSAW | Beacon, safe water | P | P |
| BCNSPP | Beacon, special purpose/general | P | P |
| BUISGL | Building single | P, A | P |
| BOYCAR | Buoy, cardinal | P | P |
| BOYISD | Buoy, isolated danger | P | P |
| BOYLAT | Buoy, lateral | P | P |
| BOYSAW | Buoy, safe water | P | P |
| BOYSPP | Buoy, special purpose | P | P |
| BOYINB | Buoy, installation | P | P |
| CGUSTA | Coastguard station | P | P |
| CHKPNT | Check point | P | |
| CTRPNT | Control Point | P | |
| DAYMAR | Day mark | P | P |
| DISMAR | Distance mark | P | |
| FOGSIG | Fog signal | P | P |
| DWRTCL | Deep water route centreline | L | |
| DWRTPT | Deep water route part | A | |
| FORSTC | Fortified structure | P | P |
| LNDMRK | Landmark | P | P |
| LIGHTS | Light | P | P |
| LITFLT | Light Float | P | P |
| LITVES | Light vessel | P | P |
| MORFAC | Mooring/Warping facility | P | P |
| PILPNT | Pile | P | |
| PILBOP | Pilot boarding place | P | |
| OBSTRN | Obstruction | P | |
| OFSPLF | Offshore platform | P | P |
| OSPARE | Offshore production area | A | |

| | | | |
|---|---|---|---|
| PILBOP | Pilot boarding place | P, A | |
| PRCARE | Precautionary area | P, A | |
| PYLONS | Pylon/bridge support | P | P |
| RADRFL | Radar reflector | P | |
| RADSTA | Radar station | P | P |
| RTPBCN | Radar transponder beacon | P | P |
| RDOCAL | Radio calling-in point | P | P |
| RDOSTA | Radio station | P | P |
| RECTRC | Recommended track | L | |
| RSCSTA | Rescue station | P | P |
| SISTAT | Signal station, traffic | P | P |
| SISTAW | Signal station, warning | P | P |
| SILTNK | Silo/tank | P | P |
| TOPMAR | Top mark | P | P |
| TSELNE | Traffic separation line | L | |
| TSEZNE | Traffic separation zone | A | |
| TSSBND | Traffic separation scheme boundary | L | |
| TSSCRS | Traffic separation scheme crossing | A | |
| TSSLPT | Traffic separation scheme lane part | A | |
| TSSRON | Traffic separation scheme roundabout | A | |
| TWRTPT | Two-way route part | A | |
| UWTROC | Underwater/awash rock | P | |
| WRECKS | Wreck | P, A | |

## 4.14 Scale Dependent Cells

Scale dependent cells will not contain any of the feature classes present in the scale independent list. Scale dependent cells with the same display scale may overlap. However, data within the cells must not overlap. Therefore, in the area of overlap only one cell may contain data.

## 4.15 Display Scales

Display scale will be the optimum viewing scale of the data within a cell. The display scale must be one of the scales listed in the table below. In addition to the optimum display scale the producer will encode the maximum and minimum display scales an ENC can be viewed at.

The display scales for ENC have been aligned with standard RADAR ranges and are as follows:

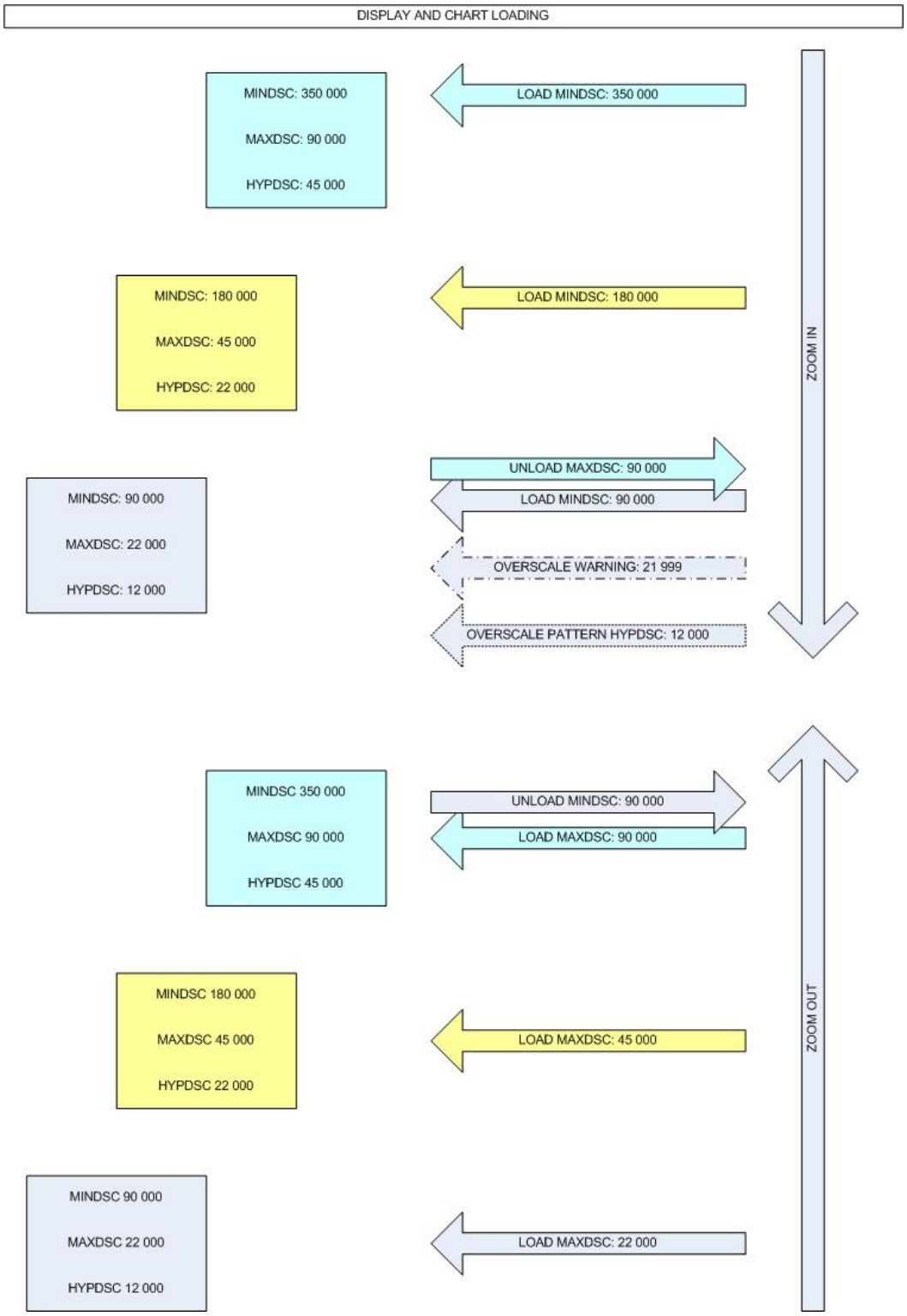
| **Standard RADAR Ranges** | **Display Scale** | **Navigation Purpose** |
|---|---|---|
| | >1:3, 000,000 | Ocean Passage |
| 200 NM | 1:3, 000,000 | Ocean Passage |
| 96 NM | 1:1,500,000 | Ocean Passage |
| 48 NM | 1:700,000 | Ocean Passage |
| 24NM | 1:350,000 | Coastal |
| 12 NM | 1:180,000 | Coastal |
| 6 NM | 1:90,000 | Coastal |

| | | |
|---|---|---|
| 3 NM | 1:45,000 | Coastal |
| 1.5 NM | 1:22,000 | Port entry |
| 0.75 NM | 1:12,000 | Port entry |
| 0.5 NM | 1:8000 | Port entry |
| 0.25 NM | 1:4000 | Port entry |
| | <=1:2000 | Port entry |

Table 1: Standard Display Scales

It will not be possible for a user to zoom past a cells display scale maximum or minimum values. In the event a user wishes to zoom into the product see the detail of the data in greater clarity a larger display scale cell should be loaded. Conversely if the user wished to get an overview of an area and zooms out a smaller display scale chart will load when the minimum value is reached. If there is no smaller or larger scale information available systems will not allow users to unload the current cell or zoom past the display scale max and min values. Producers of the ENC data have made the informed decision that data viewed beyond the max and min display scales would be degraded to such an extent that the product would become unsafe.

The presentation of symbolised lines is affected by line length. Therefore, the encoder must not split a line into numerous small edges of a length less than 0.3mm at display scale as this will result in poor symbolisation and increases file sizes unnecessarily.


DISPLAY AND CHART LOADING
MINDSC: 350 000
MAXDSC: 90 000
HYPDSC: 45 000
LOAD MINDSC: 350 000
ZOOM IN
MINDSC: 180 000
MAXDSC: 45 000
HYPDSC: 22 000
LOAD MINDSC: 180 000
MINDSC: 90 000
MAXDSC: 22 000
HYPDSC: 12 000
UNLOAD MAXDSC: 90 000
LOAD MINDSC: 90 000
OVERSCALE WARNING: 21 999
OVERSCALE PATTERN HYPDSC: 12 000
MINDSC 350 000
MAXDSC 90 000
HYPDSC 45 000
UNLOAD MINDSC: 90 000
LOAD MAXDSC: 90 000
ZOOM OUT
MINDSC 180 000
MAXDSC 45 000
HYPDSC 22 000
LOAD MAXDSC: 45 000
MINDSC 90 000
MAXDSC 22 000
HYPDSC 12 000
LOAD MAXDSC: 22 000

## 4.16 Geometry

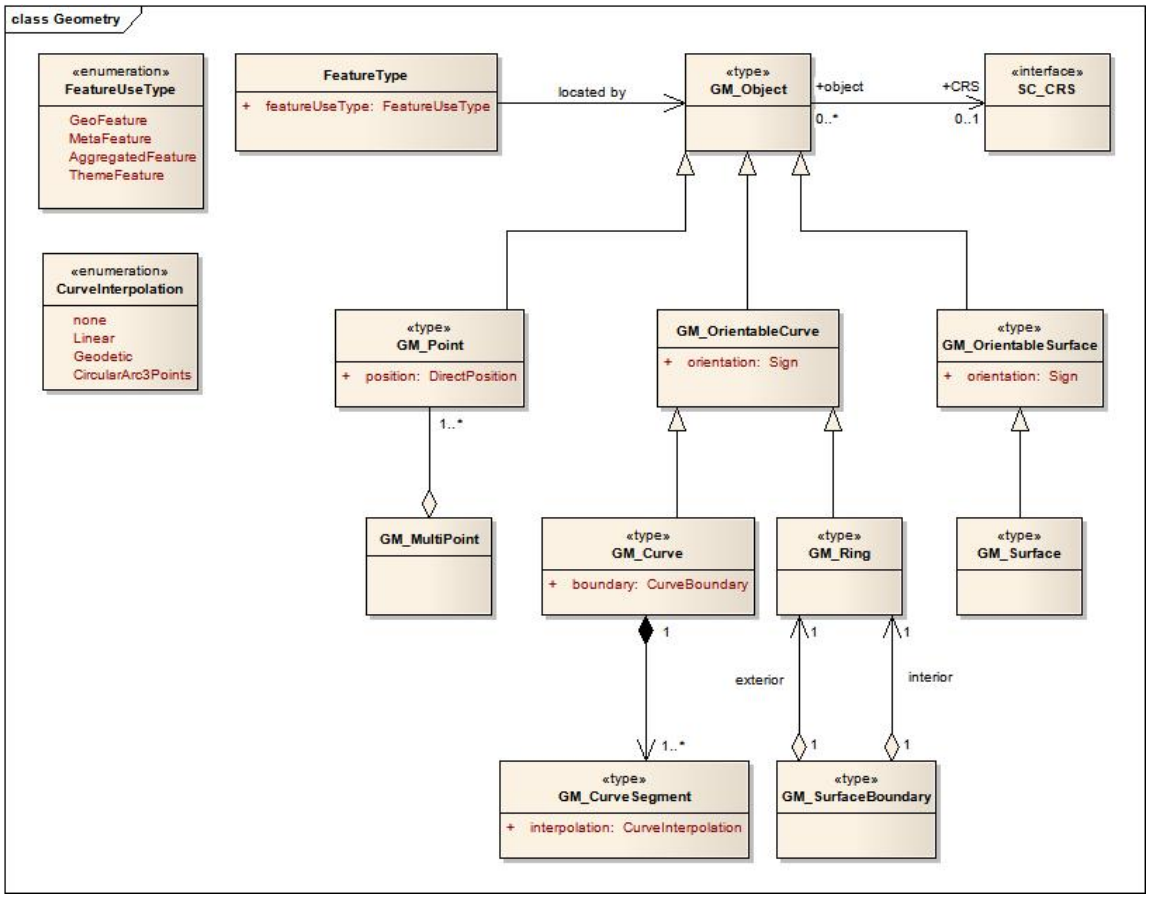



Figure ? S-100 Level 3A

Features contain descriptive attributes and do not contain any geometry (i.e. information about the shape and position of a real world entity). Spatial objects may have descriptive attributes and must contain geometry. A feature is located by a relationship to one or more spatial objects. Features may exist without referencing a spatial object, but each spatial object must be referenced by a feature.

The underlying geometry of an ENC will be constrained to S-100 level 3a which supports 0, 1 and 2 dimensional objects, points, curves and surfaces. The third dimension is expressed as an attribute of an object.

### 4.16.1 Level 3a

A set of point, curve and surface primitives with the following constraints:

- Each curve must reference a start and end point (they may be the same).
- Curves must not self intersect.
- 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 tangentially (i.e. at one point).
- 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.
- Coincident linear geometry must be avoided when there is a dependency between features.

For a complete description of the geometry in Figure ?? see S-100 part 6 – 1D and 2D Spatial.

# 5 Coordinate Reference Systems (CRS)

## 5.1 Introduction

Due to the nature of hydrography it is common practice to separate the horizontal and vertical part of a position. This leads to 2D coordinate reference systems for the horizontal positions and 1D coordinate reference systems for the vertical positions. To describe 3D coordinates those coordinate reference systems must be combined to produce a compound reference system. An ENC data set must define at least one compound CRS. An ENC compound CRS is composed of a 2D geodetic CRS (WGS84) and a vertical CRS.

## 5.2 Horizontal Geodetic Datum

For ENC the geodetic datum of the horizontal CRS must be WGS 84. If the CRS is not defined in the encoding by referencing then the CRS must be fully defined encoding all parameters.

## 5.3 Coordinate Transformations

The mariner may have to display information other than ENC data and ENC updates. In cases where this information is based on a geodetic datum other than WGS 84, it can be transformed to WGS 84 by means of the meta feature Horizontal Datum Shift Parameter (M_HOPA).

The cell may contain X and Y datum corrections to be used to provide the shift to adjust the co-ordinates from another horizontal datum to WGS 84.

Where data has been transformed to WGS 84 from another datum, the producing authority may wish to indicate the accuracy of the transformation. If so, it must be done using the attribute INFORM on the meta feature M_QUAL.

## 5.4 Vertical and Sounding Datum

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

No restriction is placed on the vertical or sounding datums that can be used to define height and depth reference systems within ENC.

### 5.4.1 Vertical Datum

Vertical datum information is encoded using the meta feature M_VDAT, or the attribute VERDAT on individual features. The values encoded in the attributes ELEVAT, HEIGHT, VERCCL, VERCLR, VERCOP and VERCSA are referenced to the specified datum(s). VERDAT must not be encoded on an feature unless at least one of the above attributes is also encoded on that feature.

The default value for the entire data set must be given in the metadata.

If the vertical datum for an area is different to the value given in the data set, it must be encoded using M_VDAT. The areas covered by these meta features must not overlap.

Height contours, going across areas having different values of vertical datum, must be split at the border of these areas.

Various datums are used on paper charts and these datums are used in the same way for ENC. For example, different datums may be used for the following:

- altitude of spot heights, height contours, landmarks,
- elevation of lights,
- vertical clearance.

Where different vertical datums are used for the various vertical measurements, the default value given by the VDAT subfield or M_VDAT applies to the first group of the above list. The attribute VERDAT on an individual feature applies to the elevation of lights and vertical clearances and must only be populated if different to the value given by VDAT or M_VDAT.

### 5.4.2 Sounding Datum

Sounding datum information is encoded using the subfield VDAT or the meta feature M_SDAT, and must be constant over large areas. The values encoded in the attributes VALSOU, DRVAL1, DRVAL2 and VALDCO, and the sounding values encoded in SOUNDG features, are referenced to this datum.

If the sounding datum for an area is different to the value given in the data set, it must be encoded using M_SDAT. The areas covered by these meta features must not overlap.

The use of the attribute VERDAT on individual features related to depth is prohibited see the feature catalogue for full list.

Depth contours and depth areas going across areas having different values of sounding datum must be split at the border of those areas.

## 5.5 Projection

No projection is to be used within the ENC. Coordinates must be encoded as geographical positions (latitude, longitude).

## 5.6 Units of Measure

Units to be used in an ENC

- Position: latitude and longitude in decimal degrees (converted into integer values).
- Depth: metres.
- Height: metres.
- Positional accuracy: metres.

- Distance: nautical miles and decimal miles, or metres.

The standard depth contour intervals allowed in ENC. In some instances the standard rage of contour intervals can be augmented by additional contours in order to delimit particular bathymetric features.

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | **2** | **5** | **10** | **15** | **20** | **30** | **50** | **100** | **200** | **300** | **500** | | **1000** | **2000** | **3000** | **5000** | **6000** | |

### 5.6.1 Positions

Latitude and longitude values are converted from decimal degrees to integers by means of the Coordinate Multiplication Factor. The number of decimal digits is chosen by the data producer and is valid through out the data set.

Coordinates must be held in ENC production systems at a resolution of 0.0000001 ($10^{-7}$) and the coordinate multiplication factor value should be set to 10000000 ($10^{7}$) for all cells.

EXAMPLE A longitude = 34.5678E is converted into X = longitude * COMF = 34.5678 * 10000000 = 345678000.

### 5.6.2 Depths

Depths are converted from decimal meters to integers by means of the 3-D (Sounding) Multiplication Factor. Soundings are never encoded with a resolution greater than one decimetre, so the value of sounding multiplication factor must be 10.

For update cells, ‘Coordinate Multiplication Factor’ [X], [Y] and the ‘3-D (Sounding) Multiplication Factor’ [Z] will not be present. In this case, the values from the original base cell should be used.

# 6 Data Quality

Data quality comprises the following:

- source of data;
- accuracy of data;
- Up-to-datedness of data.

Data quality is considered to be meta information. As such, it can be encoded at three different levels

Data quality information is considered to be application specific. Therefore, rules for encoding data quality must be defined by the relevant product specification.

## 6.1 Quality, Reliability and Accuracy of Bathymetric Data

Information about quality, reliability and accuracy of bathymetric data is given using:

- the meta feature M_QUAL for an assessment of the quality of bathymetric data,
- the meta feature M_SREL for additional information about the survey,
- the attributes QUASOU, SOUACC and TECSOU on groups of soundings or individual features,
- the attributes POSACC and QUAPOS on the spatial features.

For the mariner, M_QUAL provides the most useful information. Therefore, the use of M_QUAL is mandatory for areas containing depth data or bathymetry.

More detailed information about a survey may be given using M_SREL. For example, in incompletely surveyed areas, lines of passage soundings may be indicated as such using a linear M_SREL feature. This information is more difficult for the mariner to interpret. Therefore, the use of M_SREL is optional.

For individual objects (wrecks, obstructions etc), or small groups of soundings, QUASOU, SOUACC and TECSOU may be used to provide additional information about quality and accuracy.

### 6.1.1 Quality of bathymetric data

The meta feature M_QUAL defines areas within which uniform assessment exists for the quality of bathymetric data, and must be used to provide an assessment of the overall quality of bathymetric data to the mariner. Areas of a cell containing depth data or bathymetry must be covered by one or more M_QUAL, which must not overlap.

### 6.1.2 Survey reliability

The survey reliability may be encoded using the meta feature M_SREL.

### 6.1.3 Quality of sounding

If it is required to encode the quality of sounding, it must be done using the attribute QUASOU on either the meta feature M_SREL or on individual geo features (e.g. SOUNDG).

The quality of sounding must not be encoded using QUASOU on the depth geo feature, unless it is different to the value of QUASOU encoded on M_SREL

### 6.1.4 Sounding accuracy

Sounding accuracy is encoded using the attribute CATZOC on the meta feature M_QUAL. If it is required to encode additional sounding accuracy information, it must be done using the attribute SOUACC on either the meta feature M_QUAL or on individual geo features (e.g. SOUNDG).

The accuracy of sounding must not be encoded using SOUACC on the depth geo feature, unless it is different to the value of SOUACC encoded on M_QUAL.

### 6.1.5 Technique of sounding measurement

If it is required to encode the technique of sounding measurement, it must be done using the attribute TECSOU on either the meta feature M_QUAL or on individual geo features (e.g. SOUNDG).

The technique of sounding measurement must not be encoded using TECSOU on the depth geo feature, unless it is different to the value of TECSOU encoded on M_QUAL.

## 6.2 Accuracy of non-bathymetric data

### 6.2.1 Quality of positions

The meta feature M_ACCY may be used to provide an overall accuracy of position for all non-bathymetric features. It must not be used to provide the accuracy of bathymetric information.

The attributes QUAPOS and POSACC may be applied to any spatial object, in order to qualify the location of an feature.

QUAPOS and POSACC must not be applied to the spatial object of any geo feature if they are identical to the QUAPOS and POSACC values of the underlying meta feature.

QUAPOS gives qualitative information, whereas POSACC gives quantitative information. POSACC on the M_ACCY applies to non bathymetric data situated within the area, while QUAPOS or POSACC on the associated spatial objects, qualifies the location of the M_ACCY object itself. Meta objects M_ACCY and M_QUAL should not overlap.

#### 6.2.2 Horizontal accuracy

If it is required to encode the accuracy of a horizontal clearance (attribute HORCLR), it must be done using the attribute HORACC.

HORACC applies only to HORCLR. There is no attribute to express the accuracy of the attributes HORLEN and HORWID.

#### 6.2.3 Vertical accuracy

If it is required to encode the accuracy of a vertical clearance (attributes VERCLR, VERCOP, VERCSA, VERCCL), it must be done using the attribute VERACC.

If several vertical clearances are given for one object, the accuracy given must be that of the least accurate.

#### 6.2.4 Source of bathymetric data

Details of the source surveys used in compilation may be encoded using the meta object **M_SREL**, as described in clause 2.2.3.2.

#### 6.2.5 Source of other data

The source of non-bathymetric information should be encoded using both the attributes SORIND and SORDAT on the individual objects, but only if this information is considered to be useful to the mariner.

## 7 Data Capture and Classification

The S-101 Data Capture and Classification guide shall provide the information to map real world objects into the data set. This Guide is located in Appendix A. Data collected as S-101 shall conform to the data classification and capture guide.

## 8 Data Maintenance

### 8.1 Introduction

Maintenance shall be defined in two parts for S-101, maintenance of the product specification and maintenance of the data.

### 8.2 S-101 Product Specification Maintenance

This section specifies the procedures followed in maintaining and publishing the various parts of S-101.

### 8.2.1 Maintenance Procedures

Changes to S-101 are coordinated by the "Transfer Standard Maintenance and Application Development Working Group" (TSMAD) of the IHO and shall be made available via the IHO web site. Organizations that wish to make changes to S-1001, must address their comments to the International Hydrographic Bureau.

There are three change proposal types to S-101: clarification, correction and extension. Any change proposal must be one of these types.

All proposed changes shall be technically and commercially assessed before approval. All proposals shall be submitted using the S-101 maintenance proposal form in Annex ???.

### 8.2.2 Clarification

Clarifications are defined as non-substantive changes to S-101. Clarifications remove ambiguity and errors in spelling, punctuation and grammar. A clarification shall not cause any substantive semantic change. A clarification shall not also be classified as a correction. All clarifications shall be available for immediate use when approved by TSMAD.

### 8.2.3 Correction

Corrections are defined as substantive semantic changes to S-101, used to correct factual errors. A correction shall not also be classified as a clarification. One correction may result in multiple related actions. All cumulative clarifications shall be included with the release of approved corrections. After approval the correction shall be available for use at a date specified by TSMAD.

### 8.2.4 Extension

Extensions are significant changes to S-101. For example new regulations mandated by IMO can result in S-101 extensions. One extension may result in multiple related actions. All cumulative clarifications and corrections shall be included with the release of approved extensions. After approval the extension shall be available for use at a date specified by TSMAD.

### 8.2.5 Version Control

The IHO shall release new versions of S-101 as necessary. New versions may include clarifications, corrections and extensions. Each version shall contain a change list that identifies the changes between versions of S-101.

## 8.3 Clarification Version Control

Clarifications shall be denoted as 0.0.x. Each clarification or set of clarifications approved at a single point in time shall increment x by 1. Figure 1 shows the S-101 Clarification Version Control.

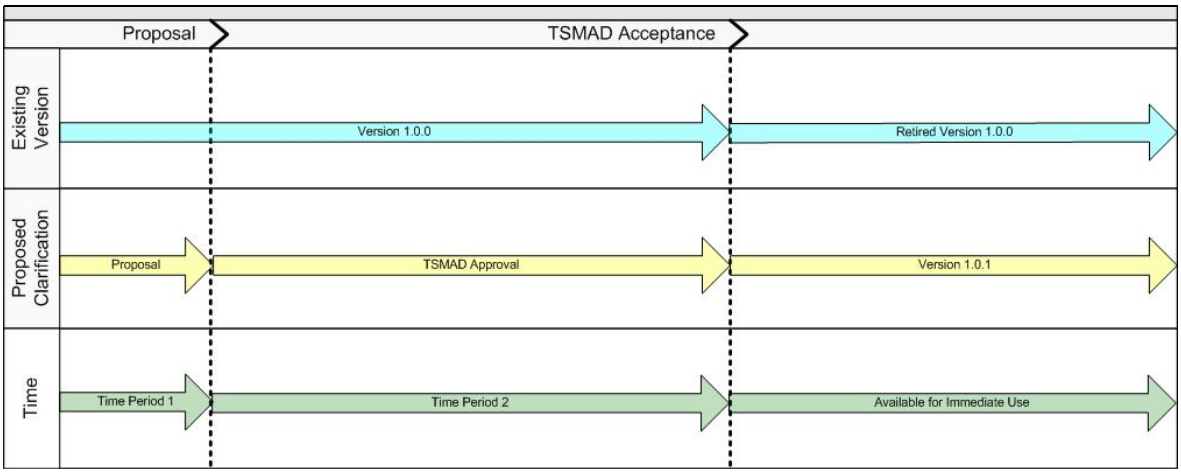



**Figure 1 — Clarification Version Control**

## 8.4 Correction Version Control

Corrections shall be denoted as 0.x.0. Each correction or set of corrections approved at a single point in time shall increment x by 1. Correction version control shall set clarification version control to 0. Figure 2 shows the S-101 Correction Version Control.

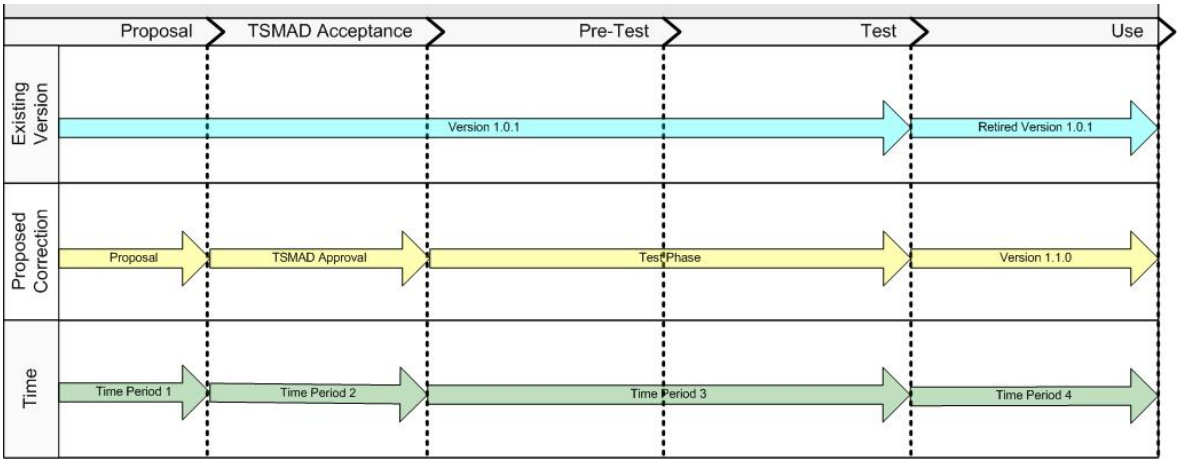



**Figure 2 — Correction Version Control**

## 8.5 Extension Version Control

Extensions shall be denoted as x.0.0. Each extension or set of extensions approved at a single point in time shall increment x by 1. Extension version control shall set the clarification and correction version control to 0. Figure 3 shows the S-101 Extension Version Control.

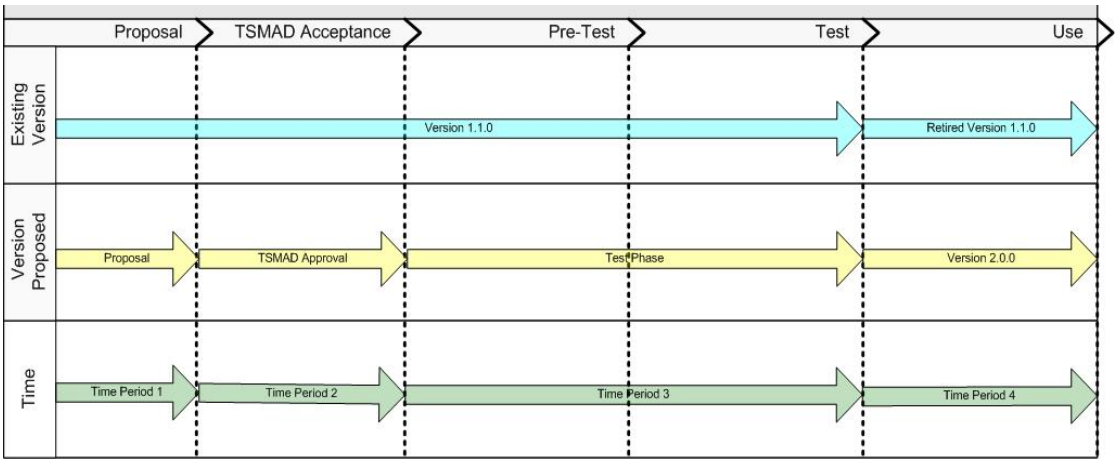



**Figure 3 — Extension Version Control**

## 8.6 Data Maintenance

| Item Name | Description | M/O | Card | type |
|---|---|---|---|---|
| maintenanceAndUpdateFrequency | Frequency with which changes and additions are made to the data product (per update scope) | M | 1..* | MD_MaintenanceInformation<br><br>(ISO 19115) |
| dataSource | Identification of the kinds of data sources usable to produce data sets | M | 1..* | LI_Source (ISO 19115) |
| productionProcess | Textual description of the production process applicable to the data sets (per scope or data source) | M | 1..* | LI_ProcessStep (ISO 19115) |

# 9 Portrayal

ECDIS pick reports will display only set A attributes in full, no abbreviations, acronyms or enumeration code numbers should be displayed.

*Attribute_A =: Attributes in this subset define the individual characteristics of an object;*
*Attribute_B =: Attributes in this subset provide information relevant to the use of the data, e.g. for presentation or for an information system;*
*Attribute_C=: Attributes in this subset provide administrative information about the object and the data describing it;*

It will be possible to identify where updates to a base cells have occurred.

S-101 shall include a portrayal catalogue.

| Item Name | Description | M/O | Card | type |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| portrayalLibraryCitation | Bibliographic reference to the portrayal library | O | 0..1 | CI_Citation (ISO 19115) |

## 10 Data Product format (encoding)

| | |
|---|---|
| formatName | ISO 8211 |
| version | 2nd Edition |
| characterSet | UTF-8 |
| specification | Information Technology – Specification for a data descriptive file for information interchange. |

See Annex A for a complete description of the data records, fields and subfields.

## 11 Data Product Delivery

| Item Name | Description |
|---|---|
| unitsOfDelivery | Cells - In order to facilitate the efficient processing of ENC data the geographic coverage of a given usage must be split into cells. |
| transferSize | 5mb |

**Volume Naming**

An exchange set may be split across several media volumes, therefore, each media volume must be uniquely identified within the exchange set. A file must not be split across volumes. Individual volumes must conform to the following naming convention:

**VSSXNN**

Where:

**V** is the mandatory first character.
**SS** is the sequence number of the specific volume within the exchange set.
**X** is the mandatory separator character.
**NN** is the total number of media volumes within the exchange set.

For example, volume one of a three volume exchange set would be named V01X03.

## 11.1 Data Exchange Set

An exchange set is a grouping of data sets in a logical, consistent and self-contained collection to support the interchange of geospatial data and meta data. It is comprised of at least one cell (i.e a collection of features) and one exchange catalogue. This is the minimum number of entities that can be encapsulated in an exchange set. An exchange set may also contain any number of support files.

– these are files of supplementary information which are linked to by the TXTDSC/PICREP (?) fields within the cells.

An exchange set is encapsulated into a form suitable for transmission either on hard or soft media 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 (i.e media identification, data extents etc…) and also may define commercial constructs such as encryption and compression methods.

This product specification defines a single example encoding for ENC exchange sets which is described in the next section. This encoding provides a hard-media / file based encoding for an exchange set with no encryptec or compressed contents and an additional file based cyclic redundancy check. It is not intended that this encoding is used for commercial distribution of ENC data as it contains no copy protection mechanisms or data authentication means. A complete encoding suitable for commercial distribution will be published in IHO XX-YY..

With all encodings it is paramount that data is only transformed and not changed. The acid test for an encodings consistency is the ability to extract individual feature information and recalculation of the features CRC value as defined in this standard. If an encoding can replicate the features CRC for arbitrary ENC data then the data has only been transformed (i.e reformatted) and not changed.

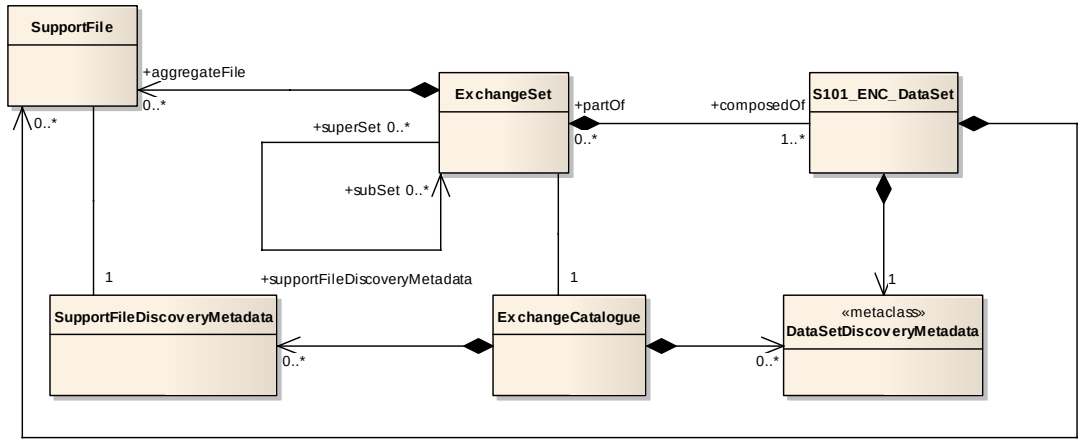



Figure ?? Exchange set

### Feature and Portrayal Catalogue Delivery

**The standard encoding**

The S-101 product specification defines an encoding which can be used as a default for transmission of data between parties. It is not suitable for commercial distribution of data and further encodings, which may draw on the standard encoding, will be defined for commercial distribution of data. It is mainly file based and has a strong resemblance to the S57 ENC 3.1.1 exchange set specification.

The encoding encapsulates exchange set elements as follows:

- ENC cells – iso8211 binary encoding of features/attributes and their associated geometry and metadata. Defiend further in XXXX
- Exchange Catalogue – iso8211 encoded representation of exchange set catalogue features [discovery metadata]. Includes an additional file level CRC check per cell in addition to the standard feature level CRC32 values.
- Useful information about the ENC dataset. This is contained within a README.TXT file.
- Supplementary files – These are contained within the exchange set as files and the map from the name included within the cell and the physical location on the media is defined within the Exchange Catalogue.

### 11.1.1 Data Sets

Three kinds of ENC data set may be produced and contained within an exchange set.

- new data set : no ENC data has previously been produced for this area and for the same navigational purpose.
- update : changing some information in an existing data set.
- new edition of a data set : including new information which has not been previously distributed by updates.

Each new data set or new edition is called a base cell file. A data set containing updates to at least one base cell file is called an update cell file.

### 11.1.2 Cell naming

Within this encoding all cells are encapsulated as files as is the Exchange catalogue. The entire exchange set is encapsulated therefore as a set of files which can be written to hard media and transmitted as required across network links.

**README file**
README.TXT is the mandatory name for this file.

**Catalogue file**
The catalogue file of the exchange set must be named CATALOG.101. No other file in the exchange set may be named CATALOG.

**ENC Cell files**
In this encoding the ENC cells files are named according to the specifications given below:
CCSXXXXX.EEE
| | | |
| | | |----- EEE = update number – this is a ‘0’ padded 3 digit number identical to the cell’s UPDN.

| | |---------- XXXXXXXX = individual cell code, up to eight characters
| |---------- S = 1. Scale Independent - 2. Scale Dependant – 3. Complete
|---------- CC = producer code

The main part forms an identifier where:

- the first two characters identify the issuing agency.
- the third character indicates the cell type
- the fourth to * characters are used for the cell code. This code can be used in any way by the producer to provide the unique file name. If characters other than numbers are used only uppercase letters are allowed the use of the underscore character in cell names is prohibited.

### 11.1.3 Support Files

Data set support files offer supplementary information that can be included in an ENC exchange set. Text, picture, audio and video files are all permissible in within this encoding.

- *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 JPEG or PNG image file format. (Portable Network graphics (PNG) or Joint Photographic Experts Group (JPEG) image files).* **(JPG), (PNG)**

- *Audio files must be encoded using the MP3 audio file format.* **(MP3)**

- *Video files must be in MP4. (MP4 also known as mpeg-4, .mp4 file format used to store digital video media types defined by the ISO/IEC Moving Picture Experts Group).***(MP4)**

| File Types | Extensions | | |
|---|---|---|---|
| **Text** | TXT | XML | HTM |
| **Picture** | JPG | PNG | |
| **Audio** | MP3 | | |
| **Video** | MP4 | | |

.

### 11.1.4 Support File Naming

All support files will have unique world-wide 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 (i.e. new, replacement and deletion).

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

CCXXXXX.EEE
| | | |
| | | ----- EEE = File extension
| | ---------- XXXXXXXX = individual cell code, up to eight characters
|---------- CC = producer code

The main part forms an identifier where:

- the first two characters identify the issuing agency.
- the third to *eighth characters are used for the support file code. This code can be used in any way by the producer to provide the unique file name. Names may be composed of the upper case alphanumeric characters A to Z, digits 0 to 9 and the special character _ (underscore).

There is no limit on the number of characters in a file name. The separator between the file name and the file type must be the character. (full stop).

### 11.1.5 Support File Discovery Meta Data

| Name | Cardinality | Type | Value | Remarks |
|---|---|---|---|---|
| S-101 SupportFileDiscoveryMetadata | - | - | | - |
| fileName | 1 | CharacterString | | |
| Purpose | 1 | S-100_SupportFilePurpose | 1. New<br>2. Replacement<br>3. deletion | Signifies a new file<br>Signifies a replacement of a file with the same name<br>Signifies a deletion of a file of that name |
| editionNumber | 1 | CharacterString | | When a data set is initially created, the edition number 1 is assigned to it. The edition number is increased by 1 at each new edition. Edition number remains the same for a re-issue. |
| issueDate | 1 | Date | | |
| productSpecification | 1 | S-100_ProductSpecification | | |
| dataType | 1 | S-100_SupportFileFormat | TXT<br>XML<br>JPG<br>PNG<br>MP3<br>MP4 | Text files<br>Text files<br>Picture files<br>Picture files<br>Audio<br>Video |
| Comment | 0..1 | CharacterString | | |
| Crc | 1 | CharacterString | | |

### 11.1.6 Exchange Catalogue

Each exchange set has a single exchange catalogue which contains the discovery meta data for each data set and references to any support files.

### 11.1.7 Updating

This section describes how the standard encoding defines updating methodologies for ENC cells. In order to ensure that feature type updates are incorporated into an ECDIS in the correct sequence without any omission, the file extension and a number of other parameters encoded in the data are used in the following way:

**file extension** every new data set, re-issue or new edition must have a .000 extension as per the translation from EDTN to the fiel extension. For update cell files the extension is the value of the UPDN field, ranging from .001 to .999. These numbers must be used sequentially, without omission. Number .001 is the first update after a new data set or a new edition, but not after a re-issue. The update sequence is not interrupted by a re-issue. After a re-issue, subsequent updates may be incorporated into the SENC created from this re-issue or to the SENC created from the original data and kept continuously updated.

**edition number** when a data set is initially created, the edition number 1 is assigned to it. The edition number is increased by 1 at each new edition. Where a cell is cancelled and its name is re-used at a later date, the edition number of the new cell must be one higher than the final edition number of the cell that it has replaced**.** Edition number remains the same for a re-issue.

**update number** update number 0 is assigned to a new data set. The first update cell file associated with this new data set must have update number 1. The update number must be increased by one for each consecutive update, until a new edition is released. The new edition must have update number 0. A re-issue of a data set must have the update number of the last update applied to the data set. In the case of an update cell file the file extension is the same as the update number.

**update application** this date is only used for the base cell files (i.e. new data sets, re-issue and new edition), not update cell files. All updates dated on or before this date must have been applied by the producer.

**issue date** date on which the data can be used.

- The update information encoded in each individual cell file is called a sequential update.
- The collection of the update information encoded in the update cell files which have been issued since the last new data set, the last re-issue of a data set or since the last update was applied to the SENC is called a cumulative update. In the example, the cumulative update for the new data set starts with update number 1. The cumulative update for the re-issue of a data set starts with update number 32. The cumulative update for a data set to which update number n has been applied starts with update number n+1.
- The update information which has been incorporated in a re-issue of a data set is called a compilation update.

Each re-issue or new edition of a data set must have the same name as the base cell file which it replaces.

In order to delete a data set, an update cell file is created the edition number must be set to 0. This message is only used to cancel a base cell file.

In order to modify a support file the attribute purpose of the support file metadata provides the mechanism.

When a feature pointing to a text, picture or application file is deleted or updated so that it no longer references the file, the ECDIS software should check to see whether any other feature referenced the same file, before that file is deleted.

An exchange set may contain base cell files and update cell files for the same cells. Under these circumstances the update cell files must follow on in the correct sequential order from the last update applied to the base cell file.

## 12 Metadata

Discovery meta data elements required for scale dependent and scale independent ENC cells.

| Name | Cardinality | Value | Type | Remarks |
|---|---|---|---|---|
| DataSetDiscoveryMeta data | - | | - | - |

| | | | | |
|---|---|---|---|---|
| metadataFileIdentifier | 1 | | CharacterString | |
| metadataPointOfContact | 1 | | CI_ResponsibleParty | |
| metadataDateStamp | 1 | | Date | |
| metadataLanguage | 1 | English | CharacterString | All data sets conforming to S-101 PS must use English language |
| fileName | 1 | | CharacterString | Dataset file name |
| filePath | | | CharacterString | Full path from the exchange set root directory |
| abstract | 1 | | CharacterString | Short description of the area covered by dataset harbour or port name, between two named locations etc. |
| dataProtection | 1 | {1} to {2} | CharacterString | 1. Encrypted<br>2. Unprotected |
| purpose | 1 | {1} to {4} | CharacterString | 1. New<br>2. New Edition<br>3. Update<br>4.Cancellation |
| specificUsage | 1 | {1} to {3} | CharacterString | 1.Port Entry<br>2.<br>3. |
| editionNumber | 1 | | CharacterString | when a data set is initially created, the edition number 1 is assigned to it. The edition number is increased by 1 at each new edition. Edition number remains<br>the same for a re-issue. |
| updateNumber | 1 | | CharacterString | Update number 0 is assigned to a new data set. |
| updateApplicationDate | 0..1 | | Date | |
| issueDate | 1 | | Date | |
| productSpecification | 1 | | S-100_ ProductSpecification | This must be encoded as S-101 |
| producingAgency | 1 | | CI_ResponsibleParty | |

| | | | | |
|---|---|---|---|---|
| displayScale | 1 | {1} to {12} | double | Display scale must be one of the 12 predefined scales detailed in Table 1. |
| horizontalDatum | 1 | | CharacterString | |
| verticalDatum | 1 | | CharacterString | |
| soundingDatum | 1 | | CharacterString | |
| dataType | 1 | | S-100_DataFormat | |
| otherDataTypeDescription | 0..1 | | CharacterString | |
| boundingBox | 1 | | EX_GeographicBounding Box | |
| boundingPolygon | 1 | | EX_BoundingPolygon | |
| comment | 0..1 | | CharacterString | |
| cyclicRedundancyCheck | 1 | | CharacterString NonNegativeInteger | |
| layerId | 1..* | | Double | Identifies the relationship to other layers that are required to view the complete data set. |

### Navigation Purpose

The navigational purpose for which an individual ENC has been compiled is indicated in the data set discovery meta data and, in the default encoding is specified in the cell filename. The following codes are used to identify the navigational purpose:

| Code | Navigation Purpose |
|---|---|
| 1 | Ocean Passage |
| 2 | Coastal |
| 3 | Port entry |
| | |

## Language

The exchange language must be English. Other languages may be used as a supplementary option. In general this means that when a national language is used in textual national attributes the English translation must exist in the international attributes. However, national geographic names do not need to be translated in the international attributes they may be left in their original national language form or may be transliterated or transcribed.

# ANNEX A Data Product format (encoding)

| | | | | |
|---|---|---|---|---|
| formatName | ISO 8211 | M | 1..* | CharacterString |
| version | Version of the format (date, number, etc.) | O | 0..1 | CharacterString |
| characterSet | Character coding standard used for the data set (western European requirement, Greek, Turkish, Cyrillic) | M | 1 | MD_CharacterSetCode (ISO 19115) |
| specification | Name of a subset, profile, or product specification of the format | O | 0..1 | CharacterString |
| fileStructure | Structure of delivery file | O | 0..1 | CharacterString |

## Introduction

This chapter define the structure and content of the catalogue file and data set file in an exchange set.

The catalogue file is defined in XML schema language and the data set files are encoded as ISO/IEC 8211 data records, fields, and subfields.

### Catalogue File (see associated S-101 Catalogue.xsd)

| Name | Cardinality | Value | Type | Remarks |
|---|---|---|---|---|
| metadataFileIdentifier | 1 | | CharacterString | Should this be changed from a mandatory in S-100 part 3 |
| metadataPointOfContact | 1 | | CI_ResponsibleParty | |
| metadataDateStamp | 1 | | Date | |
| metadataLanguage | 1 | English | CharacterString | All data sets conforming to S-101 PS must use English language |
| fileName | 1 | | CharacterString | |
| filePath | | | CharacterString | |
| abstract | 1 | | CharacterString | E.g. a harbour or port name, between two named locations etc. |
| purpose | 1 | {1} to {3} | CharacterString | 1. New, 2. New Edition, 3. Update |
| specificUsage | 1 | {1} to {3} | CharacterString | Navigation purpose<br>1. Ocean Passage, 2. Costal, 3. Port Entry |
| editionNumber | 1 | | CharacterString | when a data set is initially created, the edition number 1 is assigned to it. The edition number is increased by 1 at each new edition. Edition number remains |

| | | | | |
|---|---|---|---|---|
| | | | | the same for a re-issue. |
| updateNumber | 1 | | CharacterString | Update number 0 is assigned to a new data set. |
| updateApplicationDate | 0..1 | | Date | |
| issueDate | 1 | | Date | |
| productSpecificationEdition Number | 1 | | | |
| editionNumberS-100 | 1 | | | |
| producingAgency | 1 | | CI_ResponsibleParty | |
| displayScale | 1 | {1} to {12} | double | Display scale must be one of the 12 predefined scales detailed in Clause 4.1 |
| horizontalGeodeticDatum | 1 | | CharacterString | |
| verticalDatum | 1 | | CharacterString | |
| soundingDatum | 1 | | CharacterString | |
| boundingBox | 1 | | EX_GeographicBoundingBox | |
| boundingPolygon | 1 | | EX_BoundingPolygon | |
| comment | 0..1 | | CharacterString | |
| cyclicRedundancyCheck | 1 | | NonNegativeInteger | |
| layerId | 1..* | | Double | Identifies the relationship to other layers that are required to view the complete data set. |

**Data set files**

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

Data set file
- Data set general information record
- Data set structure information field structure
- Data set co-ordinate reference system record structure

Information records
- Information

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

Feature records
- Meta features
- Geo features (ordered from slave to master)
- Aggregated features
- Theme features

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

**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.

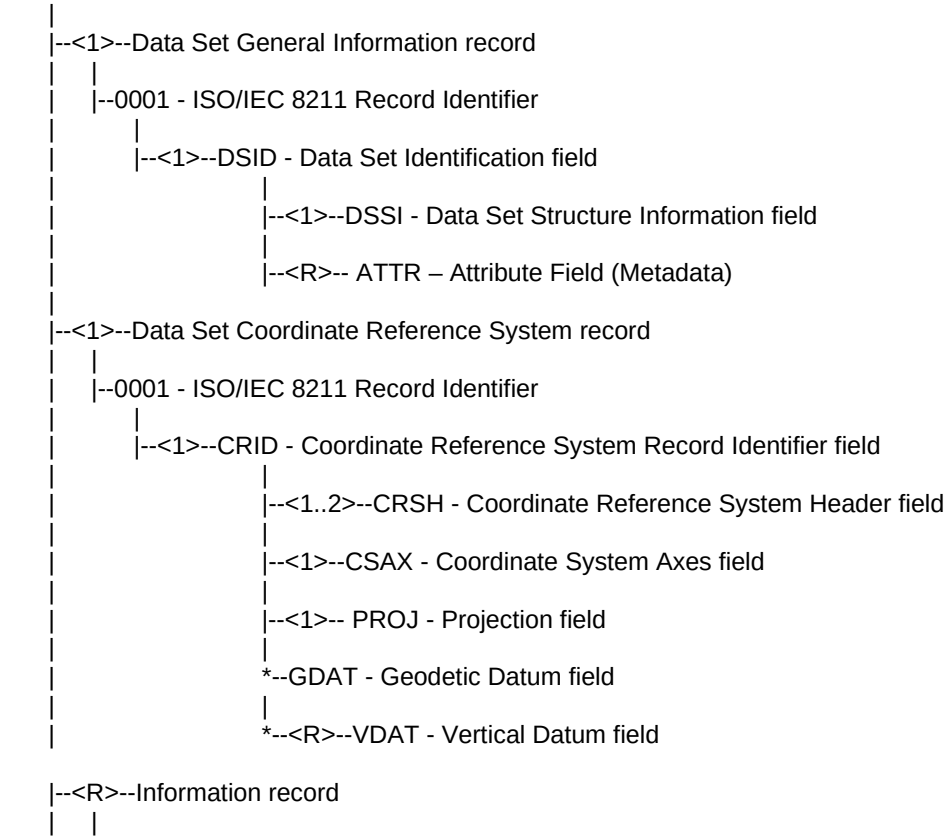
**Fields**
For base cell files, some fields may be repeated (indicated by <R>) and all of their content may be repeated (indicated by *). In order to reduce the volume of data, the encoder should repeat the sequence of subfields, in preference to creating several fields.

**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 clause ???

In the tables following the tree structure diagrams, mandatory subfields are shown by “M” in the “use” column and prohibited subfields by “P” in the same column. If there is nothing in this column, it means that the use of this subfield is optional. When a subfield value is prescribed, it is indicated in the “value” column. The “comment” column contains general comments and an indication of whether the subfield is ASCII or binary coded.

When encoding new base data sets the record update instruction (RUIN) is always set to insert. When encoding updates it can be set to insert, modify or delete.

**Base cell and update file structure**



```
|    |--0001 - ISO/IEC 8211 Record Identifier
|         |
|         |--<R>-- ATTR – Attribute field
|                   |
|                   |--<R>-- INAS – Information Association field
|
|--<R>-- Point record
|    |
|    |--0001 - ISO/IEC 8211 Record Identifier
|         |
|         |--<1>--PRID – Point Record Identifier field
|                   |
|                   |--<R>--ATTR - Attribute field
|                   |
|                   |--<R>--INAS - Vector Record Pointer field
|                   |
|                   | alternate coordinate representations
|                   |
|                   *--C2DI (2): 2-D Integer Coordinate field
|                   |
|                   *--C3DI (4): 3-D Integer Coordinate field
|                   |
|                   *--C2DF (2): 2-D Floating Point Coordinate field
|                   |
|                   *--C3DF (4): 3-D Floating Point Coordinate field
|
|--<R>--Multi Point record
|    |
|    |--0001 - ISO/IEC 8211 Record Identifier
|         |
|         |--<1>--MRID - Multi Point Record Identifier field
|                   |
|                   |--<R>--ATTR - Attribute field
|                   |
|                   |--<R>--INAS - Information Association field
|                   |
|                   |--<1>--COCC - Coordinate Control field
|                   |
|                   *--<R>--C2DI - 2-D Integer Coordinate field
|                   |
|                   *--<R>--C3DI - 3-D Integer Coordinate field
|                   |
|                   *--<R>--C2DF - 2-D Floating Point Coordinate field
|                   |
|                   *--<R>--C3DF - 3-D Floating Point Coordinate field
|
|--<R>-- Curve record
|    |
|    |--0001 - ISO/IEC 8211 Record Identifier
|         |
|         |--<1>--CRID - Curve Record Identifier field
|                   |
|                   |--<R>--ATTR - Attribute field
|                   |
|                   |--<R>--INAS - Information Association field
|                   |
|                   |--PTAS – Point Association field
|                   |
|                   |--SECC – Segment Header field
```

```
|                       |
|                       |--COCC - Coordinate Control field
|                       |
|                       | alternate coordinate representation
|                       |
|                       *--<R>--C2DI - 2-D Integer Coordinate field
|                       |
|                       *--<R>--C3DI - 3-D Integer Coordinate field
|                       |
|                       *--<R>--C2DF - 2-D Floating Point Coordinate field
|                       |
|                       *--<R>--C3DF - 3-D Floating Point Coordinate field
|
|--<R>-- Composite Curve record
|     |
|     |--0001 - ISO/IEC 8211 Record Identifier
|           |
|           |--<1>--CCID – Composite Curve Record Identifier field
|                       |
|                       |--<R>--ATTR - Attribute field
|                       |
|                       |--<R>--INAS - Information Association field
|                       |
|                       |--CCOC – Curve Component Control field
|                       |
|                       |--<R>--CUCO – Curve Component field
|
|--<R>-- Surface record
|     |
|     |--0001 - ISO/IEC 8211 Record Identifier
|           |
|           |--<1>--SRID – Surface Record Identifier field
|                       |
|                       |--<R>--ATTR - Attribute field
|                       |
|                       |--<R>--INAS - Information Association field
|                       |
|                       |--<R>--RIAS – Ring Association Field'
|
|--<R>-- Feature Type record
|     |
|     |--0001 - ISO/IEC 8211 Record Identifier
|           |
|           |--<1>--FRID - Feature Type Record Identifier field
|                       |
|                       |--FOID - Feature Object Identifier field
|                       |
|                       |--<R>--ATTR - Attribute field
|                       |
|                       |--<R>--INAS - Information Association field
|                       |
|                       |--<R>--SPAS - Spatial Association field
|                       |
|                       |--<R>--FEAS - Feature Association field
|                       |
|                       |--<R>--THAS - Theme Association field
|                       |
|                       |-<R>-MASK (*3): Masked Spatial Type field
```

Field Content

**Data Set Identification field structure**

| Field Tag: **DSID** | Field Name: Data Set Identification |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Record name | RCNM | b11 | {10} - Data Set Identification |
| Record identification number | RCID | b14 | Range: 1 to $2^{32}$-2 |
| Encoding specification | ENSP | A() | Encoding specification that defines the encoding |
| Encoding specification edition | ENED | A() | Edition of the encoding specification |
| Product identifier | PRSP | A() | Unique identifier for the data product as specified in the product specification |
| Product edition | PRED | A() | Edition of the product specification |
| Application profile | PROF | A() | Identifier that specifies a profile within the data product |
| Dataset file identifier | DSNM | A() | The file identifier of the dataset |
| Dataset title | DSTL | A() | The title of the dataset |
| Dataset reference date | DSRD | A(8) | The reference date of the dataset<br>Format: YYYYMMDD according to ISO 8601 |
| Dataset language | DSLG | A() | The (primary) language used in this dataset |
| Dataset abstract | DSAB | A() | The abstract of the dataset |
| Dataset edition | DSED | A() | The edition of the dataset |
| Dataset topic category | *DSTC | b11 | A set of topic categories |

**Data Descriptive Field**

```
3600;&%/GData□Set□Identification▲RCNM!RCID!STRD!ENED!PRSP!PRED!PROF!DSNM
!DSTL!DSRD!DSLG!DSAB!DSED\\*DSTC▲(b11,b14,7A,A(8),3A,b11)▼
```

**Data Set Structure Information field structure**

| Field Tag: **DSSI** | Field Name: Data Set Structure Information |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Dataset Coordinate Origin X | DCOX | b48 | Shift used to adjust x-coordinate before encoding |
| Dataset Coordinate Origin Y | DCOY | b48 | Shift used to adjust y-coordinate before encoding |
| Dataset Coordinate Origin Z | DCOZ | b48 | Shift used to adjust z-coordinate before encoding |
| Coordinate multiplication factor for x-coordinate | CMFX | b14 | Floating point to integer multiplication factor for the x-coordinate or longitude |
| Coordinate multiplication factor for y-coordinate | CMFY | b14 | Floating point to integer multiplication factor for the y-coordinate or latitude |
| Coordinate multiplication factor for z- | CMFZ | b14 | Floating point to integer multiplication factor for the z- |

| | | | |
|---|---|---|---|
| coordinate | | | coordinate or depths or height |
| Number of Information Type records | NOIR | b14 | Number of information records in the data set |
| Number of Point records | NOPN | b14 | Number of point records in the data set |
| Number of Multi Point records | NOMN | b14 | Number of multi point records in the data set |
| Number of Curve records | NOCN | b14 | Number of curve records in the data set |
| Number of Composite Curve records | NOXN | b14 | Number of composite curve records in the data set |
| Number of Surface records | NOSN | b14 | Number of surface records in the data set |
| Number of Feature Type records | NOFR | b14 | Number of feature records in the data set |

### Data Descriptive Field

```
1600;&□□□Data□Set□Structure□Information▲DCOX!DCOY!DCOZ!CMFX!CMFY!CMFZ!NO
IR!NOPM!NOMN!NOCN!NOXN!NOSN!NOFR▲(3b48,10b14)▼
```

### Attribute field structure

| | |
|---|---|
| Field Tag: **ATTR** | Field Name: Attribute |

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Attribute label/code | *ATLB | b12 | A valid attribute code |
| 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<br>{2} - Delete<br>{3} - Modify |
| Attribute value | ATVL | A() | A string containing a valid value for the domain of the attribute specified by the subfields above. |

### Layer ID

**Data Descriptive Field**

```
2600;&%/GAttribute▲*ATLB!ATIX!PAIX!ATIN!ATVL▲(3b12,b11,A)▼
```

**Data Set Coordinate Reference System record structure**

**Coordinate Reference System Record Identifier field structure**

| Field Tag: **CRID** | Field Name: Coordinate Reference System Record Identifier |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Record name | RCNM | b11 | {15} - Coordinate Reference System Identifier |
| Record identification number | RCID | b14 | Range: 1 to $2^{32}$-2 |
| Number of CRS Components | NCRC | b11 | {1} - Single CRS<br>{2} - Compound CRS (2 components) |

**Data Descriptive Field**

```
1100;&□□□Coordinate□Reference□System□Record□Identifier▲RCNM!RCID!NCRC▲(b
11,b14,b11)▼
```

**Coordinate Reference System Header field structure**

| Field Tag: **CRSH** | Field Name: Coordinate Reference System Header |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| CRS Type | CRST | b11 | see table |
| Coordinate System Type | CSTY | b11 | {1} - Ellipsoidal CS<br>{2} - Cartesian CS<br>{3} - Vertical CS |
| CRS Name | CRNM | A() | Name of the Coordinate Reference System |
| CRS Identifier | CRSI | A() | Identifier of the CRS from an external source.<br>Empty if not defined by reference |
| CRS Source | CRSS | b11 | {1} - IHO CRS Register<br>{2} - EPSG<br>{254} - Other Source<br>{255} - Not Applicable |
| CRS Source Information | SCRI | A() | Information about the CRS source if CRSS = 'Other Source' |

**Data Descriptive Field**

```
1600;&%/GCoordinate□Reference□System□Header▲CRST!CSTY!CRNM!CRSI!CRSS!SRC
I▲(2b11,2A,b11,A)▼
```

**Coordinate System Axes field structure**

| Field Tag: **CSAX** | Field Name: Coordinate System Axes |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Axis Type | *AXTY | b11 | see table |
| Axis Unit of Measure | AXUM | b11 | {1} - Degree<br>{2} - Grad<br>{3} - Radian<br>{4} - Metre<br>{5} - International foot<br>{6} - US survey foot |

**Data Descriptive Field**

```
2100;&□□□Coordinate□System□Axes▲*AXTY!AXUM▲(2b11)▼
```

**Projection field structure**

| Field Tag: **PROJ** | Field Name: Projection |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Projection Method | PROM | b11 | see table |
| Projection Parameter 1 | PRP1 | b48 | see table |
| Projection Parameter 2 | PRP2 | b48 | see table |
| Projection Parameter 3 | PRP3 | b48 | see table |
| Projection Parameter 4 | PRP4 | b48 | see table |
| Projection Parameter 5 | PRO5 | b48 | see table |
| False Easting | FEAS | b48 | False easting (Units of measurement according to the coordinate axis 'Easting' |
| False Northing | FNOR | b48 | False northing (Units of measurement according to the coordinate axis 'Northing' |

**Data Descriptive Field**

```
1600;&□□□Projection▲PROM!PRP1!PRP2!PRP3!PRP4!PRP5!FEAS!FNOR!▲(b11,7b48)▼
```

**Geodetic Datum field structure**

| Field Tag: **GDAT** | Field Name: Geodetic Datum |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Datum Name | DTNM | A() | Name of the geodetic datum |
| Ellipsoid Name | ELNM | A() | Name of the ellipsoid |
| Ellipsoid semi major axis | ESMA | b48 | Semi major axis of the ellipsoid in metre |
| Ellipsoid second parameter type | ESPT | b11 | {1} - Semi minor axis in metres<br>{2} - Inverse Flattening |
| Ellipsoid second parameter | ESPM | b48 | The second defining parameter of the ellipsoid |
| Central Meridian Name | CMNM | A() | Name of the central meridian |
| Central Meridian Greenwich Longitude | CMGL | b48 | Greenwich longitude of the central meridian in degrees |

**Data Descriptive Field**

```
1600;&%/GGeodetic□Datum▲DTNM!ELNM!ESMA!ESPT!ESPM!CMNM!CMGL!▲(2A,b48,b11,
b48,A,b48)▼
```

### Vertical Datum field structure

| Field Tag: **VDAT** | Field Name: Vertical Datum |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Datum Index | DTIX | b11 | Internal identifier of the Vertical Datum |
| Datum Name | DTNM | A() | Name of the Vertical datum |
| Datum Identifier | DTID | A() | Identifier of the datum in an external source |
| Datum Source | DTSR | b11 | {1} - IHO CRS Register<br>{2} - Feature Catalogue<br>{3} - EPSG<br>{254} - Other Source<br>{255} - Not Applicable |
| Datum Source Information | SCRI | A() | Information about the CRS source if DTSR = 'Other Source' |

### Data Descriptive Field

```
1600;&%/GVertical□Datum▲DTIX!DTNM!DTID!DTSR!SCRI!▲(b11,2A,b11,A)▼
```

### Information Type Identifier field structure

| Field Tag: **IRID** | Field Name: Information Type Record Identifier |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Record name | RCNM | b11 | {150} - Information Type |
| Record identification number | RCID | b14 | Range: 1 to $2^{32}$-2 |
| Object code | OBJC | b12 | A valid object code |
| Record version | RVER | b12 | RVER contains the serial number of the record edition |
| Record update instruction | RUIN | b11 | {1} - Insert<br>{2} - Delete<br>{3} - Modify |

### Data Descriptive Field

```
1100;&□□□Information□Type□Record□Identifier▲RCNM!RCID!OBJC!RVER!RUIN▲(b1
1,b14,2b12,b11)▼
```

### Coordinate Control field structure

| Field Tag: **COCC** [Upd] | Field Name: Coordinate Control |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Coordinate Update Instruction | COUI | b11 | {1} - Insert<br>{2} - Delete<br>{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 |

### Data Descriptive Field

```
1100;&□□□Coordinate□Control▲COUI!COIX!NCOR▲(b11,2b12)▼
```

### 2-D Integer Coordinate field structure

| Field Tag: **C2DI** | Field Name 2-D Integer Coordinate |
|---|---|

| 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 |

### Data Descriptive Field

```
2100;&□□□2-D□Integer□Coordinate▲*YCOO!XCOO▲(2b24)▼
```

### 3-D Integer Coordinate field structure

| Field Tag: **C3DI** | Field Name: 3-DInteger Coordinate |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Vertical Datum Id | VDID | b11 | Internal identifier of the Vertical Datum |
| 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) |

### Data Descriptive Field

```
3100;&□□□3-D□Integer□Coordinate▲VDID\\*YCOO!XCOO!ZCOO▲(b11,3b24)▼
```

### 2-D Floating Point Coordinate field structure

| Field Tag: **C2DF** | Field Name 2-D Floating Point Coordinate |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Coordinate in Y axis | *YCOO | b48 | Y-coordinate or latitude |
| Coordinate in X axis | XCOO | b48 | X-coordinate or longitude |

### Data Descriptive Field

```
2200;&□□□2-D□Floating□Point□Coordinate▲*YCOO!XCOO▲(2b48)▼
```

### 3-D Floating Point Coordinate field structure

| Field Tag: **C3DF** | Field Name: 3-D Floating Point Coordinate |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Vertical Datum Id | VDID | b11 | Internal identifier of the Vertical Datum |
| Coordinate in Y axis | *YCOO | b48 | Y- coordinate or latitude |
| Coordinate in X axis | XCOO | b48 | X- coordinate or longitude |
| Coordinate in Z axis | ZCOO | b48 | Z - coordinate (depth or height) |

### Data Descriptive Field

```
3600;&□□□3-D□Floating□Point□Coordinate▲VDID\\*YCOO!XCOO!ZCOO▲(b11,3b48)▼
```

### Point Record Identifier field structure

| Field Tag: **PRID** | Field Name: Point Record Identifier |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Record name | RCNM | 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 | b11 | {1} - Insert<br>{2} - Delete<br>{3} - Modify |

### Data Descriptive Field

```
1100;&□□□Point□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,b12,b11)▼
```

### Multi Point Record Identifier field structure

| Field Tag: **MRID** | Field Name: Multi Point Record Identifier |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Record name | RCNM | 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 | b11 | {1} - Insert<br>{2} - Delete<br>{3} - Modify |

### Data Descriptive Field

```
1100;&□□□Multi□Point□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,b12,b
11)▼
```

### Curve Record Identifier field structure

| Field Tag: **CRID** | Field Name: Curve Record Identifier |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Record name | RCNM | 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 | b11 | {1} - Insert<br>{2} - Delete<br>{3} - Modify |

**Data Descriptive Field**

```
1100;&□□□Curve□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,b12,b11)▼
```

**Point Association field structure**

| Field Tag: **PTAS** | Field Name: Point Association |
|---|---|

| Subfield name | Label | 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 |
| Topology indicator | TOPI | b11 | {1} - Beginning point<br>{2} - End point<br>{3} - Beginning & End point |

**Data Descriptive Field**

```
2100;&□□□Point□Association▲*RRNM!RRID!TOPI▲(b11,b14,b11)▼
```

**Segment Control field structure**

| Field Tag: **SECC** [Upd] | Field Name: Segment Control |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Segment update instruction | SEUI | b11 | {1} - Insert<br>{2} - Delete<br>{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 |

**Data Descriptive Field**

```
1100;&□□□Segment□Control▲SEUI!SEIX!NSEG▲(b11,2b12)▼
```

**Segment Header field structure**

| Field Tag: **SEGH** | Field Name: Segment Header |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Interpolation | INTP | b11 | {1} - Linear<br>{2} - Arc3Points<br>{3} - Geodetic |

| | | | |
|---|---|---|---|
| | | | {4} - Loxodromic |

**Data Descriptive Field**

```
1100;&□□□Segment□Header▲INTP▲(b11)▼
```

**Composite Curve Record Identifier field structure**

| | |
|---|---|
| Field Tag: **CCID** | Field Name: Composite Curve Record Identifier |

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Record name | RCNM | 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 | b11 | {1} - Insert<br>{2} - Delete<br>{3} - Modify |

**Data Descriptive Field**

```
1100;&□□□Composite□Curve□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,
b12,b11)▼
```

**Curve Component Control field structure**

| | | |
|---|---|---|
| Field Tag: **CRPC** | [Upd] | Field Name: Curve Component Control |

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Curve Component update instruction | CCUI | b11 | {1} - Insert<br>{2} - Delete<br>{3} - Modify |
| Curve Component index | CCIX | b12 | Index (position) of the addressed Curve record pointer within the CRPT field(s) of the target record |
| Number of Curve Components | NCCO | b12 | Number of Curve record pointer in the CRPT field(s) of the update record |

**Data Descriptive Field**

```
1100;&□□□Curve□Component□Control▲CCUI!CCIX!NCCO▲(b11,2b12)▼
```

### Curve Component field structure

| Field Tag: **CUCO** | Field Name: Curve Component |
|---|---|

| Subfield name | Label | 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 |
| Orientation | ORNT | b11 | {1} - Forward<br>{2} - Reverse |

### Data Descriptive Field

```
2100;&□□□Curve□Component▲*RRNM!RRID!ORNT▲(b11,b14,b11)▼
```

### Surface Record Identifier field structure

| Field Tag: **SRID** | Field Name: Surface Record Identifier |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Record name | RCNM | 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 | b11 | {1} - Insert<br>{2} - Delete<br>{3} - Modify |

### Data Descriptive Field

```
1100;&□□□Surface□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,b12,b11)
▼
```

### Ring Association field structure

| Field Tag: **RIAS** | Field Name: Ring Association |
|---|---|

| Subfield name | Label | 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 |
| Orientation | ORNT | b11 | {1} - Forward<br>{2} - Reverse |
| Usage indicator | USAG | b11 | {1} - Exterior<br>{2} - Interior |
| Ring Association update instruction | RAUI | b11 | {1} - Insert<br>{2} - Delete |

**Data Descriptive Field**

```
2100;&□□□Ring□Association▲RRNM!RRID!ORNT!USAG!RAUI▲(b11,b14,3b11)▼
```

**Feature Type Record Identifier field structure**

| Field Tag: **FRID** | Field Name: Feature Type Record Identifier |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| Record name | RCNM | b11 | {100} - Feature type |
| Record identification number | RCID | b14 | Range: 1 to $2^{32}$-2 |
| Object code | OBJC | b12 | A valid object code |
| Record version | RVER | b12 | RVER contains the serial number of the record edition |
| Record update instruction | RUIN | b11 | {1} - Insert<br>{2} - Delete<br>{3} - Modify |

**Data Descriptive Field**

```
1100;&□□□Feature□Type□Record□Identifier▲RCNM!RCID!OBJC!RVER!RUIN▲(b11,b1
4,2b12,b11)▼
```

**Feature Object Identifier field structure**

| Field Tag: **FOID** | Field Name: Feature Object Identifier |
|---|---|

| Subfield name | Label | Format | Subfield content and specification |
|---|---|---|---|
| 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 |

**Data Descriptive Field**

```
1100;&□□□Feature□Object□Identifier▲AGEN!FIDN!FIDS▲(b12,b14,b12)▼
```

**Spatial Association field structure**

| Field Tag: **SPAS** | Field Name: Spatial Association |
|---|---|

| Subfield name | Label | 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 |
| Orientation | ORNT | b11 | {1} Forward<br>{2} Reverse<br>{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 object. 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 object. If the value is $2^{32}$-1 it does not apply. |
| Spatial Association Update Instruction | SAUI | b11 | {1} - Insert<br>{2} - Delete |

**Data Descriptive Field**

```
2100;&□□□Spatial□Association▲*RRNM!RRID!ORNT!SMIN!SMAX!SAUI!▲(b11,b14,b1
1,2b14,b11)▼
```

**Feature Association field**

| | |
|---|---|
| Field Tag: **FEAS** | Field Name: Feature Association |

| Subfield name | Label | 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 |
| Association Code | ASCD | b12 | A valid code for the association |
| Role Code | RLCD | b12 | A valid code for the role |
| Feature Association Update Instruction | FAUI | b11 | {1} - Insert<br>{2} - Delete |

**Data Descriptive Field**

```
2100;&□□□Feature□Association▲*RRNM!RRID!ASCD!RLCD!APUI▲(b11,b14,2b12,b11
)▼
```

**Theme Association field**

| | |
|---|---|
| Field Tag: **THAS** | Field Name: Theme Association |

| Subfield name | Label | 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 |
| Theme Association Update Instruction | TAUI | b11 | {1} - Insert<br>{2} - Delete |

**Data Descriptive Field**

```
2100;&□□□Theme□Association▲*RRNM!RRID!TAUI▲(b11,b14,b11)▼
```

### Masked Spatial Type field structure

| Field Tag: **MASK** | Field Name: Masked Spatial Type |
|---|---|

| Subfield name | Label | 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 |
| Mask Update Instruction | MUIN | b11 | {1} - Insert<br>{2} - Delete |

### Data Descriptive Field

```
2100;&□□□Masked□Spatial□Record▲*RRNM!RRID!MUIN▲(b11,b14,b11)▼
```

## ANNEX B (informative)

# S-101 Maintenance - Change Proposal Form

| | | | |
|---|---|---|---|
| Organisation | | Date | |
| Contact | | Email | |

Change Proposal Type *Select only one option*

| 1.Clarification | 2.Correction | 3.Extension |
|---|---|---|
| | | |

## Location *Identify all change proposal locations*

| S-100 Version No. | Part No. | Section No. | Proposal Summary |
|---|---|---|---|
| | | | |

## Change Proposal

| |
|---|
| *Please provide a detailed change proposal.* |

## Change Proposal Justification

| *Please provide a suitable explanation for the change and where applicable supporting documentation.* |
| --- |
| |

**Please send completed forms and supporting documentation to Thomas.Mellor@ukho.gov.uk.**

**Notes on ISO 8211 by Jonathan Prichard.**

I have been thinking about iso8211 and ENC encodings in the context of S-101 for some time. We have been discussing the benefits of multiple encodings and the possibility of reconciling our integrity checks using a canonical form but this has led to a general discussion on the merits (or otherwise) of iso8211 encoding for ENC. iso8211 has been used ever since ENC was invented and is still the bottom layer of encoding within an ENC, i.e the data structures and records are encoded using iso8211's binary format. But how efficient is that format. Since the ENC cell is immutably associated with the file that contains the encoding it's where you should have the least "slack". The encoding of the ENC data has to be transferred via hard media or online transmission to every single customer so any inefficiencies which exist in the way the data is encoded are multiplied massively. I undertook a short survey on the amount of data compared with the amount of non-data within an ENC and the results are presented below:

**Iso8211 structure.**

**The header.**
Let's take a look at a typical ENC cell. It is a binary encoding of the ENC. iso8211 is a self describing binary format which uses a header/body structure to deliver its contents. Within a single iso8211 file there is a variable length header which describes all the records within the rest of the file and also their structure. Each record is made up of a number of subfields, each of which has a particular binary representation.

**Data records**
The header is then followed by a sequence of records. Each record follows the same structure.

1. A 5-byte length indicator for the entire record

2. A 24 byte leader which contains flags about how the record is constructed including an offset to the first byte of data.

3. A catalogue which describes each subfield, its length and offset (from the iso8211 header the reader knows then what sequence the data is in)

4. The data itself. Each record is standalone and contains no CRC values, record counts or other information. The structure of each record is laid down in the Se57 edition 3.1 ENC product specification. So, for example if we look at a simplified ENC update (I have used an update to illustrate the points made as it is a smaller file. A new edition is somewhat larger as we will see...).

**Length Offset Name/Length**
1. 01894 HEADER
2. 00301 00067 0001 00003 DSID 00195 DSSI 00036
3. 00069 00053 0001 00003 FRID 00013
4. 00069 00053 0001 00003 FRID 00013
5. 00069 00053 0001 00003 FRID 00013
6. 00069 00053 0001 00003 FRID 00013
7. 00069 00053 0001 00003 FRID 00013
8. 00181 00095 0001 00003 FRID 00013 FOID 00009 ATTF 00052 FSPT 00009
9. 00180 00095 0001 00003 FRID 00013 FOID 00009 ATTF 00051 FSPT 00009
10. 00177 00095 0001 00003 FRID 00013 FOID 00009 ATTF 00048 FSPT 00009
11. 00179 00095 0001 00003 FRID 00013 FOID 00009 ATTF 00050 FSPT 00009
12. 00230 00109 0001 00003 FRID 00013 FOID 00009 ATTF 00046 FFPT 00041 FSPT 00009

Finished. 11 records 3482 772

The above table shows a simple ENC update with just the data record and structure left behind. The header is 1894 bytes and then there are 11 data records with varying sizes and data offsets. you can see the update starts with a DSID & DSSI records and then continues with a number of feature related records. What's the point...? The point is the last line where it says "Finished". If you look in record (2) above, the first actual data record you will see that the whole record is 301 bytes long but the data doesn't start until byte 67. This is to allow enough space for the file to encode the DSSI and DSID catalogue entry before describing the data. So there are only 301-67 = 234 bytes of space being used to encode actual data. In fact, over the entire file there are 11 records which make up a file of 3,482 bytes, of which only 772 are used to encode real ENC data. The rest is header (1,894 bytes), record leaders and catalogue descriptors (in fact the "0001" records, of which there are one per record also take up 33 bytes). So, only 22% of the cell contains actual data... The rest is just iso8211 structure.
The point is... iso8211 is very good and very compact at storing data but it works best within a single file. Once you rely on multiple files you duplicate its self-describing overheads.

**What does this mean for a base cell?**
The example above is an update file. 90% of data which we distribute is actually new editions or new cells. In the case of a base cell the picture is slightly different. The size is not dominated by the 8211 header any more since the cell files are a lot larger. There are a large number of records though and in a lot of these the 8211 overhead of leader + catalogue is much larger than the data which it encompasses. I looked at some GB cells and, sparing the details of the actual records involved, found the following results (I've reproduced just the last line of the output from the previous example:

Cell Name Records Total size Data Size
GB203552.000 269 533152 378010
GB203593.000 1987 327800 214897
GB203596.000 4022 666528 437442

So you can see from the table above that 66-71% of the cell is data, the rest is record overhead!
It would be interesting to see what results could be gleaned from the current world ENC portfolio. I actually had a stab at this and got similar results. Of the 24,424 base and update cells which constituted the last UKHO AVCS base reissue about 8,000 of them were base cells. These on average contain 58% data. The remaining update cells contain about 23% data only. At the very bottom of the pile are updates with only one record. GB5A0052.002, a cancellation cell, contains 3% data only in a file containing 1,887 bytes. There are, however cells with the opposite effect GB200760.001 is 97% data. This is an update which added a small number of features with a high geographical content.

**Conclusions:**
1. It would seem we compress, encrypt and transport both in hard media and onlinedata but about 40% of it is actual ENC data

2. The rest is specific to the format we have chosen within the product specification to encode the data.

3. Although headers are likely to be highly compressible it does call into question iso8211's use in a world where cell numbers are in the 000s and vessel broadband technology still places a high value on good compression

4. Further analysis of where the choke points are and where the product specification leads to duplication of data could give valuable pointers for S-101 encoding development.