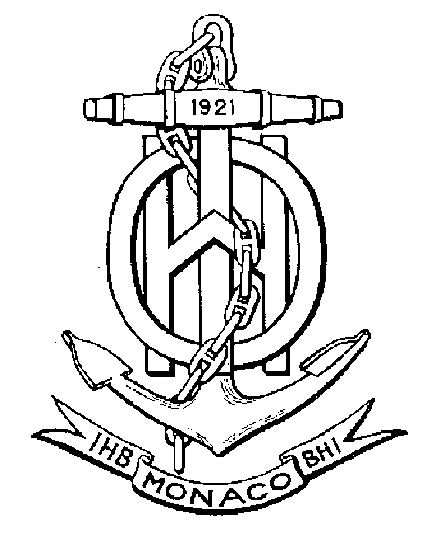
**C:\Documents and Settings\julia.powell\My Documents\IHO TSMAD\S100-0 main\IHO S-100 Main Oct 1 2007.doc****© ISO/IEC 2007 – All rights reserved****ISO-IEC\_** **63****Complementary element****Introductory element — Main element****Élément introductif — Élément central — Élément complémentaire****Introductory element — Main element — Complementary element****E****2007-10-2****ISO/IEC****ISO/IEC****2007****ISO/IEC****ISO/IEC****\_(E).** **2****Heading 2****Heading 1****0****2****STD Version 2.1c2****0** **4****INTERNATIONAL HYDROGRAPHIC ORGANIZATION**



IHO GEOSPATIAL STANDARD  
FOR UNDER KEEL CLEARANCE MANAGEMENT INFORMATION

Version 0.4.0

**2018**

Special Publication No. S-129

Under Keel Clearance Management Information – Product Specification

Published by the

International Hydrographic Organization

MONACO

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Revision History

Changes to this Product Specification are coordinated by the IHO S-100 Working Group. New editions will be made available via the IHO web site. Maintenance of the Product Specification shall conform to IHO Technical Resolution 2/2007 (revised 2010).

|  |  |  |  |
| --- | --- | --- | --- |
| Version Number | Date | Author | Purpose |
| 0.1.0 draft 1 |  |  | Initial draft |
| 0.2.0 draft 2 | 18 Sep 18 | NL | S-129 PT Meeting 3 (Busan, Republic of Korea) – output draft |
| 0.3.0 draft 3 | 29 Oct 18 | LP | Post S-129 Meeting 3 with additional input from PT |
| 0.4.0 draft 1 | 3 Dec 18 | NL | For out of session review by other IHO working groups |
| 1.0.0 Release Candidate 1 | TBC |  |  |
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# Overview

## Introduction

This document has been produced by the IHO S-100 Working Group in response to a requirement to produce a data product that can be used, primarily, as a Nautical Publication Information Overlay (NPIO) within an Electronic Chart Display and Information System (ECDIS). It is based on the IHO S-100 framework specification and the ISO 19100 series of standards.

It is a vector Product Specification intended for encoding the extent and nature of Under Keel Clearance Management (UKCM) information products for navigational purposes. Use aof UKCM products conformant to this specification is not limited to navigation systems.

A Ship’s Master has an obligation under SOLAS regulation V/34 to plan their ship’s passage from berth to berth. This Product Specification enables UKCM information to be provided to users of a UKCM service.

## Voyage planning

A ship planning its voyage needs to determine the timing(s) of suitable tidal conditions for its anticipated arrival at the location where a UKCM service is in place. The timing of a ship’s arrival can be affected by many variables, and a UKCM service is capable of providing multiple calculations, based on a range of anticipated arrival times. The identification of sufficient height of tide for specified time(s), results in a series of transit window options. After a ship provides its anticipated arrival time, location and draught, the UKCM service is capable of providing a range of suitable transit windows.

## Refined voyage planning

Once the ship has provided refined arrival timing and ship stability data, the UKCM service uses dynamic, ship-specific modelling, based on the ship’s particulars, and combines the results with observed environmental conditions (e.g. tides, wind, swell, tidal stream, etc.) within the UKCM operational area to generate a UKC route plan.

A UKC route plan provides the ship with the necessary navigation information to safely pass through the UKCM operational area, for a given transit window. The UKC route plan can be shared with other parties, such as the ship’s owners, management company, charterers, or the ship’s agent at the relevant port.

As the ship is on route to the UKCM operational area, the UKCM service checks the prevailing environmental conditions within the UKCM operational area and confirms the validity of the UKC route plan. The UKC route plan may change due to changes in predicted weather forecasts, heights of tide, or some of the ship’s particulars. This checking process allows the ship to manage its speed to meet the time of arrival to execute the UKC route plan.

The UKC route plan contains details of the earliest and latest times at which the ship can safely commence navigating shallow areas while maintaining the required UKC (note that many waterway authorities specify a minimum UKC requirement). When the ship’s agent has been provided the UKC route plan, they can contact relevant waterway authorities to make the necessary bookings, such as for a pilot or for berth allocation.

## Voyage monitoring

When the ship embarks its pilot (if applicable) and enters the UKC operational area, the UKC route plan displays on its on board navigation system. The pilot (if applicable) will generally be using a portable pilot unit (PPU) that also shows the ship’s UKC route plan. This ensures the ship will be able to navigate the UKC operational area maintaining the required UKC. It also ensures a ‘common’ picture of the proposed navigation through the UKCM area between the pilot and the bridge team.

The ship has arrived at the UKC area (e.g. port limits or the approaches to the waterway in question) and starts navigating in accordance with the UKC route plan.

The UKCM service monitors the ship’s position using AIS in real-time, or near real-time, and sends updates to the ship’s UKC route plan based on the ship’s speed and the current weather, tide and other met-ocean conditions.

The ship’s bridge team and the pilot are able to monitor, in real-time or near real-time, areas that have been calculated as non-navigable and almost non-navigable on their on board navigation systems. The areas becoming non-navigable show the ship’s bridge team and the pilot the navigable areas that are getting close to becoming non-navigable at the time the ship will reach those locations.

If a Ship Traffic Service (VTS) exists, it is able to monitor the ship’s transit and provide an information service, traffic organisation service or a navigational assistance service, and support navigation in accordance with the UKC route plan.

After the ship has completed its cargo operations and if it will be deep draught on exit from the port, then the UKCM service will be similarly used to assist the ship’s safe departure from the port through the UKCM operational area.

# References

## Normative

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document.

IHO S-100 IHO Universal Hydrographic Data Model Edition 4.0.0 – December 2018

IHO S-101 IHO Electronic Navigational Chart (ENC)

IHO S-102 IHO Bathymetric Surface Product Specification Edition 1.0.0 – April 2012

IHO S-421 IEC Route Plan Exchange Format

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

ISO 10646:2017 Information technology – Universal Coded Character Set (UCS)  
+Amd1 (2017) and DAmd2 (2017)

ISO/IEC 15948 Information technology – Computer graphics and image processing – PortableNetwork Graphics (PNG): Functional specification

ISO 19100 Series of Geographic Information Standards

ISO 19101:2014 Geographic information – Reference model

ISO 19103:2015 Geographic information – Conceptual schema

ISO 19107:2003 Geographic information – Spatial schema

ISO 19108:2002 Geographic information – Temporal schema  
+Corr1 (2006)

ISO 19109:2005 Geographic information – Rules for application schema

ISO 19110:2016 Geographic information – Methodology for feature cataloguing

ISO 19111:2003 Geographic information – Spatial referencing by coordinates  
+Corr1 (2006)

ISO 19115-1:2014 Geographic information – Metadata Part 1: Fundamentals  
+Amd1 (2018)

ISO 19117:2012 Geographic information – Portrayal

ISO 19125-1:2004 Geographic information – Simple feature access – Part 1: Common Architecture

ISO 19136:2007 Geographic information – Geography Markup Language

ISO 19136-2:2015 Geographic information – Geography Markup Language.

ISO/IEC 8211:1994 Information technology – Specification for a data descriptive file for information exchange

ISO 8601:2004\* Data elements and interchange formats – Information exchange – Representation of dates and times

ISO 639-2:1998 Codes for the representation of names of languages – Part 2: Alpha-3 code

# Terms, Definitions and Abbreviations

## Terms and Definitions

The S-100 framework is based on the ISO 19100 series of geographic standards. The terms and definitions provided here are used to standardize the nomenclature found within that framework, whenever possible. They are taken from the references cited in Clause 2.1. Modifications have been made when necessary.

**almost non-navigable area**

an area within a UKC route plan where UKC is calculated to be approaching the established UKC limit for the waterway (within a defined value range).

**coordinate**

one of a sequence of n numbers designating the position of a point in n-dimensional space

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

[ISO 19107, ISO 19111]

**coordinate reference system**

coordinate system that is related to an object by a datum

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

[ISO 19111]

**feature**

abstraction of real-world phenomena

EXAMPLE: The phenomenon named Eiffel Tower may be classified with other similar phenomena into a feature type named tower

NOTE 1: A feature may occur as a type or an instance. Feature type or feature instance shall be used when only one is meant

NOTE 2: In UML 2, a feature is a property, such as an operation or attribute, which is encapsulated as part of a list within a classifier, such as an interface, class, or data type

[ISO 19101, ISO/TS 19103, ISO 19110]

**feature attribute**

characteristic of a feature

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

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

NOTE 1: A feature attribute may occur as a type or an instance. Feature attribute type or feature attribute instance is used when only one is meant

NOTE 2: A feature attribute type has a name, a data type, and a domain associated to it. A feature attribute instance has an attribute value taken from the domain of the feature attribute type

NOTE 3: In a feature catalog, a feature attribute may include a value domain but does not specify attribute values for feature instances

[ISO 19101, ISO 19109, ISO 19110, ISO 19117]

**navigation surface**

a BAG data object representing the bathymetry and associated uncertainty with the methods by which those objects can be manipulated, combined and used for a number of tasks, certified for safety of navigation

[ONS FSD]

**non-navigable area**

an area within a UKC route plan where UKC is calculated to be less than the established UKC limit for the waterway

**sea surface**

a two-dimensional (in the horizontal plane) field representing the air-sea interface, with high-frequency fluctuations such as wind waves and swell, but not astronomical tides, filtered out.

EXAMPLE: sea surface, river surface, and lake surface

NOTE: This implies marine water, lakes, waterways, navigable rivers, etc.

**UKC route plan**

a Nautical Publication Information Overlay (NPIO) that outlines a safe route for a specific ship through a UKCM operational area for a given time period, including the depiction of non-navigable and almost non-navigable areas.

**UKCM operational area**

the geographic area in which a UKCM service is in operation and for which UKCM information can be provided.

**UKCM service**

an aid to navigation which contributes to navigational safety and efficiency. It uses data modelling which may include detailed bathymetry, predicted and real-time environmental data and ship particulars and motion, to provide a ship-specific, real-time and/or forecast UKC estimate for a given time and waterway.

## Abbreviations

This Product Specification makes use of the following abbreviations:

ECDIS Electronic Chart Display Information System

ENC Electronic Navigation Chart

GML Geography Markup Language

IEC International Electrotechnical Commission

IHO International Hydrographic Organization

ISO International Organization for Standardization

UKC Under Keel Clearance

UKCM Under Keel Clearance Management

UML Unified Modelling Language

UTC Coordinated Universal Time

## Use of Language

Within this document:

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

## GML Notations

Any requirement for this? See S-122 and S-123 PS for examples of UML Notations

# Specification Description

## Informal Description of Data Product

This clause contains general information about the data product.

Title: UKCM Information Product Specification

Abstract: UKCM services are generally used in conjunction with ENC (S-101) and routes (S-421) for aiding ships in safe passage through shallow waters. This S-129 UKCM Product Specification details the information typically provided by a UKCM service provider.

Content: A conformant dataset contains features associated with UKCM. The specific content is defined by the Feature Catalogue and the Application Schema.

Spatial Extent: Global coverage of maritime areas.

Specific Purpose: The data shall be produced for the purposes of UKCM.

## Data Product Specification metadata

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

Title: S-129 Under Keel Clearance Management Product Specification

S-100 Version: 4.0.0

S-129 Version: 0.4.0

Date: 6 Dec 18

Language: English

Classification: Unclassified

Contact: International Hydrographic Bureau,

4 quai Antoine 1er,

B.P. 445

MC 98011 MONACO CEDEX

Telephone: +377 93 10 81 00

Telefax: + 377 93 10 81 40

URL: www.iho.int

Identifier: S-129

Maintenance: For reporting issues that need correction, use the contact information.

## Product Specification Maintenance

### Introduction

Changes to S-129 will be released by the IHO as a new edition, a revision, or as a document that includes clarification. These are described below.

### New Editions

New Editionsintroduce significant changes. New Editionsenable new concepts, such as the ability to support new functions or applications, or the introduction of new constructs or data types. New Editionsare likely to have a significant impact on either existing users or future users of S-129.

### Revisions

Revisionsare defined as substantive semantic changes. Typically, revisions will introduce change to correct factual errors; introduce necessary changes that have become evident as a result of practical experience or changing circumstances. A revisionmust not be classified as a clarification. Revisionscould have an impact on either existing users or future users of this specification. All cumulative clarificationsmust be included with the release of approved corrections revisions.

Changes in a revision are minor and ensure backward compatibility with the previous versions within the same Edition. Newer revisions, for example, introduce new features and attributes. Within the same Edition, a dataset of one version could always be processed with a later version of the feature and portrayal catalogues. In most cases a new feature or portrayal catalogue will result in a revision of this specification.

### Clarifications

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

Changes in a clarification are minor and ensure backward compatibility with the previous versions within the same Edition. Within the same Edition, a dataset of one clarification version could always be processed with a later version of the feature and portrayal catalogues, and a portrayal catalogue can always rely on earlier versions of the feature catalogues.

### Version Numbers

The associated version control numbering to identify changes (n) to S-129 must be as follows:

New Editions denoted as **n**.0.0

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

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

## Specification Scope

This Product Specification describes one product and therefore requires only one scope.

**Scope ID:** Under Keel Clearance Management datasets

**Hierarchical level:** MD\_ScopeCode – 005

**Hierarchical level name:** dataset

**Level description:** information applies to the datasets

**Extent:** EX\_Extent.description: Global coverage of maritime areas

# Data product identification

This section describes how to identify datasets that conform to this specification. An under keel clearance dataset that conforms to this Product Specification uses the following general information for distinction:

title: Under Keel Clearance Management

abstract: The data product is a file containing under keel clearance data for a particular geographic region and set of times, along with the accompanying metadata describing the content, variables, applicable times and locations, and structure of the data product. Under keel clearance management data includes depths assessed as being navigationally safe and windows within which these assessments are valid, based upon observed or mathematically-predicted values.

acronym UKCM

geographicDescription: EX\_GeographicDescription: E.g., official name of region

spatialResolution: MD\_Resolution>equivalentScale.denominator (integer) or MD\_Resolution>levelOfDetail (CharacterString). E.g.: “All scales”

purpose: Under keel clearance management data is intended to be used as a layer in an ENC

language: EN

Additional values, if any, use CharacterString values from ISO 639-2

classification: Unclassified

Additional values, if any, use CharacterString values from ISO 639-2

Point of Contact: CI\_Responsibility

Use Limitation: Invalid over land

# Data content and structure

## Introduction

The S-129 product is based on the S-100 General Feature Model (GFM), and is a feature-based vector product. Figure 1 shows how the S-129 application schema is realized from the S-100 GFM. All S-129 features and information classes are derived from one of the abstract classes **FeatureType** and **InformationType** defined in the S-129 application schema, which realize the GFM meta-classes **S100\_GF\_FeatureType** and **S100\_GF\_InformationType** respectively.

**INSERT FIGURE 1 DEPICTING REALIZATIONS FROM THE S-100 GENERAL FEATURE MODEL HERE**

This section contains the Application Schema expressed in UML and an associated Feature Catalogue. The Feature Catalogue is included in Annex C, and provides a full description of each feature type including its attributes, attribute values and relationships in the data product. Figure 2 shows an overview of the S-129 application schema.

UKCM datasets consists of a UKC plan, control points and areas considered non-navigable and almost non-navigable.

S-129 datasets are generally intended to be used with ENC, and optionally with S-102 high definition bathymetry datasets. S-101 gives the background information, while S-129 datasets gives additional information related specifically to UKCM.

Dataset content will change over time during a ship’s transit. Updating datasets is achieved by replacement. The attribute ukcPurpose captures the intended purpose of a dataset. The possible values are ‘pre-plan’, ‘actual plan’ and ‘actual plan update’.

### Dataset purposes

#### Pre-plan datasets

‘Pre-plan’ datasets are used in voyage pre-planning and will produce for a ship a set of tidal windows for an arrival port, or waterway, days or weeks in advance. In this case, it is likely that the UKCM service will simply compute tidal windows based on water level and current forecast models, other weather statistics and a standard assumed route.

#### Actual plan datasets

‘Actual plan’ datasets are produced closer to the arrival/departure (approx. 24 hrs prior), and provide the mariner (crew and/or pilot) with a more detailed passage plan. This plan is generated from more frequent and/or precise weather forecasts/observations.

‘Actual plan’ update datasets include more up-to-date information and may be required every five to ten minutes. These datasets includes the route, the go/no-go areas and the 'parent' UnderKeelClearancePlan feature. The dataset will be updated based on the latest weather conditions and (optionally) actual ship position, heading and speed (e.g. as received in a UKCM service via AIS).

### Dataset updating

UKCM datasets are updated by whole dataset replacement. Which data needs to be updated, and how frequently, depends on the purpose of UKC calculation (as indicated by the 'ukcPurpose' attribute). Below is a typical updating scenario, but variations may exist depending on local circumstances.

In the pre-planning use case, a ship requests a set of tidal windows for an arrival port or waterway day or weeks in advance. In this case, the UKCM service may compute a tidal window based on predicted tides, forecast navigable depths, including safety/manoeuvrability margins, ship maximum draught, speed and squat predictions, other forecast environmental conditions and standard assumed route. In this scenario, the UKCM service could return a single dataset and generally no updates are required until approximately 24 hrs before the time when the ship enters the UKCM area.

Approximately 24 hrs before the time when a ship enters the UKCM area, the ship will need a more detailed UKC route plan. This plan usually considers more up to date information and will typically need to be updated more frequently. In this case, the non-navigable and almost non-navigable areas, any tidal windows (via Control Points), and some metadata will have changed. Depending on the variability of the met-ocean conditions, the update frequency could vary between 10 and 60 minutes.

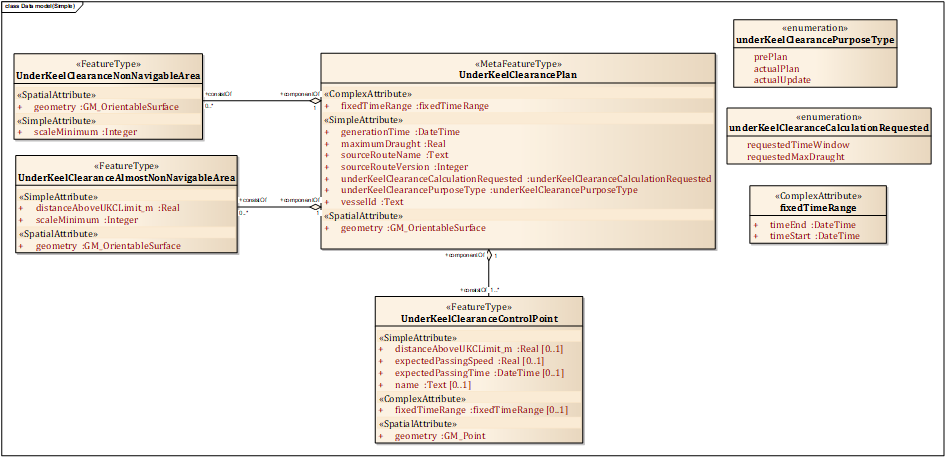
Immediately before entering the UKCM area and whilst underway, the use case changes again to become the actual plan and more up-to-date information is required, approximately every five to ten minutes. In this case, it is likely that the whole information in the dataset needs to be updated – including the route, the go/no-go areas and the 'parent' UnderKeelClearancePlan feature. The dataset will be updated based on latest observed and forecast conditions, and (optionally) actual ship position, heading and speed (e.g. as received in a UKCM service via AIS).

## Dataset Loading and Unloading

S-129 datasets are typically intended to be overlays to ENC and always displayed with ENC data in the background. Systems that support the display of S-129 datasets should provide the user with easy functions to turn the display of S-129 datasets on and off.

All S-129 datasets are scale independent and will therefore be usable across the entire scale range of underlying chart data (e.g. ENCs) for the UKCM area. The various feature instances within the dataset may include scaleMinimum attributes, but these do not change the resolution or validity of the data, only whether the data should be visible at a particular display scale.

Optionally, S-129 datasets can be viewed as overlays to a combination of ENC and S-102 datasets. The same requirements to allow the user to easily toggle the S-129 dataset on/off persist.



**Figure 2 – S-129 Data Model**

## Application Schema

This application schema is expressed in UML 2.0.

### Feature Types

#### UnderKeelClearancePlan

| **Role** | **Name** | **Description** | **Multi plicity** | **dataType** | **Remarks** |
| --- | --- | --- | --- | --- | --- |
| Class | UnderKeelClearancePlan | A UKC plan calculated for a particular ship and a particular passage |  | MetaFeatureType |  |
| SimpleAttribute | generationTime | Time the plan was generated | [1] | DateTime |  |
| SimpleAttribute | shipID | Unique identification of the ship used for the calculation | [1] | Text |  |
| SimpleAttribute | sourceRouteName | Identification of the route used as a source for the calculation | [1] | Text | Using the value of S-421.Route.routeInfoName |
| SimpleAttribute | sourceRouteVersion | Identification of the route used as a source for the calculation | [1] | Integer | Using the value of S-421.RouteHistory.routeHistoryEditionNo |
| SimpleAttribute | maximumDraught | The maximum ship draught in meters, used as base for the calculation | [1] | Real |  |
| SimpleAttribute | ukcPurpose | The purpose of the current calculation | [1] | underKeelClearancePurposeType |  |
| SimpleAttribute | typeOfCalculation | The type of calculation | [1] | underKeelClearanceCalculationType |  |
| SpatialAttribute | geometry | Boundaries of the Under Keel Clearance management area | [1] | GM\_OrientableSurface | geometric object come from Geometry class in S-100 standard |
| ComplexAttribute | fixedTimeRange | Time period | [1] | fixedTimeRange |  |

#### UnderKeelClearanceNonNavigableArea

| **Role** | **Name** | **Description** | **Multi plicity** | **dataType** | **Remarks** |
| --- | --- | --- | --- | --- | --- |
| Class | UnderKeelClearanceNonNavigableArea | An area of depth less than the calculated safe limit. |  | FeatureType | The area has a time-dependent dimension |
| SimpleAttribute | scaleMinimum | Integer | [1] | Integer |  |
| SpatialAttribute | geometry | Geometric object come from Geometry class in S-100 standard | [1] | GM\_OrientableSurface | To be used to describe the UKCM service area |

#### UnderKeelClearanceAlmostNonNavigableArea

| **Role** | **Name** | **Description** | **Multi plicity** | **dataType** | **Remarks** |
| --- | --- | --- | --- | --- | --- |
| Class | UnderKeelClearanceAlmostNonNavigableArea | An area of depth less than the calculated safe limit. |  | FeatureType | The area has a time-dependent dimension |
| SimpleAttribute | distanceAboveUKCLimit\_m |  | [1] | Real |  |
| SimpleAttribute | scaleMinimum | Integer | [1] | Integer |  |
| SpatialAttribute | geometry | Geometric object come from Geometry class in S-100 standard | [1] | GM\_OrientableSurface | To be used to describe the UKCM service area |

#### UnderKeelClearanceControlPoint

| **Role** | **Name** | **Description** | **Multi plicity** | **Data Type** | **Remarks** |
| --- | --- | --- | --- | --- | --- |
| Class | UnderKeelClearance ControlPoint | Especially selected critical passage point or line. |  | FeatureType |  |
| SimpleAttribute | distanceAboveUKCLimit\_m |  | [0]..[1] |  |  |
| SimpleAttribute | name | String | [0]..[1] | Text |  |
| SimpleAttribute | expectedPassingSpeed | float | [0]..[1] | Real |  |
| SimpleAttribute | expectedPassingTime | dateTime | [0]..[1] | DateTime |  |
| ComplexAttribute | fixedTimeRange |  | [0]..[1] | fixedTimeRange |  |
| SpatialAttribute | geometry | geometric object come from Geometry class in S-100 standard | [1] | GM\_Point |  |

### Associations

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Source** | **Multi plicity** | **Target** | **Multi plicity** | **Notes** |
| Aggregation | UnderKeelClearanceNonNavigableArea | [1] | UnderKeelClearancePlan | [1]..[\*] | Source role – consistOf  Target role – componentOf |
| Aggregation | UnderKeelClearanceAlmostNonNavigableArea | [1] | UnderKeelClearancePlan | [0]..[\*] | Source role – consistOf  Target role –componentOf |
| Aggregation | UnderKeelClearanceControlPoint | [1] | UnderKeelClearancePlan | [1]..[\*] | Source role – consistOf  Target role –componentOf |

### Complex Attribute

#### FixedTimeRange

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Role** | **Name** | **Description** | **Multiplicity** | **Data Type** | **Remarks** |
| ComplexAttribute | fixedTimeRange |  |  |  |  |
| Attribute | TimeStart | dateTime | [1] | DateTime |  |
| Attribute | TimeEnd | dateTime | [1] | DateTime |  |

### Enumerations

#### underKeelClearancePurposeType

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Role** | **Name** | **Description** | **Multiplicity** | **Data Type** | **Remarks** |
| Enumeration | underKeelClearancePurposeType |  |  |  |  |
| Literal | preplan |  |  |  |  |
| Literal | actualPlan |  |  |  |  |
| Literal | actualUpdate |  |  |  |  |

#### underKeelClearanceCalculationType

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Role** | **Name** | **Description** | **Multiplicity** | **Data Type** | **Remarks** |
| Enumeration | underKeelClearanceCalculationType | Indication of how the plan was calculated |  |  |  |
| Literal | timeWindow | UkcPlan returns available TimeWindow(s) for given draught |  |  |  |
| Literal | maxDraught | UkcPlan returns maximum draught for given TimeWindow |  |  |  |

# Feature Catalogue

## Introduction

According to ISO 19110, catalogue(s) contain definitions and descriptions of the spatial object types, their attributes and associated components occurring in one or more spatial data sets, together with any operations that may be applied.

A Feature Catalogue (FC) refers to a description of an abstraction of reality that may be used to depict one or more geographic datasets. The FC for S-129 describes the details of the application schema contained in section 6.2 in GML, and is verified by the IHO’s Feature Catalogue Builder (FCB) published by KOHA.

The FC describes the features, information types, attributes, attribute values, associations and roles which may be in a UKCM dataset. The S-129 FC is described in XML which conforms to the S-100 XML Feature Catalogue Schema. The S-129 FC is contained in Annex C or can be downloaded from the IHO website (http://s100.iho.int/S100/productspecs).

Simple attributes used in this specification are listed in Table 7.1.

## Feature Types

Feature types contain descriptive attributes that characterize real-world entities. The word ‘feature’ may be used in one of two senses – feature type and feature instance. A feature type is a class and is defined in a Feature Catalogue. A feature instance is a single occurrence of the feature type and represented as an object in a dataset. A feature instance is located by a relationship to one or more spatial instances. In this specification, a feature instance may not exist without referencing a spatial instance.

### Geographic

A Geographic (Geo) feature type carries the descriptive characteristics of a real-world entity. A geo feature type forms the principle content of the dataset and is fully defined by their associated attributes and information types.

### Meta

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. Meta attribution on individual features overrides attribution on meta features.

Meta features must be used to their maximum extent to reduce meta attribution on individual features.

### Feature Relationship

A feature relationship links instances of one feature type with instances of the same or a different feature type. There are four types of defined feature relationships in S-100, but S-129 uses only one of these –aggregation.

#### Aggregation

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

EXAMPLE A UKC route plan feature may be composed of multiple UKC non navigable area features to indicate unsafe areas.

### Attributes

S-100 defines attributes as either simple or complex.

#### Simple attributes

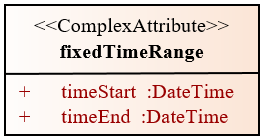
S-129 uses five types of simple attributes and these are listed in table 7-1.

|  |  |
| --- | --- |
| **Type** | **Definition** |
| Enumeration | A fixed list of valid identifiers of named literal values |
| Real | A signed Real (floating point) number consisting of a mantissa and an exponent |
| Integer | A signed integer number. The representation of an integer is encapsulation and usage dependent. |
| CharacterString | An arbitrary-length sequence of characters including accents and special characters from a repertoire of one of the adopted character sets |
| Date and Time | A DateTime is a combination of a date and a time type. Character encoding of a DateTime must follow ISO 8601:2004\* |

**Table 7-1 – Simple feature attribute types**

#### Complex attributes

Complex attributes are aggregations of other attributes that are either simple or complex. The aggregation is defined by means of attribute bindings. S-129 includes one complex attribute, fixedTimeRange, and it has two simple attributes.



## Units of measure

The following units of measure are used in S-129 PS:

* Ship draught in metres
* Ship length in metres
* Water depth in metres
* Directions in decimal degrees

# Dataset Types

UKCM datasets consists of a UKC plan, control points and areas considered non-navigable and almost non-navigable. The datasets are generally intended for use with ENC, and optionally with S-102 high definition bathymetry datasets. Dataset content will change over time during a ship’s transit. Updating datasets is achieved by replacement.

# Geometry

Geometry in S-129 datasets conforms to S-100 Geometry level 3a constrained to 2-dimensional geometry.

# Coordinate Reference Systems (CRS)

## Introduction

The location of a feature in the S-100 standard is defined by means of coordinates, which relate a feature to a position.

Projection: EPSG:4326 (WGS84)

Coordinate reference system registry: [EPSG Geodetic Parameter Registry](http://www.epsg-registry.org/)

Date type (according to ISO 19115): 002 – publication

Responsible party: International Association of Oil and Gas Producers (IOGP)

URL: http://www.iogp.org

## Horizontal Reference System

In S-129 datasets the horizontal CRS must be the ellipsoidal (geodetic) system EPSG: 4326 (WGS84). The full reference to EPSG: 4326 can be found at [www.epsg-registry.org](http://www.epsg-registry.org)

## Vertical Reference System

The vertical coordinate is directed upward (i.e., away from the Earth’s centre) from its origin, the vertical datum, and has units of metres. That is, a positive value for the level of the current relative to the vertical datum means that the level is above the vertical datum. This is consistent with the bathymetric CRS in S-102 1.0.0. The vertical datum is not an ellipsoid but is one of the following: (a) the sea surface (defined in section 3.1), (b) a vertical, sounding, or chart datum (MSL, LAT, etc.), or (c) the sea floor.

## Temporal Reference System

The temporal reference system is the Gregorian calendar for date and UTC for time. Time is measured by reference to Calendar dates and Clock time in accordance with ISO 19108:2002, Temporal Schema clause 5.4.4. All date and time variables must follow the format specified in ISO 8601:2004.

* A date variable will have the following 8-character format: yyyymmdd.
* A time variable will have the following 7-character format: hhmmssZ.
* A date-time variable will have the following 16-character format: yyyymmddThhmmssZ.

# Data Quality

## Introduction

Areas where UKCM services are in place are typically covered by very high definition and up to date bathymetry, and have available met-ocean data.

Bathymetric, tidal and other met-ocean data used to generate products in compliance with this Product Specification are provided by official sources using quality assured processes outside the scope of this Product Specification. This information is, therefore, of the highest possible quality and guaranteed by the processes employed by the relevant authorities.

Quality of UKCM products used for navigation depends on the combined quality of many inputs including observed and forecast data (e.g. bathymetry, tide, water levels, currents, etc.) and ship positional data. Quality information relevant to the many data inputs used by a UKCM service is difficult to produce as a meaningful metric of UKCM product quality able to be understood by the mariner.

Data validity is time-limited and is another reason why it is not practical to provide a meaningful measure of data quality for UKCM products.

UKCM products are generated containing margins that account for uncertainty to guarantee the safety of individual ships for stated periods of validity.

# Data Capture and Classification

The Data Capture and Encoding Guide (DCEG) gives guidance for how to encode UKCM datasets for the various stages of a journey to and through a UKCM area. The document can be found in **Annex A.**

# Maintenance

Dataset maintenance is dependent on local conditions and the policies of the UKCM service provider. Typically, a ship would be sent several UKCM information products during a transit of a UKCM area in order to ensure the ship has correct and up to date UKCM information.

## Maintenance and Update Frequency

In the pre-planning use case the UKCM service may simply compute a tidal window based on predicted tide, forecast navigable depths, including safety/manoeuvrability margins, ship maximum draught, speed and squat predictions, other forecast environmental conditions and standard assumed route. In this pre-planning scenario, the UKCM service could only return a single dataset and generally no updates would be required until approximately 24 hours before the time when the ship enters the UKCM area.

About 24 hours before the time when the ship enters the UKCM area the ship will need a more detailed passage plan, which will be updated more frequently. Depending on the variability of the observed and forecast conditions in the UKCM area, the update frequency might range between 10 minutes to 60 minutes.

As the ship is approaching the UKCM area, more up-to-date information will be required and UKCM product datasets may be updated as frequently as every five to ten minutes.

## Data Source

Data sources used when creating UKCM product datasets can vary with each UKCM area. Source information can include high definition bathymetric data, observed or forecast water level and current, and observed or forecast climatic data. This information is combined into modelling with a ship’s details such as draughts, speed and position to create UKCM product datasets that are individually tailored for each ship.

## Production Process

The production process of UKCM product datasets will vary depending on the environmental sensors used in each UKCM area, and may also vary depending on the stage of a passage the ship is on.

# Portrayal

The Portrayal Catalogue (PC) in Annex D defines how S-129 datasets are to be portrayed. The PC specifies the symbols and portrayal rules needed to display S-129 features.

The PC contains portrayal functions to map the features to symbols, symbol definitions, colour definitions, portrayal parameters and portrayal management concepts such as viewing groups.

# Data Product format (encoding)

The GML encoding of S-129 datasets is based on the S-100 profile of GML 3.2.1. This is described in S-100 Edition 4.0.0 Part 10b.

Detailed documentation of the S-201 encoding schema is provided in Annex B of this document.

Format Name: GML

Version: 3.2.1

Character Set: UTF-8

Specification: S-100 4.0.0 profile of GML 3.2.1

## Encoding of Latitude and Longitude

Values of latitude and longitude must be expressed with a precision of 9 decimal places. Coordinates must be encoded as decimals in the format described below. The encoding is indicated by multiplication factor fields defined in the S-100 GML schema dataset identification record.

### Encoding of coordinates as decimals

Values should be coded as decimal numbers with 9 or fewer digits after the decimal. The normative encoding is in degrees, with an accuracy of 10-9 degrees (i.e. 9 digits after the decimal point). The decimal point must be indicated by the “.” character.

Trailing zeroes after the decimal point (and the decimal point itself if appropriate) may be omitted at producer discretion, but the accuracy must still be as indicated (e.g. 10-9 degrees for coordinates of default accuracy).

Latitude and longitude multiplication factors held in the Dataset Structure Information field under [coordMultFactorX] and [coordMultFactorY] must be set to a value corresponding to the encoding, e.g., {1} for coordinates encoded in decimal degrees.

EXAMPLE 1 A longitude = 42.0000 is converted into X = longitude \* coordMultFactorX = 42.0000 \* 1 = 42.000000000.

## Numeric Attribute Encoding

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

## Text Attribute Values

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

## 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 FC and summarised in Annex A – Data Classification and Encoding Guide.

## Unknown Attribute Values

When a mandatory attribute code or tag is present but the attribute value is missing, it means that the producer wishes to indicate that this attribute value is unknown. Missing mandatory attributes must be “nilled” with a GML *nilReason* attribute giving the reason for omission.

Optional attributes must be omitted altogether if the value is unknown or missing. They must not be “nilled.”

## Structure of dataset files

### Sequence of objects

The order of data objects in each dataset file is described below:

1. Dataset Identification Information
2. Dataset structure information
3. Spatial records for by-reference geometries
   1. Point
   2. Multi point
   3. Curve
   4. Composite Curve
   5. Surface
4. Information objects
5. Feature objects (Geometry may be encoded inline or by reference)
   1. Meta features
   2. Geo features
6. S-129 Collection objects

## Object identifiers

The “name” of feature records must provide a unique world-wide identifier of feature records. The “name” of the record is the combination of the subfields **agency**, **featureObjectIdentifier**, and **featureIdentificationSubdivision** elements of the **featureObjectIdentifier** element of the object.

Features, information types, collection objects, meta features, and geometries (inline or external) are all required by the schema to have a **gml:id** attribute with a value that is unique within the dataset. The **gml:id** values must be used as the reference for the object from another object in the same dataset or another dataset.

## Dataset validation

Fields may be repeated or omitted as permitted by the XML schemas and the validation tests. Since XML schema cannot encode rules for conditional presence or attributes, these rules can be checked by Schematron rules or other validation code.

## Data overlap

S-129 datasets shall not overlap temporally but may spatially overlap other S-129 datasets.

## Data quality

One or more QualityOfNonbathymetricData feature shall cover the dataset.

# Data Product Delivery

## Introduction

This clause specifies the encoding and delivery mechanisms for an S-129 dataset. Data which conforms to this Product Specification must be delivered by means of an exchange set.

Units of Delivery: Exchange set

Transfer Size: Unlimited

Medium Name: Digital data delivery

Other Delivery Information:

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

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

Support files contain supplementary information which is linked to the features and information types by attributes. The attributes containing these links are described in the application schema and feature catalogue.

An exchange set may be encapsulated in a form suitable for transmission by a mapping called a transmission encoding. An encoding translates each of the elements of the exchange set into a logical form suitable for writing to media and for transmission. 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.

If the data is transformed (e.g. for encryption or compression purposes) its content must not be changed.

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

The exchange set elements are as follows:

Mandatory Elements:

* S-129 datasets – GML encoding of features/attributes and their associated geometry and metadata.
* Exchange Catalogue – the XML encoded representation of exchange set catalogue features [discovery metadata].

Optional Elements:

* Supplementary files – These are contained within the exchange set as files and the map from the name included within the dataset and the physical location is defined within the Exchange Catalogue.
* Feature Catalogue – If it is necessary to deliver the latest feature catalogue to the end user it may be done using the S-129 exchange set mechanism for datasets (i.e. include the updated feature catalogue in an exchange set).
* Portrayal Catalogue - If it is necessary to deliver the latest portrayal catalogue to the end user it may be done using the S-129 exchange set mechanism for datasets (i.e. include the updated feature catalogue in an exchange set).

S-129 Exchange set structure conforms to S-100 4.0.0 Figure 4a-D-3 without modification.



Figure XX - Exchange set structure

### Catalogue File Naming Convention

The exchange catalogue acts as the table of contents for the exchange set. The catalogue file of the exchange set must be named CATALOG.XML. No other file in the exchange set may be named CATALOG.XML. The content of the exchange catalogue file is described in Section 17.3.

## Dataset

### Datasets

Datasets are distributed as files which are part of exchange sets structured as described in this specification. The distribution media or transmission method is at the discretion of the producer and/or distributor.

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

* New dataset and new edition of a dataset (base dataset): Each new edition of a dataset must have the same name as the dataset that it replaces. A new edition can also contain data that has previously been produced for the same UKCM area. The encoding structure is located in Annex B.
* Cancellation: The dataset is cancelled and is deleted from the SYSTEM. The structure for a cancellation is described in clause 13.2.X. A dataset shall be considered cancelled when a newer edition has been received or the validTimeEnd of the UnderKeelClearancePlan is exceeded.

### Dataset size

There is no recommended maximum file size for UKCM datasets, however future testing may determine there should be a size limit. ??MB

### Dataset file naming

Dataset files shall be named:

129XXXXYYYYYYYY.GML

The file name forms a unique identifier where:

* the first three characters are fixed to 129, and identify the dataset as a S-129 dataset.
* The fourth to seventh characters indicate the issuing agency (mandatory) in accordance with IHO S-62.
* the eight to fifteenth characters are optional and may be used in any way by the producer to provide the unique file name. It is not required to use all characters. The following characters are allowed in the dataset name, A to Z, 0 to 9 and the special character \_ (underscore).
* GML – the character sequence “GML” or “gml”.

## Support Files

The only support file type allowed for S-129 is an optional file describing the route which was used to calculate the S-129 dataset. Changes to the route during transit should be kept to a minimum, and the file should be included only when it is changed. The specific route file is identified within the S-129 dataset by the following simple attributes:

* SourceRouteName
* SourceRouteVersion

|  |  |  |
| --- | --- | --- |
| **File Types** | **Extensions** | **Comment** |
| **XML** |  |  |
|  | RTZ | An XML file format for Route Exchange as specified in the edition 4 of IEC 61174 Annex S. |
|  |  | An XML file format for Route Exchange as specified in S-421 when published. |

Note: The route file exchange format specified in IEC61174 Annex S is being developed into an S-100 based Product Specification S-421. S-421 will provide guidelines for using the Route Plan together with S-129 in an ECDIS or other navigation system.

### Support File Naming

Files shall be named as follows:

129XXXXYYYYYYYY.EEE

The file name forms a unique identifier where:

* the first three characters are fixed to 129, and identify the dataset as a S-129 based dataset.
* The fourth to seventh characters indicate the issuing agency (mandatory) in accordance with IHO S-62.
* the eight to fifteenth characters are optional and may be used in any way by the producer to provide the unique file name. It is not required to use all characters. The following characters are allowed in the dataset name, A to Z, 0 to 9 and the special character\_ (underscore).
* EEE – support file extension (note – must conform to the file format).

# Metadata

## Introduction

The S-129 UKCM metadata description is based on the S-100 metadata document section, which is a profile of the ISO 19115 standard. These documents provide a structure for describing digital geographic data and define metadata elements, a common set of metadata terminology, definitions and extension procedures.

Two metadata packages are described in this Product Specification: dataset metadata; and, exchange set metadata.



Figure 18 - Metadata packages

Note 1: Types with CI\_, EX\_, and MD\_ prefixes are from packages defined in ISO 19115 and adapted by S-100. Types with S100\_ prefix are from packages defined in S-100.

Note 2: When a dataset is terminated, the ‘purpose’ metadata field is set to 3 (terminated), and the ‘editionNumber’ metadata field is set to 0. All other metadata fields must be blank.

Note 3: The implication of only updating by new edition is that, if a support file is terminated a new edition of the dataset is required.

**Use of S-421 for providing UKCM related routes**

Add text to describe how S-129 makes use of S-421

\*\*Note comments by Stefan in relation to same\*\*



## Language

The language used for the metadata is English.

## S100\_ExchangeCatalogue

Each exchange set has a single S100\_ExchangeCatalogue, which contains meta information for the data and support files in the exchange set.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_ExchangeCatalogue | An exchange catalogue contains the discovery metadata about the exchange datasets and support files | - | - | - |
| identifier | Uniquely identifies this exchange catalogue | 1 | S100\_CatalogueIdentifier |  |
| contact | Details about the issuer of this exchange catalogue | 1 | S100\_CataloguePointOfContact |  |
| productSpecification | Details about the Product Specifications used for the datasets contained in the exchange catalogue | 0..1 | S100\_ProductSpecification | Conditional on all the datasets using the same Product Specification |
| metadataLanguage | Details about the Language | 1 | CharacterString | Value shall be English |
| exchangeCatalogueName | Catalogue filename | 1 | CharacterString | Value shall be CATLOG.XML |
| exchangeCatalogueDescription | Description of what the exchange catalogue contains | 1 | CharacterString |  |
| exchangeCatalogueComment | Any additional Information | 0..1 | CharacterString |  |
| compressionFlag | Is the data compressed | 0..1 | Boolean | 1 indicates Yes and 0 indicates No |
| algorithmMethod | Type of compression algorithm | 0..1 | CharacterString |  |
| sourceMedia | Distribution media | 0..1 | CharacterString |  |
| replacedData | If a data file is cancelled is it replaced by another data file | 0..1 | Boolean |  |
| dataReplacement | Cell name | 0..1 | CharacterString |  |

### S100\_CatalogueIdentifier

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_CatalogueIdentifier | An exchange catalogue contains the discovery metadata about the exchange datasets and support files | - | - | - |
| identifier | Uniquely identifies this exchange catalogue | 1 | CharacterString |  |
| editionNumber | The edition number of this exchange catalogue | 1 | CharacterString |  |
| date | Creation date of the exchange catalogue | 1 | Date |  |
| time | Creation time of the exchange catalogue | 0..1 | Time |  |

### S100\_CataloguePointofContact

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_CataloguePointOfContact | Contact details of the issuer of this exchange catalogue | - | - | - |
| organization | The organization distributing this exchange catalogue | 1 | CharacterString | This could be an individual producer, value added reseller, etc. |
| phone | The phone number of the organization | 0..1 | CI\_Telephone |  |
| address | The address of the organization | 0..1 | CI\_Address |  |

## S100\_DatasetDiscoveryMetaData

| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| --- | --- | --- | --- | --- |
| S100\_DatasetDiscoveryMetadata | Metadata about the individual datasets in the exchange catalogue | - | - | - |
| fileName | Dataset file name | 1 | CharacterString |  |
| filePath | Full path from the exchange set root directory | 1 | CharacterString | Path relative to the root directory of the exchange set. The location of the file after the exchange set is unpacked into directory <EXCH\_ROOT> will be <EXCH\_ROOT>/<filePath>/<filename> |
| description | Short description giving the area or location covered by the dataset | 1 | CharacterString | E.g. the underkeel clearance management zone. |
| dataProtection | Indicates if the data is encrypted | 0..1 | Boolean | 0 indicates an unencrypted dataset  1 indicates an encrypted dataset |
| protectionScheme | specification or method used for data protection | 0..1 | CharacterString | Eg S-63 |
| digitalSignature | Indicates if the data has a digital signature | 1 | CharacterString |  |
| copyright | Indicates if the dataset is copyrighted | 0..1 | MD\_LegalConstraints ->MD\_RestrictionCode <copyright> (ISO 19115) |  |
| classification | Indicates the security classification of the dataset | 0..1 | Class  MD\_SecurityConstraints>MD\_ClassificationCode (codelist) | 1. unclassified  2. restricted  3. confidential  4. secret  5. top secret |
| purpose | The purpose for which the dataset has been issued | 1 | MD\_Identification>purpose  CharacterString | pre plan, actual plan, or actual update. |
| specificUsage | The use for which the dataset is intended | 1 | MD\_USAGE>specificUsage (character string)  MD\_USAGE>userContactInfo (CI\_ResponsibleParty) | For navigation through <name of UKCM area> by <ship name>. |
| issueDate | date on which the data was made available by the data producer | 1 | Date |  |
| issueTime | time on which the data was made available by the data producer | 1 | Time |  |
| productSpecification | The Product Specification used to create this dataset | 1 | S100\_ProductSpecification |  |
| producingAgency | Agency responsible for producing the data | 1 | CI\_ResponsibleParty |  |
| optimumDisplayScale | The scale with which the data is optimally displayed | 0..1 | Integer | Example: A scale of 1:25000 is encoded as 25000 |
| maximumDisplayScale | The maximum scale with which the data is displayed | 0..1 | Integer |  |
| minimumDisplayScale | The minimum scale with which the data is displayed | 0..1 | Integer |  |
| horizontalDatumReference | Reference to the register from which the horizontal datum value is taken | 1 | characterString | EPSG |
| horizontalDatumValue | Horizontal Datum of the entire dataset | 1 | Integer | 4326 |
|  |  |  |  |  |
|  |  |  |  |  |
| dataType | The encoding format of the dataset | 1 | S100\_DataFormat | Must be GML |
| otherDataTypeDescription | Encoding format other than those listed. | 0..1 | CharacterString |  |
| dataTypeVersion | The version number of the dataType. | 1 | CharacterString | 3,2,1 S-100 4.0.0 Profile |
| dataCoverage | Provides information about data coverages within the dataset | 1..\* | S100\_DataCoverage |  |
| comment | any additional information | 0..1 | CharacterString |  |
| layerID | Identifies other layers with which this dataset is intended to be used or portrayed | 0..\* | CharacterString | In navigation system, S-129 datasets must be used with ENC. |

### S100\_DataCoverage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_DataCoverage |  | - | - | - |
| ID | Uniquely identifies the coverage | 1 | Integer | - |
| boundingBox | The extent of the dataset limits | 1 | EX\_GeographicBoundingBox | - |
| boundingPolygon | A polygon which defines the actual data limit | 1..\* | EX\_BoundingPolygon | - |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

### S100\_DataFormat

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_DataFormat | The encoding format | - | - | - |
| ISO/IEC 8211 |  | - | - | - |
|  |  |  |  |  |
| GML |  | - | - | - |
| HDF5 |  |  |  |  |
| Other |  | - | - | - |

### S100\_ProductSpecification

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_ProductSpecification | The Product Specification contains the information needed to build the specified product | - | - | - |
| name | The name of the Product Specification used to create the datasets | 1 | CharacterString | 129 |
| version | The version number of the Product Specification | 1 | CharacterString | 1.0.0 |
| date | The version date of the Product Specification | 1 | Date | CCYYMMDD |

## S100\_SupportFileDiscoveryMetadata

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_SupportFiletDiscoveryMetadata | Metadata about the individual support files in the exchange catalogue | - | - | - |
| fileName | Name of the support file | 1 | CharacterString |  |
| fileLocation | Full location from the exchange set root directory | 1 | CharacterString | Path relative to the root directory of the exchange set. The location of the file after the exchange set is unpacked into directory <EXCH\_ROOT> will be <EXCH\_ROOT>/<filePath>/<filename> |
| purpose | The purpose for which the dataset has been issued | 1 | S100\_SupportFilePurpose | E.g. new, re-issue, new edition, update etc. |
| editionNumber | The edition number of the dataset | 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 | date on which the data was made available by the data producer | 1 | Date |  |
| productSpecification | The Product Specification used to create this file | 1 | S100\_ProductSpecification |  |
| dataType | The encoding format of the dataset | 1 | S100\_SupportFileFormat |  |
| otherDataTypeDescription | Encoding format other than those listed. | 0..1 | CharacterString |  |
| dataTypeVersion | The version number of the dataType. | 1 | CharacterString |  |
| comment |  | 0..1 | CharacterString |  |
| digitalSignatureReference | Digital Signature of the file | 0..1 | CharacterString | Reference to the appropriate digital signature algorithm |
| digitalSignatureValue | Value derived from the digital signature | 0..1 | CharacterString |  |
| fileName | Name of the support file | 1 | CharacterString |  |

### S100\_SupportFileFormat

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_SupportFormat | The format used in the support file | - | - | - |
| ASCII |  | - | - |  |
| JPEG2000 |  | - | - |  |
| HTML |  | - | - |  |
| XML |  | - | - |  |
| XSLT |  | - | - |  |
| VIDEO |  | - | - |  |
| TIFF |  |  |  |  |

### S100\_SupportFilePurpose

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_SupportFilePurpose | The reason for inclusion of the support file in this exchange set | - | - | - |
| new | A file which is new | - | - | Signifies a new file. |
| replacement | A file which replaces an existing file | - | - | Signifies a replacement for a file of the same name |
| deletion | Deletes an existing file | - | - | Signifies deletion of a file of that name |

## S100\_CatalogueMetadata

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_Catalogue |  | - | - | - |
| filename | The name for the catalogue | 1..\* | CharacterString |  |
| fileLocation | Full location from the exchange set root director | 1..\* | CharacterString | Path relative to the root directory of the exchange set. The location of the file after the exchange set is unpacked into directory <EXCH\_ROOT> will be <EXCH\_ROOT>/<filePath>/<filename> |
| scope | Subject domain of the catalogue | 1..\* | S100\_CatalogueScope |  |
| versionNumber | The version number of the Product Specification | 1..\* | CharacterString |  |
| issueDate | The version date of the Product Specification | 1..\* | Date |  |
| productSpecification | The Product Specification used to create this file | 1..\* | S100\_ProductSpecification |  |
| digitalSignatureReference | Digital Signature of the file | 1 | CharacterString | Reference to the appropriate digital signature algorithm |
| digitalSignatureValue | Value derived from the digital signature | 1 | CharacterString |  |

### S100\_CatalogueScope

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** | **Mult** | **Type** | **Remarks** |
| S100\_CatalogueScope |  | - | - | - |
| featureCatalogue |  |  |  |  |
| portrayalCatalogue |  |  |  |  |

1. Data Classification and Encoding Guide

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| IHO Definition: **FEATURE:** Definition. (Authority for definition). | | | | | | |
| **S-101 Geo Feature: Feature (S-57 Acronym)** S-101 feature and corresponding S-57 acronym | | | | | | |
| **Primitives: Point, Curve, Surface** Allowable geometric primitive(s) | | | | | | |
| *Real World*  Example of real world instance(s) of the Feature. | *Paper Chart Symbol*  Example(s) of paper chart equivalent symbology for the Feature. | | | *ECDIS Symbol*  Example(s) of ECDIS symbology for the Feature. | | |
| **S-101 Attribute** | | **S-57 Acronym** | **Allowable Encoding Value \*** | | **Type** | **Multiplicity** |
| Category of beer | |  | 1 : ale  2 : lager  3 : porter  4 : stout  5 : pilsener  6 : bock beer  7 : wheat beer | | EN | 1,1 |
| This section liststhe full list of allowable attributes for the S-101 feature. Attributes are listed in alphabetical order. Sub-attributes (Type prefix (S)) of complex (Type C) attributes are listed in alphabetical order and indented directly under the entry for the complex attribute (see below for example). | | This section liststhe corresponding S-57 attribute acronym. A blank cell indicates no corresponding S-57 acronym. | This section liststhe allowable encoding values for S-101 (for enumerate (E) Type attributes only). Further information about the attribute is available in Section XX. | | Attribute type (see clause X.X). | Multiplicity describes the “cardinality” of the attribute in regard to the feature. See clause X.X. |
| Fixed date range | |  |  | | C | 0,1 |
| Date end | | (DATEND) |  | | (S) DA | 0,1 |
| Date start | | (DATSTA) |  | | (S) DA | 0,1 |
| INT 1 Reference: The INT 1 location(s) of the Feature – by INT1 Section and Section Number.  **X.X.X Sub-clause heading(s) (see S-4 – B-YYY.Y)**  Introductory remarks. Includes information regarding the real world entity/situation requiring the encoding of the Feature in the ENC, and where required nautical cartographic principles relevant to the Feature to aid the compiler in determining encoding requirements.  Specific instructions to encode the feature.  Remarks:   * Additional encoding guidance relevant to the feature.   **X.X.X.X Sub-sub-clause heading(s) (see S-4 – B-CCC.C)**  Clauses related to specific encoding scenarios for the Feature. (Not required for all Features).  Remarks:   * Additional encoding guidance relevant to the scenario (only if required).   Distinction: List of features in the Product Specification distinct from the Feature. | | | | | | |

Feature Attributes and Enumerate Proposals

|  |
| --- |
| **Attribute Name:** IHO Definition:   1. **Enumerate Name**   IHO Definition: If Applicable   1. **Enumerate Name**   Remarks: |

|  |
| --- |
| **Attribute Name:** IHO Definition:  Unit:  Resolution:  Format:  Example:  Remarks:   * No remarks. |

Associations/Aggregations/Compositions

|  |  |  |  |
| --- | --- | --- | --- |
| **Association/Aggregation/Composition Name:** IHO Definition:  Remarks: | | | |
| **Role Type** | **Role** | **Features** | **Multiplicity** |
| Association  Aggregation  Composition |  |  |  |
|  |  |  |
|  |  |  |

1. Data Product format (encoding)

Eivind – was this the content to be added here?

<?xml version="1.0" encoding="utf-8"?>

<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:S100="http://www.iho.int/s100gml/1.0" xmlns:gml="http://www.opengis.net/gml/3.2" xmlns="http://www.iho.int/S124/gml/cs0/0.1" xmlns:S100EXT="http://www.iho.int/s100gml/1.0+EXT" targetNamespace="http://www.iho.int/S124/gml/cs0/0.1" elementFormDefault="unqualified" version="0.1-20180531">

<!--

=============================================================================================================

S100 XML/GML Schema for S-129 (S-129 Under Keel Clearance Management Information Product Specification).

=============================================================================================================

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THIS IS A DRAFT AND NO WARRANTIES ARE GIVEN TO ACCURACY OR FUNCTION OF THIS DOCUMENT

Document history

Draft 0.0.1 20181031 Draft based on S-129 UML as is in PS v0.1.1 (September 26, 2018). First draft.

===============================================================================================================

-->

<!-- To do: Schematron validation rules; -->

<!-- profile: xmlns:gml="http://www.iho.int/S-100/profile/s100\_gmlProfile"

deployment:

(1) change gml namespace to official GML namespace http://www.opengis.net/gml/3.2

(2) add profile namespace xmlns:s100="http://www.iho.int/S-100/profile/s100\_gmlProfile"

(3) update import statement below correspondingly -->

<xs:import namespace="http://www.iho.int/s100gml/1.0" schemaLocation="../../../S100/4.0.0/S100GML/20180502/s100gmlbase.xsd"/>

<xs:import namespace="http://www.opengis.net/gml/3.2" schemaLocation="../../../S100/4.0.0/S100GML/20180502/S100\_gmlProfile.xsd"/>

<xs:import namespace="http://www.iho.int/S-100/profile/s100\_gmlProfile" schemaLocation="../../../S100/4.0.0/S100GML/20180502/S100\_gmlProfileLevels.xsd"/>

<xs:import namespace="http://www.iho.int/s100gml/1.0+EXT" schemaLocation="../../../S100/4.0.0/S100GML/20180502/s100gmlbaseExt.xsd"/>

<!-- ============= -->

<!-- common types -->

<!-- ============= -->

<!-- none included in this version since it seems the schema can be created with built-in types -->

<!-- ===================================== -->

<!-- spatial property convenience types -->

<!-- ===================================== -->

<xs:complexType name="GM\_Point">

<xs:choice>

<xs:element ref="S100:pointProperty"/>

</xs:choice>

</xs:complexType>

<xs:complexType name="GM\_Curve"> <!-- likely not needed -->

<xs:choice>

<xs:element ref="S100:curveProperty"/>

</xs:choice>

</xs:complexType>

<xs:complexType name="GM\_Surface">

<xs:choice>

<xs:element ref="S100:surfaceProperty"/>

</xs:choice>

</xs:complexType>

<!-- ============================ -->

<!-- complex attributes -->

<!-- ============================ -->

<xs:complexType name="fixedTimeRangeType">

<xs:annotation>

<xs:documentation>Time interval</xs:documentation>

</xs:annotation>

<xs:sequence>

<xs:element name="timeStart" type="xs:dateTime" minOccurs="1" maxOccurs="1" />

<xs:element name="timeEnd" type="xs:dateTime" minOccurs="1" maxOccurs="1"/>

</xs:sequence>

</xs:complexType>

<!-- ========================================= -->

<!-- enumeration types -->

<!-- ========================================= -->

<xs:simpleType name="underKeelClearancePurposeTypeType">

<xs:annotation>

<xs:documentation>The relevant phase of a UKC passage plan</xs:documentation>

</xs:annotation>

<xs:restriction base="xs:string">

<xs:enumeration value="pre plan">

<xs:annotation>

<xs:documentation>An indicative UKC plan that identifies potential sailing windows for a nominated vessel draught, days, weeks or months prior to the planned passage through the UKCM region.</xs:documentation>

</xs:annotation>

</xs:enumeration>

<xs:enumeration value="actual plan">

<xs:annotation>

<xs:documentation>A detailed UKC plan that identifies sailing windows and no-go areas, integrating live weather data, hours or days prior to transiting the UKCM region.</xs:documentation>

</xs:annotation>

</xs:enumeration>

<xs:enumeration value="actual update'">

<xs:annotation>

<xs:documentation>A near real-time, detailed, UKC plan that identifies sailing windows and no-no areas, using live weather, vessel position and traffic data, while the vessel is transiting the UKCM region.</xs:documentation>

</xs:annotation>

</xs:enumeration>

</xs:restriction>

</xs:simpleType>

<xs:simpleType name="underKeelClearanceCalculationTypeType">

<xs:annotation>

<xs:documentation>Indication of the aim of the UKC plan: to find the maximum safe vessel draught for transiting the UKCM region, or to find sailing windows for a nominated vessel draught</xs:documentation>

</xs:annotation>

<xs:restriction base="xs:string">

<xs:enumeration value="time window">

<xs:annotation>

<xs:documentation>The available wim window(s) for a given draught.</xs:documentation>

</xs:annotation>

</xs:enumeration>

<xs:enumeration value="max draught">

<xs:annotation>

<xs:documentation>The maximum draught for a given time window.</xs:documentation>

</xs:annotation>

</xs:enumeration>

</xs:restriction>

</xs:simpleType>

<!-- ========================================= -->

<!-- feature types -->

<!-- ========================================= -->

<xs:element name="FeatureType" type="FeatureType" abstract="true" substitutionGroup="gml:AbstractFeature"/>

<xs:complexType name="FeatureType" abstract="true">

<xs:annotation>

<xs:documentation>Generalized feature type which carries all the common attributes</xs:documentation>

</xs:annotation>

<xs:complexContent>

<xs:extension base="S100:AbstractFeatureType"/>

</xs:complexContent>

</xs:complexType>

<xs:element name="UnderKeelClearancePlan" type="UnderKeelClearancePlanType" substitutionGroup="FeatureType"/>

<xs:complexType name="UnderKeelClearancePlanType">

<xs:annotation>

<xs:documentation>A UKC plan calculated for a particular vessel, for a particular passage.</xs:documentation>

</xs:annotation>

<xs:complexContent>

<xs:extension base="FeatureType">

<xs:sequence>

<xs:element name="fixedTimeRange" type="fixedTimeRangeType" minOccurs="1" maxOccurs="1"/>

<xs:element name="generationTime" type="xs:dateTime" minOccurs="1" maxOccurs="1"/>

<xs:element name="vesselID" type="xs:string" minOccurs="1" maxOccurs="1"/>

<xs:element name="sourceRouteName" type="xs:string" minOccurs="1" maxOccurs="1"/>

<xs:element name="sourceRouteVersion" type="xs:int" minOccurs="1" maxOccurs="1"/>

<xs:element name="maximumDraught" type="xs:decimal" minOccurs="1" maxOccurs="1"/>

<xs:element name="underKeelClearancePurposeType" type="underKeelClearancePurposeTypeType" minOccurs="1" maxOccurs="1"/>

<xs:element name="underKeelClearanceCalculationType" type="underKeelClearanceCalculationTypeType" minOccurs="1" maxOccurs="1"/>

<xs:element name="geometry" type="GM\_Surface" minOccurs="1" maxOccurs="1"/>

<xs:element name="consitOf" type="gml:ReferenceType" minOccurs="1" maxOccurs="unbounded"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<xs:element name="UnderKeelClearanceNonNavigableArea" type="UnderKeelClearanceNonNavigableAreaType" substitutionGroup="FeatureType"/>

<xs:complexType name="UnderKeelClearanceNonNavigableAreaType">

<xs:annotation>

<xs:documentation>Anarea of depth less than the calculated safe limit.</xs:documentation>

</xs:annotation>

<xs:complexContent>

<xs:extension base="FeatureType">

<xs:sequence>

<xs:element name="scaleMinimum" type="xs:int" minOccurs="1" maxOccurs="1"/>

<xs:element name="geometry" type="GM\_Surface" minOccurs="1" maxOccurs="1"/>

<xs:element name="componentOf" type="gml:ReferenceType" minOccurs="1" maxOccurs="1"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<xs:element name="UnderKeelClearanceAlmostNonNavigableArea" type="UnderKeelClearanceAlmostNonNavigableAreaType" substitutionGroup="FeatureType"/>

<xs:complexType name="UnderKeelClearanceAlmostNonNavigableAreaType">

<xs:annotation>

<xs:documentation>An area of depth almost less than the valculated safe limit, as established for the waterway.</xs:documentation>

</xs:annotation>

<xs:complexContent>

<xs:extension base="FeatureType">

<xs:sequence>

<xs:element name="distanceAboveUKCLimit\_m" type="xs:decimal" minOccurs="1" maxOccurs="1"/>

<xs:element name="scaleMinimum" type="xs:int" minOccurs="1" maxOccurs="1"/>

<xs:element name="geometry" type="GM\_Surface" minOccurs="1" maxOccurs="1"/>

<xs:element name="componentOf" type="gml:ReferenceType" minOccurs="1" maxOccurs="1"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<xs:element name="UnderKeelClearanceControlPoint" type="UnderKeelClearanceControlPointType" substitutionGroup="FeatureType"/>

<xs:complexType name="UnderKeelClearanceControlPointType">

<xs:annotation>

<xs:documentation>Selected critical passage point or line</xs:documentation>

</xs:annotation>

<xs:complexContent>

<xs:extension base="FeatureType">

<xs:sequence>

<xs:element name="distanceAboveUKCLimit\_m" type="xs:decimal" minOccurs="0" maxOccurs="1"/>

<xs:element name="expectedPassingSpeed" type="xs:decimal" minOccurs="0" maxOccurs="1"/>

<xs:element name="expectedPassingTime" type="xs:dateTime" minOccurs="0" maxOccurs="1"/>

<xs:element name="name" type="xs:string" minOccurs="0" maxOccurs="1"/>

<xs:element name="fixedTimeRange" type="fixedTimeRangeType" minOccurs="0" maxOccurs="1"/>

<xs:element name="geometry" type="GM\_Point" minOccurs="1" maxOccurs="1"/>

<xs:element name="componentOf" type="gml:ReferenceType" minOccurs="1" maxOccurs="1"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<!-- ==================================================== -->

<!-- cartographic features -->

<!-- ==================================================== -->

<!-- none in the specification -->

<!-- ========================================= -->

<!-- information types -->

<!-- ========================================= -->

<xs:element name="InformationType" type="InformationTypeType" abstract="true" substitutionGroup="gml:AbstractGML"/>

<xs:complexType name="InformationTypeType" abstract="true">

<xs:annotation>

<xs:documentation>Generalized information type which carry all the common attributes</xs:documentation>

</xs:annotation>

<xs:complexContent>

<xs:extension base="S100:AbstractInformationType"/>

</xs:complexContent>

</xs:complexType>

<!-- none in the specification, abstract type retained for dataset structure -->

<!-- ============================================= -->

<!-- codelists -->

<!-- ============================================= -->

<!-- none in the specification -->

<!-- ============================================= -->

<!-- types and elements for the dataset definition -->

<!-- ============================================= -->

<xs:complexType name="DatasetType">

<xs:annotation>

<xs:documentation>Dataset element for dataset as "GML document"</xs:documentation>

</xs:annotation>

<xs:complexContent>

<xs:extension base="gml:AbstractFeatureType">

<xs:sequence>

<xs:element name="DatasetIdentificationInformation" type="S100:DataSetIdentificationType" minOccurs="0">

<xs:annotation>

<xs:documentation>Dataset identification information</xs:documentation>

</xs:annotation>

</xs:element>

<xs:element name="DatasetStructureInformation" type="S100:DataSetStructureInformationType" minOccurs="0">

<xs:annotation>

<xs:documentation>Dataset structure information</xs:documentation>

</xs:annotation>

</xs:element>

<xs:group ref="S100:Geometry" minOccurs="0" maxOccurs="unbounded">

<xs:annotation>

<xs:documentation>Allows spatial objects to be located outside feature objects (for references, and compatibility with ISO 8211 encoding)</xs:documentation>

</xs:annotation>

</xs:group>

<xs:choice minOccurs="0" maxOccurs="unbounded">

<xs:element name="imember" minOccurs="0" maxOccurs="unbounded" type="IMemberType">

<xs:annotation>

<xs:documentation>intended for S100 information types. Extension of GML practice, not addressed by ISO 19136.</xs:documentation>

</xs:annotation>

</xs:element>

<xs:element name="member" minOccurs="0" maxOccurs="unbounded" type="MemberType">

<xs:annotation>

<xs:documentation>intended for technical GML 3.2 requirement for making the dataset a "GML document" and clause 21.3 of the OGC GML standard</xs:documentation>

</xs:annotation>

</xs:element>

</xs:choice>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<!-- treatment of S-100 Information types is provisional, because GML does not have the concept, and they must be modeled as AbstractGML -->

<xs:complexType name="MemberType">

<xs:annotation>

<xs:documentation>dataset member</xs:documentation>

</xs:annotation>

<xs:complexContent>

<xs:extension base="gml:AbstractFeatureMemberType">

<xs:sequence>

<xs:element ref="gml:AbstractFeature"/>

</xs:sequence>

<xs:attributeGroup ref="gml:AssociationAttributeGroup"/>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<xs:complexType name="IMemberType">

<xs:annotation>

<xs:documentation>dataset member S-100 infotmation types</xs:documentation>

</xs:annotation>

<xs:complexContent>

<xs:extension base="gml:AbstractFeatureMemberType">

<xs:sequence>

<xs:element ref="InformationType"/>

</xs:sequence>

<xs:attributeGroup ref="gml:AssociationAttributeGroup"/>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<xs:complexType name="GenericFeatureType">

<xs:complexContent>

<xs:extension base="S100:AbstractFeatureType">

<xs:sequence>

<xs:any namespace="##local" minOccurs="0" maxOccurs="unbounded"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<xs:element name="DataSet" type="DatasetType"/>

</xs:schema>

1. Feature Catalogue

The FC (feature catalogue) is a document that describes the content of a data model which is an abstraction of reality that may be used to depict geographic datasets. The FC for S-129 describes the details of application schema in 4.2 of this Product Specification with GML and it is verified by the FCB (Feature Catalogue Builder) published by KOHA on behalf of IHO.

1 Catalogue header information

Name: Feature Catalogue for S-129

Scope: Dynamic under keel clearance management information

Field of Application: Under keel clearance management

Version Number:

Version date: 2018-10-19

Producer information:

Individual name:

Organisation name: International Hydrographic Organization

Position Name:

Contact Information:

Phone:

Address:

| **deliveryPoint** | **city** | **administrativeArea** | **postalCode** | **country** | **electronicMailAddress** |
| --- | --- | --- | --- | --- | --- |
| International Hydrographic Organization,  4 quai Antoine 1er,  B.P. 445 |  |  | MC 98011 MONACO CEDEX |  |  |

Online resource information:

Hours of Service:

Contact Instructions:

Role: user

Classification: unclassified

2 Definition Sources

No definition sources in catalogue.

3 Simple Attributes

3.1 Generation Time

Name: Generation Time

Definition:

Code: 'generationTime'

Remarks:

Aliases: (none)

Value Type: dateTime

3.2 Ship ID

Name: Vessel ID

Definition:

Code: 'vesselID'

Remarks:

Aliases: (none)

Value Type: text

3.3 Source Route Name

Name: Source Route Name

Definition:

Code: 'sourceRouteName'

Remarks:

Aliases: (none)

Value Type: text

3.4 Source Route Version

Name: Source Route Version

Definition:

Code: 'sourceRouteVersion'

Remarks:

Aliases: (none)

Value Type: text

3.5 Maximum Draught

Name: Maximum Draught

Definition:

Code: 'maximumDraught'

Remarks:

Aliases:

Value Type: real

3.6 Distance Above UKC Limit

Name: Distance Above UKC Limit

Definition:

Code: 'distanceAboveUKCLimit\_m'

Remarks:

Aliases:

Value Type: real

3.7 Scale Minimum

Name: Scale Minimum

Definition:

Code: 'scaleMinimum'

Remarks:

Aliases:

Value Type: integer

3.8 Expect Passing Time

Name: Expect Passing Time

Definition:

Code: 'expectPassingTime'

Remarks:

Aliases:

Value Type: dateTime

3.8 Expect Passing Speed

Name: Expect Passing Speed

Definition:

Code: 'expectPassingSpeed'

Remarks:

Aliases:

Value Type: real

4 Enumerations

4.1 UnderKeelClearance Purpose Type

Name: UnderKeelClearance Purpose Type

Definition:

Code: 'UnderKeelClearancePurposeType'

Remarks:

Aliases: (none)

Value Type:??

Listed Values

| **Label** | **Definition** | **Code** | **Remarks** |
| --- | --- | --- | --- |
| 'prePlan' Aliases: (none) | An indicative UKC plan that identifies potential sailing windows for a nominated ship draught, days, weeks or months prior to the planned passage through the UKCM region. | 1 |  |
| 'actualPlan' Aliases: (none) | A detailed UKC plan that identifies sailing windows and no-go areas, integrating live weather data, hours or days prior to transiting the UKCM region. | 2 |  |
| 'actualUpdate' Aliases: (none) | A near real-time, detailed, UKC plan that identifies sailing windows and no-go areas, using live weather, ship position and traffic data, while the ship is transiting the UKCM region. | 3 |  |

4.2 UnderKeelClearance Calculation Request

Name: UnderKeelClearance Calculation Request

Definition:

Code: 'UnderKeelClearanceCalculationRequest'

Remarks:

Aliases: (none)

Value Type:??

Listed Values

| **Label** | **Definition** | **Code** | **Remarks** |
| --- | --- | --- | --- |
| 'timeWindow' Aliases: (none) | The available time window(s) for a given draught. | 1 |  |
| 'maxDraught' Aliases: (none) | The maximum draught for a given time window. | 2 |  |

5 Complex Attributes

5.1 Fixed Time Range

Name: Fixed Time Range

Definition:

Code: 'fixedTimeRange'

Remarks:

Aliases: (none)

Sub-Attributes

| **Sub-attribute** | **Type** | **Mult.** | **Permitted Values** | **sequential** |
| --- | --- | --- | --- | --- |
| timeStart | dateTime |  |  | false |
| timeEnd | dateTime |  |  | false |

6 Roles

6.1 Component of

Name: Component of

Definition: A pointer to the aggregate in a whole-part relationship.

Code: 'componentOf'

Remarks: Definition may need to be discussed with S-101 team and GI registry manager

Aliases: (none)

6.2 Consists of

Name: Consists of

Definition: A pointer to a part in a whole-part relationship

Code: 'consistsOf'

Remarks: Definition may need to be discussed with S-101 team and GI registry manager

Aliases: (none)

7 Feature Types

7.1 UnderKeelClearancePlan

Name: UnderKeelClearancePlan

Abstract type: true

Definition: This feature is MetaFeature of UKCM information

Code: 'UKCP'

Remarks:

Aliases: (none)

Supertype: MetaFeatureType

Feature use type: meta

Permitted primitives: noGeometry

Attribute Bindings

| **Attribute** | **Type** | **Mult.** | **Permitted Values** | **Sequential** |
| --- | --- | --- | --- | --- |
| generationTime | Simple |  |  | false |
| vesselID | Simple |  |  | false |
| sourceRouteName | Simple |  |  | false |
| sourceRouteVersion | Simple |  |  | false |
| maximumDraught | Simple |  |  | false |
| UnderKeelClearancePurposeType | Enumeration |  | 1 : prePlan  2 : actualPlan  3 : actualUpdate | false |
| UnderKeelClearanceCalculationRequested | Enumeration |  | 1 : timeWindow  2 : maxDraught | false |
| fixedTimeRange | Complex |  |  | false |

7.2 UnderKeelClearanceNonNavigableArea

Name: UnderKeelClearanceNonNavigableArea

Abstract type: false

Definition: Non Navigation Area.

Code: 'UnderKeelClearanceNonNavigableArea'

Remarks:

Aliases: (none)

Supertype: FeatureType

Feature use type: geographic

Permitted primitives: surface

Attribute Bindings

| **Attribute** | **Type** | **Mult.** | **Permitted Values** | **Sequential** |
| --- | --- | --- | --- | --- |
| scaleMinimum | Simple |  |  | false |

7.3 UnderKeelClearanceAlmostNavigableArea

Name: UnderKeelClearanceAlmostNavigableArea

Abstract type: false

Definition: Almost Navigable Area.

Code: 'UnderKeelClearanceAlmostNavigableArea'

Remarks:

Aliases: (none)

Supertype: FeatureType

Feature use type: geographic

Permitted primitives: surface

Attribute Bindings

| **Attribute** | **Type** | **Mult.** | **Permitted Values** | **Sequential** |
| --- | --- | --- | --- | --- |
| scaleMinimum | Simple |  |  | false |
| distanceAboveUKCLimit\_m | Simple |  |  | false |

7.4 UnderKeelClearanceControlPoint

Name: UnderKeelClearanceControlPoint

Abstract type: false

Definition: UnderKeelClearance ControlPoint

Code: 'UnderKeelClearanceControlPoint'

Remarks:

Aliases: (none)

Supertype: FeatureType

Feature use type: geographic

Permitted primitives: point

Attribute Bindings

| **Attribute** | **Type** | **Mult.** | **Permitted Values** | **Sequential** |
| --- | --- | --- | --- | --- |
| name | Simple | 0..1 |  | false |
| distanceAboveUKCLimit\_m | Simple | 0..1 |  | false |
| expectedPassingTime | Simple | 0..1 |  | false |
| expectedPassingSpeed | Simple | 0..1 |  | false |
| fixedTimeRange | Complex | 0..1 |  | false |

1. Portrayal Catalogue

The PC provides those portrayal functions for S-129 UKCM with GML as a machine readable form to display the features of data model. This PC is verified by the PCB (Portrayal Catalogue Builder) published by KOHA on behalf of IHO.

1 Catalogue header information

Name: Portrayal Catalogue for S-129

Scope: Dynamic under keel clearance management information

Field of Application: Under keel clearance management

Version Number:

Version date: 2018-10-19

Producer information:

Individual name:

Organisation name: International Hydrographic Organization

Position Name:

Contact Information:

Phone:  
Address:

| **deliveryPoint** | **city** | **administrativeArea** | **postalCode** | **country** | **electronicMailAddress** |
| --- | --- | --- | --- | --- | --- |
| International Hydrographic Organization, 4 quai Antoine 1er,  B.P. 445 |  |  | MC 98011 MONACO CEDEX |  |  |

Online resource information:

Hours of Service:

Contact Instructions:

Role: user

Classification: unclassified

2 Definition Sources

No definition sources in catalogue.

3 Color Profiles

3.1 UKC color profile

Name: UKC color profile

Description: Color profile for UKC information

ID: UKCColorProfile

Language: en (English)

Remarks:

File Name: colorProfile.xml

File Type: ColorProfile

File Format: XML

4 Symbols

4.1 Control Point

Name: Control Point

Description: Control Point in UKC

ID: CP

Language: en (English)

Remarks:

File Name: CP.svg

File Type: Symbol

File Format: SVG

5 Line styles

5.1 Route

Name: Route

Description:

ID: ROUTERemarks:

File Name: ROUTE.xml

File Type: LineStyle

File Format: XML

6 Area Fills

6.1 Almost Navigable Area

Name: Almost Navigable Area

Description:

ID: ANARemarks

File Name: ANA.xml

File Type: AreaFill

File Format: XML

6.2 Non Navigable Area

Name: Non Navigable Area

Description:

ID: ANA

Remarks:

File Name: NNA.xml

File Type: AreaFill

File Format: XML

7 Fonts

(No description)

8 Viewing Group

(No description)

9 Rules

9.1 Main rule set

Name: Main rule set

Description:

ID: main

Remarks:

File Name: main.xsl

File Type: Rule

File Format: XSLT

Rule Type: TopLevelTemplate

9.2 Control Point

Name: Control Point

Description:

ID: controlpoint

Remarks:

File Name: ControlPoint.xsl

File Type: Rule

File Format: XSLT

Rule Type: SubTemplate

9.3 Information Box

Name: Information Box

Description:

ID: InformationBox

Remarks:

File Name: InformationBox.xsl

File Type: Rule

File Format: XSLT

Rule Type: SubTemplate

9.4 Almost Navigable Area

Name: Almost Navigable Area

Description:

ID: AlmostNavigableArea

Remarks:

File Name: AlmostNavigableArea.xsl

File Type: Rule

File Format: XSLT

Rule Type: SubTemplate

9.5 Non Navigable Area

Name: Non Navigable Area

Description:

ID: NonNavigableArea

Remarks:

File Name: NonNavigableArea.xsl

File Type: Rule

File Format: XSLT

Rule Type: SubTemplate

1. Data Validation Checks

# References

IHO S-58 ENC VALIDATION CHECKS Edition 6.0.0 – 2016

# Abbreviations

PS – Product Specification

DCEG – Data Classification and Encoding Guide

# Production validation checks for S-129 Under Keel Clearance Management

The following checks are intended for production systems designed to produce S-129 UKCM datasets. The checks can be administered at any time during the production phase. All checks should be considered as warnings, even though more severe classifications are available, due to the status of the development and lack of experience with system use of S-129 datasets, it is considered premature to classify any checks as error or critical error at this time. All operators and spatial expressions are defined in Annex A.

## Check Classification

|  |  |  |
| --- | --- | --- |
| C | Critical Error | An error which would make an ENC unusable in ECDIS through not loading or causing an ECDIS to crash or presenting data which is unsafe for navigation. |
| E | Error | An error which may degrade the quality of the ENC through appearance or usability but which will not pose a significant danger when used to support navigation. |
| W | Warning | An error which may be duplication or an inconsistency which will not noticeably degrade the usability of an ENC in ECDIS. |

### Check application

|  |  |  |
| --- | --- | --- |
| B | Base | Apply check to new dataset, new edition, and post-update dataset (after updates have been applied to the base). |
| U | Update | Apply check to update datasets in isolation. |
| S | Post-update | Apply check only to a post-update dataset, i.e., subsequent to application of all available updates. |

Checks do not apply to dataset terminations or cancellations, except where the check description explicitly states it applies in case of a termination or cancellation.

## Checks relating to UKCM Product Specification

| **No** | **Check description** | **Check message** | **Check solution** | **Conformity to:** | **Apply to** |
| --- | --- | --- | --- | --- | --- |
| 100 | For each feature object where its geometry is not COVERED\_BY a DataCoverage. | Objects fall outside the coverage object. | Ensure objects are not outside of the limits of the cell. | PS 15.4 | B |
| 101 | If the cell file size is greater than XX Megabytes. | The cell is larger than XXMb in size. | Ensure that the cell is not larger than XXMb. | PS 14.2.2 | B |
| 102 | If DataCoverage meta object(s) do not exist within the data set. | Mandatory feature object(s) are missing. | Include mandatory meta feature object(s) DataCoverage. | PS 15.4 | B |
| 103 | If any mandatory attributes are not Present. | Mandatory attributes are not encoded. | Populate mandatory attributes. | DCEG and PS 13.5 | B |
| 104 | If any mandatory attributes are present but the attribute value is unknown. | Mandatory attributes are encoded, but attribute value is unknown. | The reason for omission must be given by populating a GML nilReason attribute. | PS 13.5 | B |
| 105 | For each feature object with an attribute of type Float or Integer where the value contains zeroes before the first numerical digit or after the last numerical digit. | Values have been padded with non-significant zeroes. E.g. For a signal period of 2.5 sec, the value of SIGPER must be 2.5 and not 02.500. | Remove non-significant zeroes. | PS 13.2 | B |
| 106 | For each feature object with an attribute value identical to a corresponding attribute of a meta object it is COVERED\_BY. | An attribute value of a meta object is duplicated on a geo object. | Remove duplicate value from geo object. | Logical consistency | B |
| 107 | For each association between features instances, features instances and information instances, and between information instances that is not defined in the feature catalogue. | Wrong association used. | Use correct association type. | Logical consistency | B |
| 108 | For each role name on associations that is not defined in the feature catalogue. | Wrong role used. | Use correct role name. | Logical consistency | B |
| 109 | For each association that is not defined in the feature catalogue. | Unknown association is used. | Use association that is defined in the feature catalogue. | Logical consistency | B |
| 110 | For each role name that is not defined in the feature catalogue. | Unknown role name is used. | Use role name that is defined in the feature catalogue. | Logical consistency | B |
| 111 | For each association ensure associated classes are only those permitted by the feature catalogue. | Class is associated in an illegal association. | Ensure correct association is used between classes. | Logical consistency | B |
| 112 | For each role name ensure it is only used with permitted associations. | Role name is used on an illegal association. | Ensure correct role names are used on the association. | Logical consistency | B |
| 113 | Ensure dataset conformance to the GML schema. | Dataset does not conform to the GML schema | Ensure conformance to the GML schema | PS 13 | B |
| 114 | Ensure all text fields are encoded using UTF-8 | Illegal character set used. | Change character encoding to UTF-8. | PS 13 | B |
| 115 | If the horizontalDatum Reference and Value attributes of DataSetDiscoveryMetadata are Not equal to 2 (WGS 84). | horizontalDatum is not EPSG 4326. | Set the horizontalDatum reference and value attributes to EPSG 4326. | PS 15.4 | B |
| 116 | If the file names in an exchange set are not in accordance with the Product Specification. | File names are not in accordance with the Product Specification. | Amend file names. | PS 14.2.3 | B |
| 117 | For each feature instance that does not OVERLAP OR is WITHIN an area of dataCoverage | Object outside area of coverage. | Remove object or amend coverage. | PS 15.4 | B |
| 118 | For each feature instance, which does not have a valid feature class label/code as defined by the feature catalogue. | Object has invalid feature class code. | Amend object class code. | Logical consistency | B |
| 119 | For each attribute, which does not have a valid attribute label/code as defined by the feature catalogue. | Attribute has invalid attribute label/code. | Amend attribute label/code. | Logical consistency | B |
| 120 | For each feature object, which contains attributes outside the list of permissible attributes for the feature class (as defined in the feature catalogue). | Attribute not permitted on feature class. | Remove attribute. | Logical consistency | B |
| 121 | If the order of the data in a dataset is not correct. | Incorrect data order. | Amend data order. | PS 13.6.1 | B |
| 122 | For each attribute instance where the total number of instances exceed the permitted number of instances. | Too many instances of attribute. | Ensure correct attribute encoding. | Logical consistency | B |
| 123 | For each feature instance of type FixedTimeRange where timeStart is encoded later than timeEnd. | Feature has timeStart encoded later than timeEnd. | Ensure values of FixedTimeRange subattributes timeEnd and timeStart are logical. | Logical consistency | B |  |
| 124 | For each feature instance where FixedTimeRange subattribute timeStart is notNull AND timeEnd is Null OR not Present. | Feature has timeStart without a value of timeEnd. | Populate timeEnd or remove timeStart. | Logical consistency | B |  |
| 125 | For each feature instance where FixedTimeRange subattribute timeEND is notNull AND timeStart is Null OR not Present. | Object has timeEnd without a value of timeStart. | Populate timeStart or remove timeEnd. | Logical consistency | B |  |
| 126 | For each instance of a file referenced in the data, and it not present in the exchange set. | File referenced in the dataset is not present in the exchange set. | Add file to exchange set or remove reference to file. | PS 14.3 | B |  |
| 127 | For each instance of a dataset, present in the exchange set and that does not have dataset discovery metadata. | Dataset discovery metadata is missing for dataset. | Add dataset discovery metadata. | PS 15.4 | B |  |
| 128 | For each instance of a support file, present in the exchange set and that does not have support file discovery metadata. | Support file discovery metadata is missing for support file. | Support file discovery metadata. | PS 15.5 | B |  |
| 129 | For each file referenced by the catalogue file in the exchange set, and not present in the exchange set. | File is missing from exchange set. | Add file to exchange set or remove reference to file. | PS 15.6 | B |  |
| 130 | For each dataset discovery metadata file that does not correspond to the dataset discovery metadata content table. | Dataset discovery metadata file that does not correspond to the dataset discovery metadata content table. | Ensure correct encoding of the discovery metadata file. | PS 15.4 | B |  |
| 131 | For each support file discovery metadata file, does not correspond to the support file discovery metadata content table. | Support file discovery metadata file, does not correspond to the support file discovery metadata content table. | Ensure correct encoding of the support file metadata file. | PS 15.5 | B |  |
| 132 | For each cancellation (termination) of a dataset that does not exist on the system or has already been cancelled. | Terminated dataset is not present. | Ignore the update. |  | B |  |
| 133 | For each cancellation (termination) of a dataset where the update exchange set contains a corresponding dataset file. | Cancellations cannot contain data objects. | Remove the dataset file from the exchange set or correct the metadata. | Logical consistency | B |  |
| 134 | For the Date Time attributes generationTime, expectedPassingTime, Timestart and TimeEnd where encoding is not according to format. | Attributes are not encoded according to attribute type format. | Encode according to attribute type format. | PS 5.2.3 and 8.3 | B |  |
| 135 | If any optional attributes are present but the attribute value is unknown or missing. | Optional attributes are encoded, but attribute value is unknown or missing. | Remove optional attributes when value is unknown or missing. | PS 13.5 | B |  |
| 136 | For optional attributes present where attribute value is unknown or missing and a GML nilReason attribute is created. | Optional attributes where attribute value is unknown or missing must not be "nilled". | Remove optional attributes and the GML nilReason attribute. | PS 13.5 | B |  |
| 137 | For each feature record where the name is not unique WITHIN the dataset. | Duplicate gml:id exist within the dataset. | Ensure that no duplicate gml:id exist. | PS 13.7 | B |  |
| 138 | For an exchange set where the catalogue file is not named CATALOG.XML | Catalogue file is not named correctly | Rename the catalogue file to CATALOG.XML | PS14.1.1 | B |  |
| 139 | For datasets not named according to dataset file naming convention. | Dataset file name is not according to file naming convention. | Rename according to naming convention. | PS 14.2.3 | B |  |
| 140 | For support files not named according to support file naming convention. | Support file name is not according to file naming convention. | Rename according to naming convention. | PS 14.3.1 | B |  |
| 141 | If the file names in an exchange set are not in accordance with the Product Specification. | File names are not in accordance with the Product Specification. | Amend file names. | PS 14.2.3 and 14.3.1 | B |  |
| 142 | For each feature instance which is not COVERED\_BY the combined coverage of QualityOfNonbathymetricData meta feature instance. | Feature instance not covered by an QualityOfNonbathymetricData instance. | Ensure full coverage of QualityOfNonbathymetricData instance. | PS 13.10 | B |  |
| 143 | For each feature instance, which CROSS the 180° meridian. | Data crossing the 180° meridian | Split the dataset along the 180° meridian. |  | B |  |
| 144 | For each UnderKeelClearancePlan without any UnderKeelClearanceControlPoint associated with it. | An UnderKeelClearancePlan must consist of minimum 1 UnderKeelClearanceControlPoint association. | Associate UnderKeelClearancePlan with UnderKeelClearanceControlPoint association. | PS 4.3 and 4.3.2 and Logical consistency | B |  |

1. Geometry

# Introduction

## ISO 19125-1:2004 geometry.

This section defines ISO 19125-2004 geometric terms used in this Annex.

### Definitions for ISO 19125-1:2004 geometry

These definitions are for the primitives defined by ISO 19125-1:2004 which are single point, single Line and single area geometry objects:

* *Polygon – A Polygon has a geometric dimension of 2. It consists of a boundary and it’s interior, not just a boundary on its own. It is a simple planar surface defined by 1 exterior boundary and 0 or more interior boundaries. The geometry used by an S-57 Area feature is equivalent to a Polygon.*
* *Polygon boundary – A Polygon boundary has a geometric dimension of 1 and is equivalent to the outer and inner rings used by an S-57 Area feature.*
* *LineString – A LineString is a Curve with linear interpolation between Points. A LineString has a geometric dimension of 1. It is composed of one or more segments – each segment is defined by a pair of points. The geometry used by an S-57 Line feature is equivalent to a LineString.*
* *Line - An ISO 19125-1:2004 line is a LineString with exactly 2 points. Note that the geometry used by an S-57 Line feature is equivalent to a LineString, not a line in ISO 19125-1:2004 terms. In this document the term Line refers to an S-57 Line feature or a LineString which can have more than two points.*
* *Point* – Points have a geometric dimension of 0. The geometry used by an S-57 Point feature is equivalent to an ISO 19125-1:2004 point.

*Reciprocal – inversely related or opposite*

The following table matches 19125-1:2004 geometric terms to S-57 terms:

|  |  |
| --- | --- |
| **ISO 19125-1:2004** | S-57 |
| Polygon | Area feature geometry OR Area |
| Polygon boundary | outer and inner rings |
| LineString | Line feature geometry OR Line |
| Point | Point feature geometry OR Point |

### Definition of symbols used in ISO 19125-1:2004

I = interior of a geometric object

E = exterior of a geometric object

B = boundary of a geometric object

∩ = the set theoretic intersection

U = the set theoretic union

∧ = AND

Ú = OR

≠ = not equal

 = the empty or null set

**a** = first geometry, interior and boundary (the topological definition)

**b** = second geometry, interior and boundary (the topological definition)

dim = geometric dimension – 2 for Polygons , 1 for LineStrings and 0 for Points

Dim(x) returns the maximum dimension (-1, 0, 1, or 2) of the geometric objects in x, with a numeric value of -1 corresponding to dim (Æ).

Note:

* Neither interior nor exterior include the boundary (i.e. I, E and B are mutually exclusive).
* The boundary of a Polygon includes its set of outer and inner rings.
* The boundary of a LineString is its end points except for a closed LineString, which has no boundary; the rest of the LineString is its interior.
* A Point does not have a boundary.

## ISO 19125-1:2004 geometric operator relationships

In ISO 19125-1:2004 (see Reference [1]), the dimensionally extended nine-intersection model (DE-9IM) defines 5 mutually exclusive geometric relationships between two objects (Polygons, LineStrings and/or Points). One and only one relationship will be true for any two given objects (see Reference [2]):

1. WITHIN

2. CROSSES

3. TOUCHES

4. DISJOINT

5. OVERLAPS

There are others that help further define the relationship:

1. CONTAINS

* the reciprocal of WITHIN
* Within is the primary operator; however, if **a** is not within **b** then **a** may contain **b** so CONTAINS may be the unique relationship between the objects.

2. EQUAL

* a special case of WITHIN / CONTAINS.

3. INTERSECTS

* reciprocal of DISJOINT
* have at least one point in common

4. COVERS and is COVERED\_BY

* reciprocal operators
* extends CONTAINS and WITHIN respectively

5. COINCIDENT

Note that COVERS, COVERED\_BY and COINCIDENT relational operators are not described in the ISO 19125-1:2004 document.

The formulas given in this annex (e.g. a.Disjoint(b) a b *=* ) are the generalized ones given for ISO 19125-1, not the more specific DE-9IM formulas (i.e. DE-9IM predicates). The generalized formulas use topologically closed notation (i.e. geometry includes the interior and boundary unless otherwise stated), whereas the DE-91M formulas refer to the interior and boundary of geometry separately. Note that different versions of documents describing 19125-1 give different generalized formulas – this annex is using the formulas that are the most consistent with the DE-9IM predicates. If a generalized formula appears to contradict a DE-9IM predicate as defined in ISO 19125-1:2004, the DE-9IM predicate takes precedence. Software is expected to be consistent with DE-9IM predicates.

## How the relationships apply to S-57 Features

Geometric relationships will be tested on an entire S-57 feature object as a single geometric entity. Note that S-57 Point, Line and Area feature geometry is equivalent in ISO 19125-1:2004 terms to Point, LineString and Polygon geometry respectively.

A Line feature in S-57 may be made up of several individual edges. The geometric relationship operators used with a Line feature will consider the sequence of edges as a single geometry (LineString).

A test on an Area feature will operate on the entire Polygon.

In an S-57 file a Line or Area feature may be split into pieces as a result of a cutting operation from a data source. In that case each feature record in the dataset is treated as a separate LineString or Polygon when testing geometric relationships.

If a test intends to operate only on a feature’s specific components – Polygon boundary (all rings), Polygon outer ring, Polygon inner rings, edges, vertexes or nodes then it must make this explicit in the description of the test. When a specific linear portion is specified in a test (Polygon boundary, edge) then it is treated as a LineString while individual vertexes or points will be treated as points.

For example a test to look for cases where object class A OVERLAPS object class B would operate on the entire geometry. While a test to see if boundary of Area object class A OVERLAPS an edge of Line class B will be comparing Area boundaries to edges using Line to Line comparisons.

# Geometric Operator Definitions

ISO 19125-1 definitions referenced in this section, refer to section 6.1.14.3 entitled “Named spatial relationship predicates based on the DE-9IM” in the ISO 19125-1:2004 document.

In the diagrams within this annex LineString corresponds to the S-57 Line geometric primitive.

**EQUALS –** Geometric object **a** is spatially equal to geometric object **b**.

*The two geometric objects are the same. This is a special case of WITHIN.*



**Examples of the EQUALS relationship**Note: ISO 19107:2003 describes equality more formally as:

Two different GM\_Objects are equal if they return the same Boolean value for the operation GM\_Object::contains for every tested DirectPosition within the valid range of the coordinate reference system associated to the object.

NOTE - Since an infinite set of direct positions cannot be tested, the internal implementation of equal must test for equivalence between two, possibly quite different, representations. This test may be limited to the resolution of the coordinate system or the accuracy of the data. Application schemas may define a tolerance that returns true if the two GM\_Objects have the same dimension and each direct position in this GM\_Object is within a tolerance distance of a direct position in the passed GM\_Object and vice versa.

For the purposes of S-58, a GM\_Object is any spatial object as described in A.1.1 (Polygons, LineStrings, and Points). A spatial object is always equal to itself, i.e., **a** EQUALS **a** is always true.

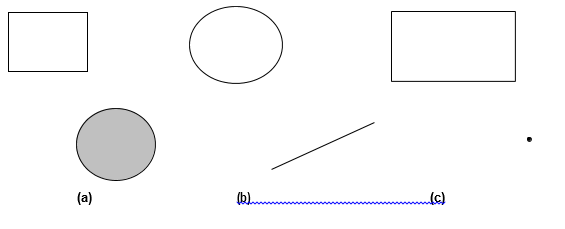
**DISJOINT –**  Geometric object **a** and geometric object **b** do not intersect.

*The two geometric objects have no common points.*

The ISO 19125-1 definition of DISJOINT is:

***a****.Disjoint(****b****)* ***a******b*** *=* 

This translates to: **a** is disjoint from **b** if the intersection of **a** and **b** is the empty set.



**Examples of the DISJOINT relationship**

**TOUCHES –** Geometric object **a** intersects with geometric object **b** but they do not share interior points.

*Only the boundary of one geometry intersects with the boundary or interior of another geometry.*

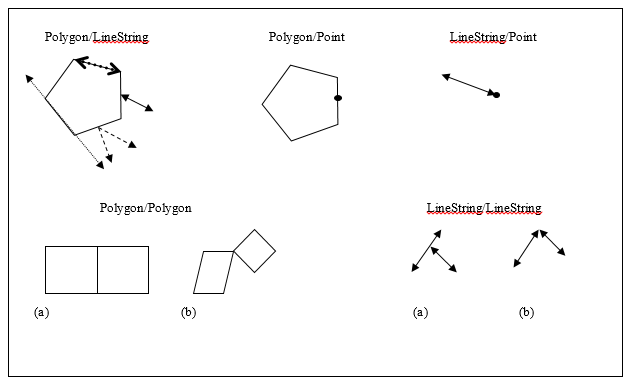
*The only thing the geometric objects have in common is contained in the union of their boundaries.*

The ISO 19125-1 definition of TOUCHES is:

***a****.Touch(****b****)* *(I(****a****)**I(****b****) =* *)* *(****a******b****)* 

This translates to: **a** touches **b** if the intersection of the interior of **a** and the interior of **b** is the empty set AND the intersection of **a** and **b** is not the empty set.

Note: This operator applies to the Area/Area, Line/Line, Line/Area, Point/Area and Point/Line relationships. It does not apply to a Point/Point relationship since points do not have a boundary.



**Examples of the TOUCHES relationship.**

*Note the Polygon touches Polygon example (a) is also a case where the Polygon boundaries are COINCIDENT. In the Polygon/LineString example two of the LineStrings that share a linear portion of the Polygon boundary are also COINCIDENT with the Polygon boundary.*

**WITHIN** – Geometric object **a** is completely contained in geometric object **b**.

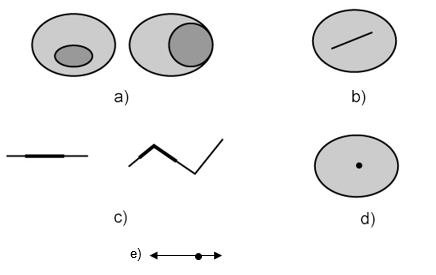
*WITHIN includes EQUALS.*

The definition of WITHIN is:

**a**. Within(**b**) ⇔ (**a** ∩ **b** = **a**) ∧ (I(**a**) ∩ I(**b**) ≠ )

This translates to: **a** is within **b** if the intersection of **a** and **b** equals **a** AND the intersection of the interior of **a** and the interior of **b** is not the empty set.

Note that this formula matches the one given in **the OpenGIS Simple Features Specification for SQL, Revision 1.1 (OpenGIS Project Document 99-049, Release Date: May 5, 1999**) which is the precursor to ISO 19125-1.



**Examples of the WITHIN relationship — Polygon/Polygon (a), Polygon/LineString (b), LineString/LineString (c), Polygon/Point (d), and LineString/Point (e)**

*Note that a Line that completely falls on a Polygon boundary is not WITHIN the Polygon, it TOUCHES it. In that case it would also be COINCIDENT with the Polygon boundary and COVERED\_BY the Polygon.*

**OVERLAPS -** The intersection of two geometric objects with the same dimension results in an object of the same dimension but is different from both of them.

*For two Polygons or two LineStrings, part of each geometry, but not all, is shared with the other.*

The OVERLAPS relationship is defined for Area/Area and Line/Line relationships. Points are either equal or disjoint.

*Note that this does not include lines that cross.*

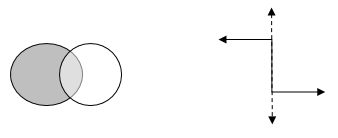
The ISO 19125-1 definition of OVERLAPS is:

***a****.Overlaps(****b****)* *(dim(I(****a****)) = dim(I(****b****)) = dim(I(****a****)* *I(****b****)))* *(****a******b******a****)* *(****a******b******b****)*

This translates to: **a** OVERLAPS **b** if the geometric dimension of:

1. the interior of **a**
2. the interior of **b**
3. the intersection of the interiors of **a** and **b**

are all equal AND the intersection of **a** and **b** does not equal either **a** or **b**.



**Examples of the OVERLAPS relationship**

Note Lines that OVERLAP are also COINCIDENT.

**CROSSES –** The intersection of geometric object **a** and geometric object **b** returns geometry with a dimension less than the largest dimension between **a** and **b** but is not the same as geometric object **a** or **b**.

*Two LineStrings cross each other if they meet on an interior point. A LineString crosses a Polygon if the LineString is partly inside the Polygon and partly outside.*

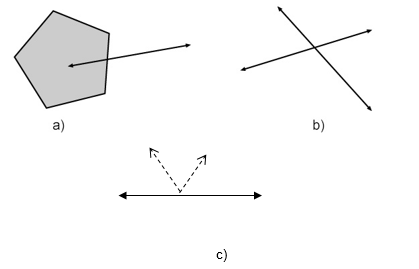
The definition of CROSSES is:

***a****.Cross(****b****)*  *(I(****a****)* *I(****b****)* *)*  *(dim(I(****a****)* *I(****b****)) < max(dim(I(****a****)), dim(I(****b****))))* *(****a******b******a*** *)* *(****a******b******b****)*

This translates to: **a** crosses **b** if the intersection of the interiors of **a** and **b** is not the empty set AND the dimension of the result of the intersection of the interiors of **a** and **b** is less than the largest dimension between the interiors of **a** and **b** AND the intersection of **a** and **b** does not equal either **a** or **b**.

Note that “*(I(****a****)* *I(****b****)* *)* “ was added to the beginning of the ISO 19125-1 formula so that it would not be true for disjoint geometry.

The CROSSES operator only applies Line/Line and Line/Area relationships.



**Examples of the CROSSES relationship**

*Note that example c) shows one solid line and one dashed line – their interiors intersect. If any Line were split into two separate Line features at the intersection point then the relationship would be TOUCHES because a boundary would be involved.*

**INTERSECTS** is the reciprocal of DISJOINT.

*The two geometric objects cross, overlap or touch, or one is within (or is contained by) the other. They have at least one common point.*

**CONTAINS** is the reciprocal of WITHIN.

*Given two geometric objects,* ***a*** *and* ***b****, if* ***a*** *is within* ***b*** *then* ***b*** *must contain* ***a****.*

**COVERED\_BY** (not a standard ISO 19125-1 operator)

No point of geometry **a** is outside geometry **b**.

The definition of COVERED\_BY is:

**a**. COVERED\_BY (**b**) ⇔ (**a** ∩ **b** = **a**)

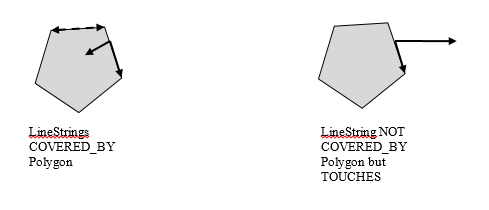
This translates to: **a** is COVERED\_BY **b** if the intersection of **a** and **b** equals **a**.

The following expressions are equivalent to **a** is COVERED\_BY **b**:

1. Polygon (**a**) is COVERED\_BY Polygon (**b**): Polygon **a** is WITHIN a polygon **b** (WITHIN includes EQUALS)
2. Point (**a**) is COVERED\_BY Polygon (**b**): Point **a** is WITHIN or TOUCHES polygon **b**
3. Line (**a**) is COVERED\_BY Polygon (**b**): Line **a** is WITHIN polygon **b** or WITHIN the boundary of Polygon **b**
4. Line (**a**) is COVERED\_BY Line (**b**): Line **a** is WITHIN Line **b** (WITHIN includes EQUALS)
5. Point (**a**) is COVERED\_BY Line (**b**): Point **a** is WITHIN or TOUCHES Line **b**
6. Point (**a**) is COVERED\_BY Poiint (**b**): Point **a** EQUALS Point **b**

*Note that the figure below on the left is an example of Lines that are COVERED\_BY a polygon.*

*The figure on the right is NOT an example of a Line that is covered by a Polygon – it is an example of a Line that TOUCHES a Polygon. In both cases the Lines are COINCIDENT with the Polygon boundary.*



**COVERS** (not a standard ISO 19125-1 operator)

COVERS is the reciprocal of COVERED\_BY.

*Given two geometric objects,* ***a*** *and* ***b****, if* ***a*** *is* COVERED\_BY ***b*** *then* ***b*** *must cover* ***a****.*

**COINCIDENT** (not an ISO 19125-1 operator)

Two geometric Lines OVERLAP or one geometric Line is WITHIN the other. Note that EQUAL Lines are also COINCIDENT by this definition.

*The intersection of two geometric Lines results in one or more Lines.*

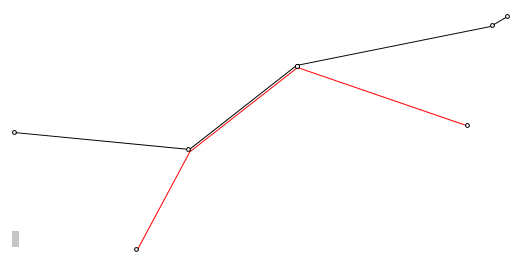
This operator is only to be used to compare a Line with another Line. Note that normally the boundary of a Polygon is not the same as a Line but for this operation the boundary of a Polygon, exterior and interior rings, is treated as Lines for the COINCIDENT test.

The following expressions are equivalent to **a** is COINCIDENT with **b**:

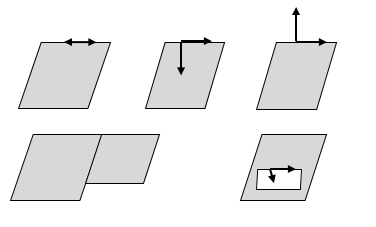
1. Polygon (**a**) is COINCIDENT with Polygon (**b**): The boundary of Polygon **a** OVERLAPS or is WITHIN the boundary of Polygon **b**.

2. Line (**a**) is COINCIDENT WITH Polygon (**b**) : Line **a** OVERLAPS or is WITHIN the boundary of Polygon **b**.

3. Line (**a**) is COINCIDENT WITH Line (**b**): Line **a** OVERLAPS or is WITHIN Line **b**



The case above is an example of two COINCIDENT geometric Lines.



Above are other examples of objects COINCIDENT with the boundary of a Polygon. LineStrings following a portion of a Polygon boundary or Polygons sharing a boundaryportion.

*Note that by definition a Line can be COINCIDENT with an interior boundary of a Polygon*.

*Note that other relationships may also be true such as COVERED\_BY or TOUCHES since COINCIDENT is not mutually exclusive.*

***Bibliography***

[1] ISO 19125-1:2004, *Geographic Information – Simple feature access – Part 1 Common architecture*

[2] CLEMENTINI, E., DI FELICE, P., VAN OOSTROM, P. *A Small Set of Formal Topological Relationships Suitable for End-User Interaction, in D. Abel and B. C. Ooi (Ed.), Advances in Spatial Databases* — Third International Symposium. SSD 1993. LNCS **692**, pp. 277-295. Springer Verlag. Singapore (1993)

[3] ISO 19107:2003, *Geographic information* *Spatial schema*

[4] OpenGIS Simple Features Specification for SQL, Revision 1.1*(OpenGIS Project Document 99-049, Release Date: May 5, 1999)*