S-129

Under Keel Clearance Management Product Specification

Edition 2.0.0 – December 2024

IHO

International Hydrographic Organization

Published by the
International Hydrographic Organization
4b quai Antoine 1er
Principauté de Monaco
Tel: (377) 93.10.81.00
Fax: (377) 93.10.81.40
info@iho.int
www.iho.in

© Copyright International Hydrographic Organization 2024

This work is copyright. Apart from any use permitted in accordance with the Berne Convention for the Protection of Literary and Artistic Works (1886), and except in the circumstances described below, no part may be translated, reproduced by any process, adapted, communicated or commercially exploited without prior written permission from the International Hydrographic Organization (IHO). Copyright in some of the material in this publication may be owned by another party and permission for the translation and/or reproduction of that material must be obtained from the owner.

This document or partial material from this document may be translated, reproduced or distributed for general information, on no more than a cost recovery basis. Copies may not be sold or distributed for profit or gain without prior written agreement of the IHO Secretariat and any other copyright holders.

In the event that this document or partial material from this document is reproduced, translated or distributed under the terms described above, the following statements are to be included:

"Material from IHO publication [reference to extract: Title, Edition] is reproduced with the permission of the IHO Secretariat (Permission No ……./…) acting for the International Hydrographic Organization (IHO), which does not accept responsibility for the correctness of the material as reproduced: in case of doubt, the IHO's authentic text shall prevail. The incorporation of material sourced from IHO shall not be construed as constituting an endorsement by IHO of this product."

"This [document/publication] is a translation of IHO [document/publication] [name]. The IHO has not checked this translation and therefore takes no responsibility for its accuracy. In case of doubt the source version of [name] in [language] should be consulted."

The IHO Logo or other identifiers shall not be used in any derived product without prior written permission from the IHO Secretariat.

Document Control

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 must conform to IHO Resolution 2/2007as amended.

Version Number	Date	Author	Purpose
0.1.0 draft		S-129 PT	Initial draft
0.2.0 draft	18 Sep 18	S-129 PT	S-129 PT Meeting 3 (Busan, Republic of Korea) – output draft
0.3.0 draft	29 Oct 18	S-129 PT	Post S-129 Meeting 3 with additional input from PT
0.4.0 draft	3 Dec 18	S-129 PT	For out of session review by other IHO working groups
0.5.0 draft	08 Feb 19	S-129 PT	For review by S-100WG and S-129 PT
0.5.1	26 Feb 19	S-129 PT	Updates made at S-100WG meeting 27-29 Feb 19
0.6.0	8 Mar 19	S-129 PT	Clean version post S-100WG meeting of 27-29 Feb 19 for final IHO Secretariat editorial makeover
1.0.0	Jun 2019	S-129 PT	First Edition for implementation and testing purposes
1.1.0	Nov 2023	S-129 PT	Revision based on 5th, 6th, and 7th S-129 PT meeting outcomes and PS validation in Tjeldsundet S-129 Operational Test. Other identified corrections also applied.
1.2.0	Jul 2024	S-129 PT	Revision based on changes in line with S-100 Edition 5.2.0, and clarified usage of S-421 for passage route information. Other corrections and updates.
1.3.0	Sep 2024	S-129 PT	Revision based on comments made to S-129 Edition 1.2.0
2.0.0	Oct 2024	S-129 PT	Changes based on comments made to S-129 Edition 1.3.0
2.0.0	Dec 2024	HSSC	First operational Edition.

Page intentionally left blank

Contents

Document Control ... iii
Summary of Substantive Changes ... vii
1 Overview ... 1
1.1 Introduction ... 1
1.2 Initial voyage planning to navigate through a UKCM Operational Area ... 1
1.3 Refined voyage planning to navigate through a UKCM Operational Area ... 1
1.4 Voyage monitoring ... 2
1.5 Alerts and Indications ... 3
2 References ... 3
2.1 Normative ... 3
3 Terms, Definitions and Abbreviations ... 4
3.1 Use of Language ... 4
3.2 Terms and Definitions ... 4
3.3 Abbreviations ... 6
4 Specification Description ... 6
4.1 S-129 General Data Product Description ... 6
4.2 Data Product Specification Metadata ... 7
4.3 IHO Product Specification Maintenance ... 8
5 Specification Scope ... 8
6 Dataset Identification ... 9
7 Data Content and Structure ... 9
7.1 Introduction ... 9
7.2 Application Schema ... 13
8 Feature Catalogue ... 22
8.1 Introduction ... 22
8.2 Feature Types ... 23
8.3 Units of measure ... 24
9 Dataset Types ... 24
10 Dataset Loading and Unloading ... 24
11 Geometry ... 25
12 Coordinate Reference Systems (CRS) ... 25
12.1 Introduction ... 25
12.2 Horizontal Reference System ... 25
12.3 Vertical Reference System ... 25
12.4 Temporal Reference System ... 25
13 Data Quality ... 26
13.1 Introduction ... 26
14 Data Capture and Classification ... 26
15 Maintenance ... 26
15.1 Maintenance and Update Frequency ... 26
15.2 Data Source ... 27
15.3 Production Process ... 27
16 Portrayal ... 27
17 Data Product Format (Encoding) ... 27
17.1 Encoding of Latitude and Longitude ... 27
17.2 Numeric Attribute Encoding ... 28
17.3 Text Attribute Values ... 28
17.4 Mandatory Attribute Values ... 28
17.5 Unknown Attribute Values ... 28
17.6 Structure of dataset files ... 28
17.7 Object identifiers ... 29
17.8 Dataset validation ... 29
17.9 Data overlap ... 29
17.10 Data quality ... 29
18 Data Product Delivery ... 29
18.1 Introduction ... 29
18.2 Dataset ... 31
18.3 Data Integrity ... 32

18.4 Support Files ..... **Error! Bookmark not defined.**
19 Metadata 32
19.1 Introduction 32
19.2 Use of S-421 to provide routes in UKC plans 33
19.3 Language 33
19.4 Dataset metadata 33
19.5 S100_ExchangeCatalogue 35
19.6 S100_DatasetDiscoveryMetadata 36
19.7 S100_SupportFileDiscoveryMetadata 41
19.8 S100_CatalogueDiscoveryMetadata 42
Annex A. Data Classification and Encoding Guide 45
A.1 UnderKeelClearancePlan 45
A.2 UnderKeelClearancePlanArea 46
A.3 UnderKeelClearanceNonNavigableArea 47
A.4 UnderKeelClearanceAlmostNonNavigableArea 48
A.5 UnderKeelClearanceControlPoint 49
A.6 Association Names 50
A.7 Association Roles 51
A.8 Attribute and Enumerate Descriptions 51
Annex B. Schema documentation for S129.xsd 57
B.1 Schema(s) 57
B.2 Complex Type(s) 57
B.3 Simple Type(s) 71
Annex C. Feature Catalogue 73
C.1 Catalogue header information 73
C.2 Definition Sources 74
C.3 Simple Attributes 75
C.4 Enumerations 80
C.5 Complex Attributes 82
C.6 Roles 83
C.7 Feature Types 85
Annex D. Portrayal Catalogue 89
D.1 Catalogue header information 89
D.2 Definition Sources 90
D.3 Color Profiles 91
D.4 Symbols 92
D.5 Line styles 94
D.6 Area Fills 95
D.7 Fonts 96
D.8 Viewing Group 97
D.9 Viewing Group Layer 98
D.10 Context 98
D.11 Rules 99
Annex E. Data Validation Checks 101
Annex F. Geometry 103
F.1 Introduction 103
F.2 Geometric Operator Definitions 105

Summary of Substantive Changes

Bold references in the Clauses Effected column indicate the principle sections/clauses that are impacted by the described change.

Change Summary	Clauses Affected

Page intentionally left blank

1 Overview

1.1 Introduction

The IHO's S-100 Working Group has prepared this document in response to a requirement to produce a dataset comprising Under Keel Clearance Management (UKCM) information that can be used as a Nautical Publication Information Overlay (NPIO) within an Electronic Chart Display and Information System (ECDIS). It is based on the IHO's S-100 framework specification and the ISO 19100 series of standards.

S-129 is a vector Product Specification intended for encoding the UKCM information products for navigational purposes. Use of UKCM products conformant to this specification is not limited to navigation systems.

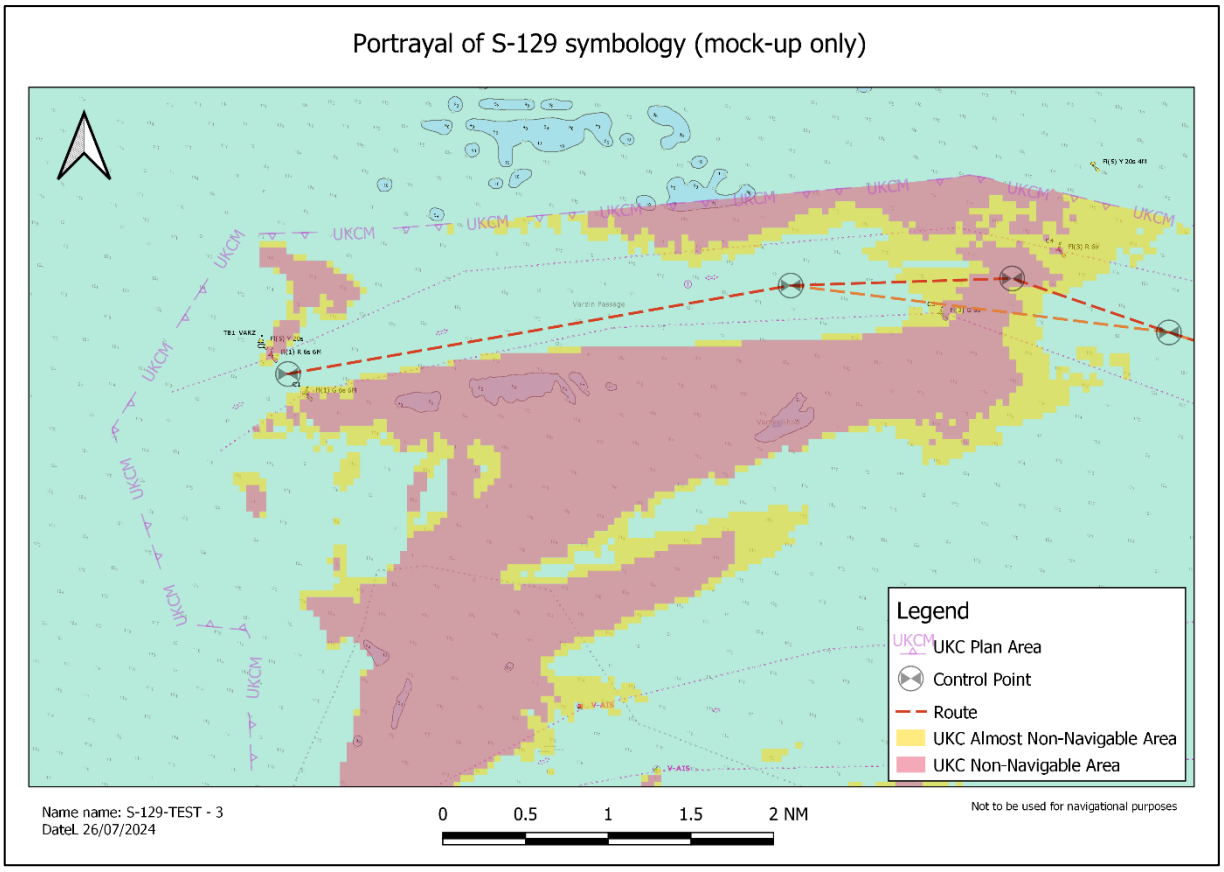


Figure 1-1 – Example of S-129 UKCM information depiction

A ship's master has an obligation under SOLAS regulation V/34 to plan their ship's voyage from berth to berth. This Product Specification enables UKCM information to be provided to users of a UKCM Service.

1.2 Initial voyage planning to navigate through a UKCM Operational Area

A ship planning its voyage needs to determine the time periods when there are suitable tidal conditions for it to transit a UKCM Operational Area. A UKCM Service Provider completes calculations based on a range of possible arrival times to determine a Pre-plan, which contains one or more time windows for a specified draught for a ship's master to choose from.

1.3 Refined voyage planning to navigate through a UKCM Operational Area

A ship's master selects a time window to transit through a UKCM Operational Area and advises the UKCM Service Provider. A ship also sends the UKCM Service Provider updated information about its

particulars (for example stability and draught information). The UKCM Service Provider uses specialized ship and waterway-specific modelling that includes predicted and observed environmental conditions (for example tide, wind, swell, tidal stream, etc.) to generate an Actual Plan for a ship.

An Actual Plan contains a route for the ship to take through the UKCM Operational Area and one or more control points. Control points are, in effect, waypoints and include time window information. An Actual Plan provides the ship with the necessary navigation information to safely pass through the UKCM Operational Area at a given time. The Actual Plan also includes any relevant non-navigable areas and almost non-navigable areas.

To facilitate logistics planning, the Actual 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. For example, it can be used to provide information that assists the ship's agent and relevant waterway authorities with making necessary bookings, such as for a pilot or for a berth.

As the ship nears the UKCM Operational Area, the UKCM Service Provider checks the prevailing environmental conditions within the UKCM Operational Area and confirms the validity of the Actual Plan. The Actual Plan may alter due to changes in predicted weather forecasts, heights of tide, or the ship's particulars. The Actual Plan might be cancelled through replacement (using an Actual Update) when changes are required. This checking process allows the ship to manage its speed to meet the required time window to execute the Actual Plan.

The Actual Update contains details of the earliest and latest times at which the ship can safely commence navigating shallow areas in the UKCM Operational Area while maintaining the required UKC (note that waterway authorities specify minimum UKC requirements for ships operating within a UKCM Operational Area). The Actual Update also includes any relevant non-navigable areas and almost non-navigable areas within the UKCM Operational Area.

1.4 Voyage monitoring

When the ship enters the UKCM Operational Area, the Actual Update can be displayed on the ship's navigation system. When a pilot is embarked, they will, generally, be using a Portable Pilot Unit (PPU) that also shows the ship's UKC plan (as this is also provided to the pilot by the UKCM Service Provider). Having the same information displayed on both the ship's navigation system and the pilot's PPU helps a ship's crew support the pilot navigating the ship through a UKCM Operational Area, while maintaining the required UKC.

The UKCM Service Provider receives transmitted ship AIS data which allows them to send Actual Update datasets that contain the updated UKC plan metadata, non-navigable areas, almost non-navigable areas, and, if necessary, new versions of the route and control points, based on the ship's speed and the current environmental conditions.

The ship's crew and the pilot (when embarked) 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 shown as almost non-navigable indicate to the ship's bridge team and the pilot (when embarked) the navigable areas that are close to becoming non-navigable at the time the ship would reach those locations.

If a Vessel Traffic Service (VTS) is in operation for the UKCM Operational Area, the VTS can monitor the ship's transit and support navigation in accordance with the Actual Plan and/or Actual Update, which it has been provided with.

In port settings, after the ship has completed its cargo operations, and if the ship's draught is such that the local area UKCM system must be used to exit the port, then the UKCM Service Provider would, similarly, be used to assist the ship's safe departure from the port through the UKCM Operational Area.

1.5 Alerts and Indications

The intent behind the inclusion of the S-129 product as an information layer within the IHO's S-100 framework is to enhance navigational awareness without introducing additional complexity or operational risks. S-129, which provides mariners with a depiction of UKC 'go' and no-go' areas for a given route and time, offers valuable situational data that complements other navigational products like S-101 and S-102/S-104. However, to ensure that this supplementary information does not inadvertently overload the user or cause unnecessary confusion, the S-129 layer is designed to be non-intrusive, providing visual information only, without triggering any alarms. This approach maintains a clear separation between crucial navigational alarms and non-essential data displays, ensuring that mariners can prioritize safety-critical alerts.

The decision not to have S-129 trigger any alarms is also based on the need to preserve the integrity and reliability of existing Electronic Chart Display and Information System (ECDIS) alarms generated via S-101 for ENC data and the combined alarms produced from bathymetric and water level information in S-102/S-104. If the S-129 layer were to issue alarms, it could interfere with or mask more critical alarms required for safe navigation, leading to potential navigational errors or delayed responses. Therefore, by providing S-129 as an information layer only, the system ensures a cleaner, more intuitive user experience without diminishing the operational importance of other safety-related ECDIS functions.

2 References

2.1 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 5.2.0 – June 2024
IHO S-101	IHO Electronic Navigational Chart (ENC) Product Specification
IHO S-102	IHO Bathymetric Surface Product Specification
IHO S-104	IHO Water Level Information for Surface Navigation Product Specification
IEC 63173-1	S-421 route plan based on S-100
IHO S-52	IHO Specifications for Chart Content and Display Aspects of ECDIS Edition 6.1.1 – October 2014 (with clarifications up to June 2015)
ISO 10646:2017	Information technology – Universal Coded Character Set (UCS) +Amd1 (2017) and Amd2 (2017)
ISO/IEC 15948	Information technology – Computer graphics and image processing – Portable Network Graphics (PNG): Functional specification
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 (GML)
ISO 19136-2:2015	Geographic information – Geography Markup Language (GML)
ISO/IEC 8211:1994	Information technology – Specification for a data descriptive file for information exchange
ISO 8601-1:2019	Date and time – Representation for information interchange – Part 1: Basic rules
ISO 8601-2:2019	Date and time – Representation for information interchange – Part 2: Extensions
ISO 639-2:1998	Codes for the representation of names of languages – Part 2: Alpha-3 code

3 Terms, Definitions and Abbreviations

3.1 Use of Language

Within this document:

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

3.2 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 where necessary.

Actual Plan

An Actual Plan is specific to a ship and a UKCM Operational Area for a waterway, and contains a route – defined by a set of geographical control points – with time windows for each control point, and non-navigable and almost non-navigable areas.

Actual Update

An Actual Update is a replacement Actual Plan.

Almost non-navigable area

An area within a UKCM Operational Area where UKC for a specific ship is calculated to be approaching the UKC limit for the waterway (within a specified value range).

Control Point

A geographical position denoting a point along a specific ship's route within a UKCM Operational Area where the ship must pass within a time range or time window (that is, start and end time) calculated by the UKCM Service Provider.

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

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

Coordinate Reference System
Coordinate system that is related to an object by a datum.

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

Feature
Abstraction of real-world phenomena.

NOTE 1: A feature may occur as a type or an instance. Feature type or feature instance should 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.

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

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

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

Navigation Surface
A 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.

Non-navigable Area
An area within a UKCM Operational Area where UKC for a specific ship is calculated to be less than the UKC limit for the waterway.

Pre-plan
A Pre-plan is a set of tidal windows available for which a ship can transit through a UKCM Operational Area at a specified draught while satisfying minimum UKC requirements.

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.

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

EXAMPLE: sea surface, river surface, lake surface.

UKC Plan
There are three kinds of UKC plans: a Pre-plan, an Actual Plan, and an Actual Update.

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 information and/or forecast information for a given time and waterway.

UKCM Service Provider
A UKCM Service Provider is an entity responsible for implementing, providing, and maintaining a UKCM Service. Its role involves producing and disseminating under keel clearance (UKC) information, which enhances navigational safety and efficiency within a designated port of waterway where a UKCM Operational Area has been established.

3.3 Abbreviations

This Product Specification makes use of the following abbreviations:

AIS Automatic Identification System

BAG Bathymetric Attributed Grid

ECDIS Electronic Chart Display and Information System

ENC Electronic Navigational 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

4 Specification Description

4.1 S-129 General Data Product Description

General data product information.

Title: UKCM Information Product Specification

Abstract: UKCM Services are generally used in conjunction with ENC (S-101) and route information for aiding ships in safe passage through shallow waters. S-421 Route Exchange Data Format, if available, is considered the preferred method for providing route information. This S-129 UKCM Product Specification details the information typically provided by a UKCM Service Provider.

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

Spatial Extent:

Description: Global coverage of maritime areas.

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

4.2 Data Product Specification Metadata

NOTE: This information uniquely identifies this Product Specification and provides information about its creation and maintenance. For further information on dataset metadata, see the metadata clause (Chapter 19 - Metadata).

Title: The International Hydrographic Organization Under Keel Clearance Management Product Specification

S-100 Version: 5.2.0

S-129 Version: 2.0.0

Date: December 2024

Language: English

Classification: Unclassified

Contact: International Hydrographic Organization,
4b quai Antoine 1er,
B.P. 445
MC 98011 MONACO CEDEX
Telephone: +377 93 10 81 00
Telefax: +377 93 10 81 40
Email: info@iho.int

URL: www.iho.int

Identifier: S-129

Maintenance: Changes to the Product Specification S-129 are coordinated by the IHO S-100 Working Group (S-100WG) and must be made available via the IHO web site. Maintenance of the Product Specification must conform to IHO Technical Resolution 2/2007, as amended.

4.3 IHO Product Specification Maintenance

4.3.1 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.

4.3.2 New Editions

New Editions introduce significant changes. *New Editions* enable new concepts, such as the ability to support new functions or applications, or the introduction of new constructs or data types. *New Editions* are likely to have a significant impact on either existing users or future users of S-129. All cumulative *revisions* and *clarifications* must be included with the release of approved New Editions.

4.3.3 Revisions

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

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

In most cases, a new feature or portrayal catalogue will result in a revision of this specification.

4.3.4 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 clarifications 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.

4.3.5 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**

5 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

6 Dataset Identification

This section describes how to identify datasets that conform to this Product Specification. An Under Keel Clearance Management dataset that conforms to this Product Specification uses the following general information for distinction:

Title: Under Keel Clearance Management

Abstract: The dataset 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 dataset. Under keel clearance management data includes vessel and voyage specific areas assessed as being navigationally safe or unsafe with regard to under keel clearance, and windows within which these assessments are valid, based upon observed and/or mathematically-predicted values. The frequency of dataset updates depends on the voyage and local conditions.

Acronym: UKCM

Geographic Description: EX_GeographicDescription: For example, official name of region

Spatial Resolution: MD_Resolution>equivalentScale.denominator (integer) or MD_Resolution>levelOfDetail (CharacterString). For example, “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

7 Data Content and Structure

7.1 Introduction

This section discusses:

- the application schema expressed in UML 2,0, shown in *Figure 7-2. S-129 Data Model*;
- the associated feature catalogue (included in Annex C);

- the dataset types, providing a full description of each feature type including its attributes, attribute values and relationships in the dataset;
- the geometry of each feature type, where applicable
- dataset loading and unloading; and

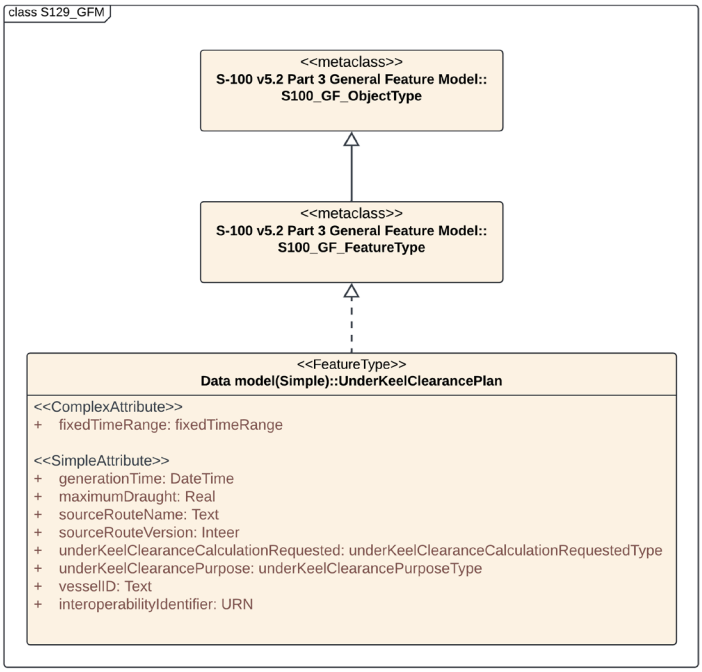


Figure 7-1 – Relationship between S-100 meta class and S-129 application schema

The S-129 features are based on the S-100 General Feature Model (GFM) and are a feature-based vector product. Figure 7-1 shows the relations between the S-129 Application Schema and the S-100 GFM.

All S-129 features are derived from the feature **UnderKeelClearancePlan** defined in the S-129 Application Schema and this **UnderKeelClearancePlan** realizes the GFM meta-classes **S100_GF_FeatureType**.

S-129 datasets are generally intended to be used with S-101 ENC, and optionally with S-102 (Bathymetric Surface), S-104 (Water Level Information for Surface Navigation), or S-111 (Surface Currents) datasets. S-101 provides the background information, while S-129 datasets provide additional information related specifically to UKCM. S-129 datasets are also intended to be used with S-421, if available, to provide passage route information. When S-421 datasets are unavailable, alternative methods, such as RTZ route plan exchange format, can be used to provide passage route information.

Dataset content will change over time during a ship's transit. Updating datasets is achieved by replacement. The attribute "underKeelClearancePurpose" captures the intended purpose of a dataset. The possible values are 'Pre-plan', 'Actual Plan' and 'Actual Update'.

7.1.1 Dataset purposes

7.1.1.1 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, for a specified draught, 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.

7.1.1.2 Actual Plan datasets

Actual Plan datasets are produced closer to the arrival/departure (for example, 24 hours 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.

7.1.1.3 Actual Update datasets

Actual Update datasets include more up-to-date information and may be required every five to ten minutes. These datasets include the route, the under keel clearance plan area, almost non-navigable areas, and non-navigable areas under the 'parent' UnderKeelClearancePlan feature. The dataset will be updated based on the latest weather conditions and, if available, actual ship position, heading and speed (for example as received by a UKCM Service Provider via a ship's transmitted AIS signal).

7.1.2 Dataset use cases

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 'underKeelClearancePurpose' attribute). The following 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/departure port or waterway, for a specified draught, days 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 a standard assumed route. In this scenario, the UKCM Service could return a single Pre-plan dataset, and generally no updates are required until closer to the time when the ship enters the UKCM Operational Area (for example, approximately 24 hrs prior to entry).

Closer to the time time of a ship entering the UKCM Operational Area (for example, 24 hours prior), the ship will need a more detailed UKC plan. This Actual 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, for example between 10 and 60 minutes.

Immediately before entering the UKCM Operational Area and whilst underway, the use case changes again to become the Actual Update. Throughout the Actual Plan phase, more up-to-date UKC information is required, provided more frequently than Actual Plan datasets (for example, 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 almost non-navigable areas, non-navigable 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 (for example as received in a UKCM Service via AIS). As a ship's transit is underway, and its actual position is updated, it is likely that the extent of the almost non-navigable and non-navigable areas need to be updated. The boundaries of the UKC plan area will also likely need to be updated to reflect areas no longer in scope of the UKC calculation (e.g. areas behind transiting vessel).

Page intentionally left blank

7.2 Application Schema

Figure 7-2 is the UML data model for the S-129.

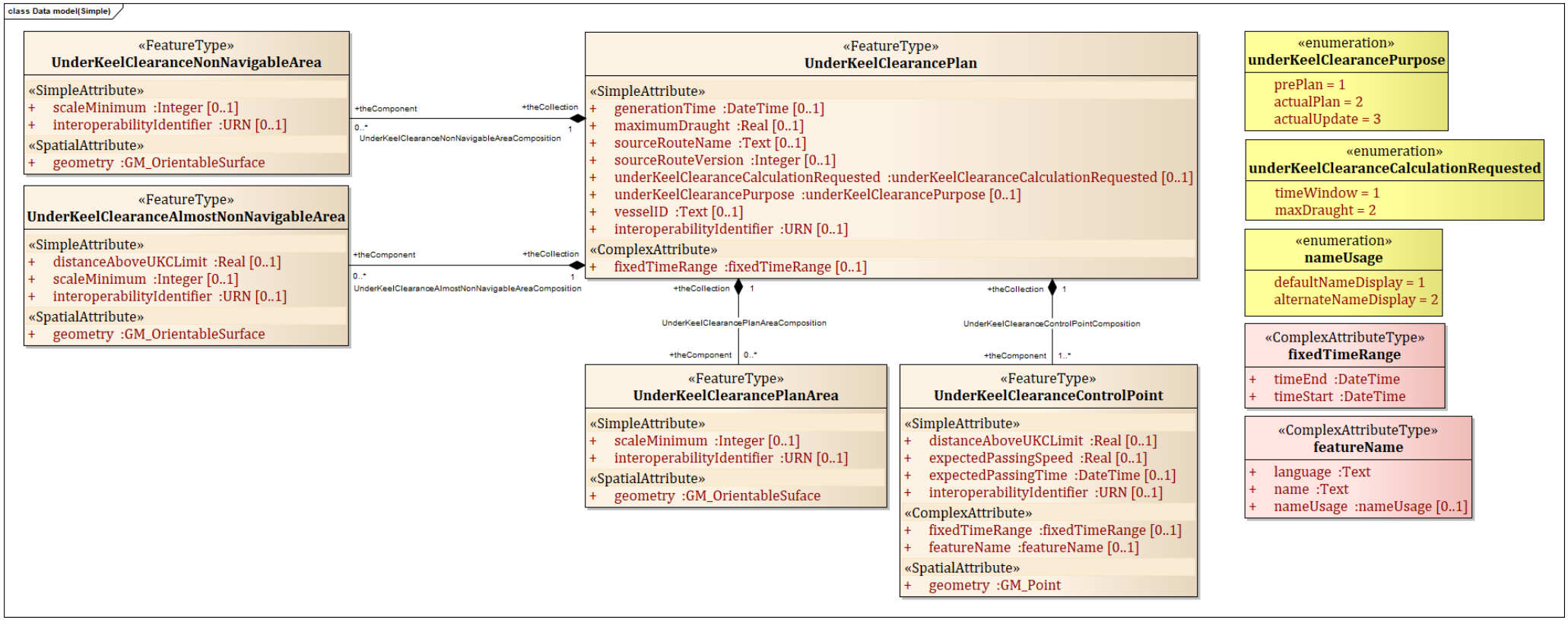


Figure 7-2. S-129 Data Model

7.2.1 Feature Types

7.2.1.1 UnderKeelClearancePlan

Role	Name	Description	Mult	dataType	Remarks
Class	UnderKeelClearancePlan	A UKC plan calculated for a particular vessel, for a particular passage		FeatureType	
SimpleAttribute	generationTime	Time the UKC plan was generated	[0..1]	DateTime	
SimpleAttribute	vesselID	Vessel identifier, based on MRN. Can be either IMO or MMSI based	[0..1]	Text	
SimpleAttribute	sourceRouteName	Identification of the route used as a source for the calculation	[0..1]	Text	May be provided through different methods, such as S-421, RTZ, or as generated by the UKCM Service. If provided, for example, using S-421, the value of "*S-421.Route.routeID*" is used for machine-readable identification, or the value of "*S-421.RouteInfo.routeInfoName*" is used for human-readable identification.
SimpleAttribute	sourceRouteVersion	Identification of the route used as a source for the calculation	[0..1]	Integer	May be provided through different methods, such as S-421, RTZ, or as generated by the UKCM Service. Can be used to supplement information provided by "*sourceRouteName*", especially if "*sourceRouteName*" provides insufficient route information. If provided, for example, using S-421, the value of "*S-421.Route.routeEditionNo*" is used.

Role	Name	Description	Mult	dataType	Remarks
SimpleAttribute	maximumDraught	The maximum vessel draught in metres, used as base for the calculation	[0..1]	Real	
SimpleAttribute	underKeelClearancePurpose	The relevant phase of a UKC passage plan.	[0..1]	underKeelClearancePurposeType	
SimpleAttribute	underKeelClearanceCalculationRequested	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.	[0..1]	underKeelClearanceCalculationRequestedType	
SimpleAttribute	interoperabilityIdentifier	A common unique identifier for entities which describe a single real-world feature, and which is used to identify instances of the feature in end-user systems where the feature may be included in multiple data product types.	[0..1]	URN	
ComplexAttribute	fixedTimeRange	Time period	[0..1]	fixedTimeRange	

7.2.1.2 UnderKeelClearancePlanArea

Role	Name	Description	Mult	dataType	Remarks
Class	UnderKeelClearancePlanArea	The area for which an under keel clearance plan has been calculated for a particular vessel, for a particular passage.		FeatureType	
SimpleAttribute	scaleMinimum	The minimum scale at which the feature may be used for example for ECDIS presentation.	[0..1]	Integer	
SimpleAttribute	interoperabilityIdentifier	A common unique identifier for entities which describe a single real-world feature, and which is used to identify instances of the feature in end-user systems where the feature may be included in multiple data product types.	[0..1]	URN	
SpatialAttribute	geometry	Geometric object comes from Geometry class in S-100 standard.	[1]	GM_OrientableSurface	Boundaries of the Under Keel Clearance Plan Area. The extents of the boundaries are likely to be updated in Actual Update datasets, to reflect areas no longer in scope of the UKC calculation. (Refer to Section 7.1.2).

7.2.1.3 UnderKeelClearanceNonNavigableArea

Role	Name	Description	Mult	dataType	Remarks
Class	UnderKeelClearanceNonNavigableArea	An area of under keel clearance less than the calculated safe limit		FeatureType	The area has a time-dependent dimension
SimpleAttribute	scaleMinimum	The minimum scale at which the feature may be used for example for ECDIS presentation.	[0..1]	Integer	
SimpleAttribute	interoperabilityIdentifier	A common unique identifier for entities which describe a single real-world feature, and which is used to identify instances of the feature in end-user systems where the feature may be included in multiple data product types.	[0..1]	URN	
SpatialAttribute	geometry	Geometric object come from Geometry class in S-100 standard	[1]	GM_OrientableSurface	Encompassed by UnderKeelClearancePlanArea

7.2.1.4 UnderKeelClearanceAlmostNonNavigableArea

Role	Name	Description	Mult	dataType	Remarks
Class	UnderKeelClearanceAlmostNonNavigableArea	An area of under keel clearance almost less than the calculated safe limit, as established for the waterway		FeatureType	The area has a time-dependent dimension
SimpleAttribute	distanceAboveUKCLimit	The distance of the lowest part of the ship's keel above the established Under Keel Clearance Limit for the waterway, expressed in metres.	[0..1]	Real	
SimpleAttribute	scaleMinimum	The minimum scale at which the feature may be used for example for ECDIS presentation.	[0..1]	Integer	
SimpleAttribute	interoperabilityIdentifier	A common unique identifier for entities which describe a single real-world feature, and which is used to identify instances of the feature in end-user systems where the feature may be included in multiple data product types.	[0..1]	URN	
SpatialAttribute	geometry	Geometric object come from Geometry class in S-100 standard	[1]	GM_OrientableSurface	Encompassed by UnderKeelClearancePlanArea

7.2.1.5 UnderKeelClearanceControlPoint

Role	Name	Description	Mult	Data Type	Remarks
Class	UnderKeelClearance ControlPoint	Especially selected critical passage point or line		FeatureType	
SimpleAttribute	distanceAboveUKCLimit	The distance of the lowest part of the ship's keel above the established Under Keel Clearance Limit for the waterway, expressed in metres.	[0..1]	Real	
ComplexAttribute	featureName	Provides the name of an entity, defines the national language of the name, and provides the option to display the name at various system display settings.	[0..1]	featureName	
SimpleAttribute	expectedPassingSpeed	The expected passing speed for a ship for a nominated Under Keel Clearance Control Point.	[0..1]	Real	
SimpleAttribute	expectedPassingTime	The expected passing time for a ship for a nominated Under Keel Clearance Control Point.	[0..1]	DateTime	
SimpleAttribute	interoperabilityIdentifier	A common unique identifier for entities which describe a single real-world feature, and which is used to identify instances of the feature in end-user systems where the feature may be included in multiple data product types.	[0..1]	URN	
ComplexAttribute	fixedTimeRange	Time interval.	[0..1]	fixedTimeRange	

Page intentionally left blank

7.2.2 Feature Relationship

	Source	Mult	Target	Mult	Roles
Composition	UnderKeelClearancePlanArea	[1]	UnderKeelClearancePlan	[0..*]	Source role – theComponent Target role – theCollection
Composition	UnderKeelClearanceNonNavigableArea	[1]	UnderKeelClearancePlan	[0..*]	Source role – theComponent Target role – theCollection
Composition	UnderKeelClearanceAlmostNonNavigableArea	[1]	UnderKeelClearancePlan	[0..*]	Source role – theComponent Target role – theCollection
Composition	UnderKeelClearanceControlPoint	[1]	UnderKeelClearancePlan	[1..*]	Source role – theComponent Target role – theCollection

7.2.3 Complex Attribute

7.2.3.1 Fixed Time Range

Role	Name	Description	Multiplicity	Data Type	Remarks
ComplexAttribute	fixedTimeRange	Time interval.			
Attribute	timeStart	The start time of an active period.	[0..1]	DateTime	
Attribute	timeEnd	The end time of an active period.	[0..1]	DateTime	

7.2.3.2 Feature Name

Role	Name	Description	Multiplicity	Data Type	Remarks
ComplexAttribute	featureName	Provides the name of an entity, defines the national language of the name, and provides the option to display the name at various system display settings.			
Attribute	language	The method of human communication, either spoken or written, consisting of the use of words in a structured and conventional way.	[1]	Text	
Attribute	name	The individual name of a feature.	[1]	Text	
Attribute	nameUsage	Classification of the type and display level of the name of a feature in an end-user system.	[0..1]	Enumeration	

7.2.4 Enumerations

Name	Description	Multiplicity	Data Type	Values
underKeelClearancePurpose	The relevant phase of a UKC passage plan.	[0..1]	Enumeration	1: Pre Plan 2: Actual Plan 3: Actual Update
underKeelClearanceCalculationRequested	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.	[0..1]	Enumeration	1: Time Window 2: Maximum Draught
nameUsage	Classification of the type and display level of the name of a feature in an end-user system.	[0..1]	Enumeration	1: defaultNameDisplay 2: alternateNameDisplay

8 Feature Catalogue

8.1 Introduction

As outlined in ISO 19110, catalogues contain definitions and descriptions of the spatial object types, their attributes and associated components occurring in one or more spatial datasets, 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 uses GML to describe the details of the application schema contained in Section 7.2 and is verified by the IHO's Feature Catalogue Builder (FCB).

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.

Feature Catalogue and can be downloaded from the IHO GI Registry website (https://registry.iho.int/productspec/list.do).

8.2 Feature Types

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

8.2.1 Geographic

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

8.2.2 Meta

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

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

8.2.3 Feature Relationship

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

8.2.3.1 Aggregation

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

8.2.3.2 Composition

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

EXAMPLE: A UKC plan feature may comprise multiple UKC non-navigable area features to indicate unsafe areas, computed based on information as contained in the UKC plan feature. Therefore, if a UKC plan feature is deleted, its component UKC non-navigable area features must also be deleted as they make up the UKC non-navigable area/UKC plan Composition.

8.2.4 Attributes

S-100 defines attributes as either simple or complex.

8.2.4.1 Simple attributes

S-129 uses five types of simple attributes, as listed in ***Table 8-1***.

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.
Character String	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 8601-1:2019 and ISO 8601-2:2019.

Table 8-1 – Attribute types

8.2.4.2 Complex attributes

Complex attributes are aggregations of other attributes that are either simple or complex. The aggregation is defined by means of attribute bindings. S-129 includes the following complex attributes:

- fixedTimeRange – contains simple attributes of “timeStart” and “timeEnd”
- featureName – contains simple attributes of “name”, “language”, and “nameUsage”

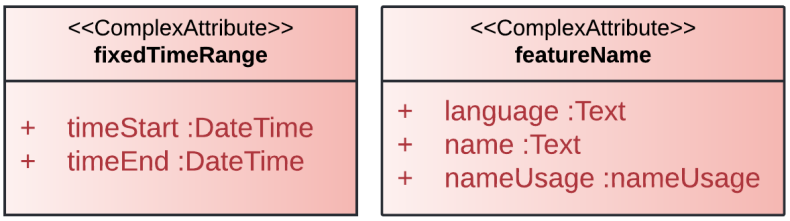


Figure 8-1 –Complex Attributes used in S-129

8.3 Units of measure

The following units of measure are used in the S-129 Product Specification:

- Ship draught in metres
- Ship speed in metres per second
- UKC above the established UKC Limit, in metres

9 Dataset Types

UKCM datasets consists of a UKC plan, UKC plan area, control points and areas considered non-navigable and almost non-navigable. The datasets are generally intended for use with S-101 ENC, and (optionally) with S-102 (Bathymetric Surface), S-104 (Water Level Information for Surface Navigation), or S-111 (Surface Currents) datasets. Dataset content will change over time during a ship’s transit. Updating of datasets is achieved by replacement.

10 Dataset Loading and Unloading

S-129 datasets are typically intended to be overlays to S-101 ENC and always displayed with S-101 ENC data in the background. Systems that support the display of S-129 datasets should provide the user with simple 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 for the UKCM Operational 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 S-101 ENC and S-102 (Bathymetric Surface) datasets, with S-104 (Water Level Information for Surface Navigation) datasets incorporated where applicable. The same requirements to allow the user to easily toggle the S-129 dataset on/off persist.

11 Geometry

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

12 Coordinate Reference Systems (CRS)

12.1 Introduction

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

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

12.2 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 https://epsg.org/

12.3 Vertical Reference System

The vertical coordinate is directed upward from its origin (that is, away from the Earth's centre) – the vertical datum – and has units of metres. That is, a positive value for the level relative to the vertical datum means that the level is above the vertical datum. This is consistent with the bathymetric CRS in S-102 Edition 1.0.0. The vertical datum is not an ellipsoid but is one of the following: (a) the sea surface (defined in clause 3.2), (b) a vertical, sounding, or chart datum (MSL, LAT, etc.), or (c) the sea floor.

12.4 Temporal Reference System

The temporal reference system is the Gregorian calendar for date and UTC for time. Time is measured by reference to Calendar dates and Clock time in accordance with ISO 19108:2002, Temporal Schema clause 5.4.4. All date and time variables must follow the format specified in ISO 8601-1:2019 and ISO 8601-2:2019.

- 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.

13 Data Quality

13.1 Introduction

Areas where UKCM Services are in place are typically covered by very high definition bathymetry, and have available predicted and observed (that is, real time or near real time) 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, assumed to be of high 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 (for example bathymetry, tide, water levels, currents, tidal streams 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.

14 Data Capture and Classification

The S-129 Data Classification and Encoding Guide (DCEG) gives guidance for how to encode UKCM datasets for the various stages of a journey to and through a UKCM Operational Area. The document can be found in Annex A.

15 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 Operational Area in order to ensure the ship has correct and up-to-date UKCM information.

15.1 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 closer to the time of the ship entering the UKCM Operational Area (for example, 24 hours prior).

Closer to the time of the ship entering the UKCM Operational 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 Operational Area, the update frequency might range between 10 minutes to 60 minutes.

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

15.2 Data Source

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

15.3 Production Process

The production process of UKCM product datasets will vary depending on the environmental sensors used in each UKCM Operational Area and may also vary depending on the stage of a ship's passage.

16 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, line styles, colour definitions, portrayal parameters and portrayal management concepts such as viewing groups.

17 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 5.0.0 Part 10b.

Detailed documentation of the S-129 encoding schema is provided in Annex B of this document.

Format Name: GML

Version: 3.2.1

Character Set: UTF-8

Specification: S-100 5.0.0 profile of GML 3.2.1

17.1 Encoding of Latitude and Longitude

Values of latitude and longitude must be expressed with a precision of 7 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.

17.1.1 Encoding of coordinates as decimals

Values should be coded as decimal numbers with 7 or fewer digits after the decimal. The normative encoding is in degrees, with an accuracy of 10^{-7} degrees (that is, 7 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 (for example 10^{-7} 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 (for example {1} for coordinates encoded in decimal degrees).

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

17.2 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.

17.3 Text Attribute Values

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

17.4 Mandatory Attribute Values

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

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

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

17.5 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.”

17.6 Structure of dataset files

17.6.1 Sequence of objects

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

i. Dataset identification information

ii. Dataset structure information

iii. Spatial records for by-reference geometries
   - iii.1. Point
   - iii.2. Multi point
   - iii.3. Curve
   - iii.4. Composite curve
   - iii.5. Surface

iv. Information objects

v. Feature objects (Geometry may be encoded inline or by reference)
   - v.1. Meta features
   - v.2. Geo features

vi. S-129 Collection objects

17.7 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 sub-fields **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.

17.8 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.

17.9 Data overlap

S-129 datasets may spatially overlap other S-129 datasets.

S-129 datasets may temporally overlap other S-129 datasets. As S-129 datasets include forecast information, it is possible that S-129 datasets for different vessels correspond to overlapping voyage times or sailing windows.

In the case of S-129 dataset updates, new S-129 datasets can replace preceding S-129 datasets for the same vessel, UKCM Operational Area, and planned time of voyage, to account for prevailing environmental and/or voyage conditions.

17.10 Data quality

One or more QualityOfNonbathymetricData feature must cover the dataset.

18 Data Product Delivery

18.1 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: See Clause 18.2.2

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 (for example media identification, data extents, etc.) and also may define commercial constructs such as encryption and compression methods.

Depending on the required level of detail, particularly when non-navigable and almost non-navigable areas are included, S-129 files can be constructed accordingly to maximise efficiency of transmission.

Further, S-129 files can be compressed using guidance provided in S-100 Part 15 in cases where files would otherwise take too long to transmit.

It is anticipated that uncompressed S-129 files for an area of 36 by 10 nautical miles, may range in size between 0.7MB and 2.5MB, depending on the complexity and extent of the no-go areas. Compressed versions of such files can reduce file sizes to between 28KB and 93KB respectively.

If the data is transformed (for example 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 (that is, 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 (that is, include the updated Portrayal Catalogue in an exchange set).

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

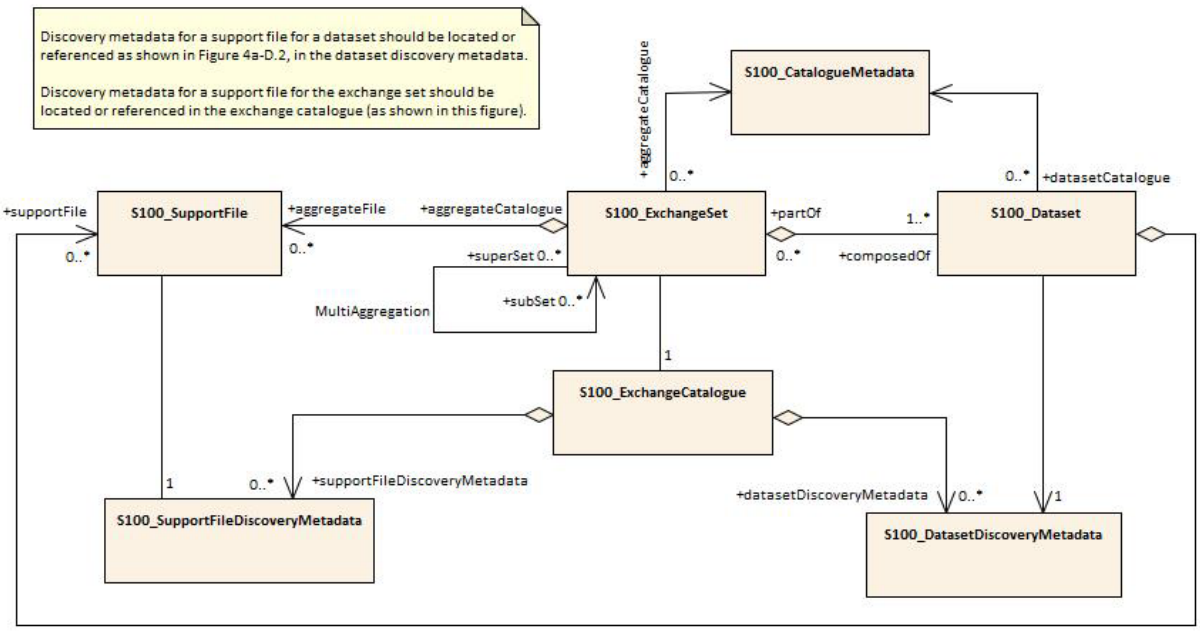


Figure 18-1 – Exchange set structure

18.1.1 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 clause 19.5.

18.2 Dataset

18.2.1 Datasets

Datasets are distributed as files which are part of exchange sets structured as described in this Product 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:

1. 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 Operational Area. The encoding structure is included in Annex B.
2. Cancellation: A dataset shall be considered cancelled when a newer edition has been received or its temporal extent (i.e. *temporalExtent* metadata) is exceeded.

18.2.2 Dataset size

The recommended maximum file size for S-129 UKCM datasets is 20MB. Future usage or testing may result in a different recommended file size limit.

18.2.3 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 eighth 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”.

18.3 Data Integrity

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

18.3.1 Data Encryption

Dataset files may or may not be encrypted. If encrypted, the encryption method defined in S-100 Part 15 must be applied.

18.3.2 Use of Digital Signatures

Digital signatures shall be used on all files. The signature method is defined in S-100 Part 15.

19 Metadata

19.1 Introduction

The S-129 UKCM metadata description is based on S-100 Part 17 Discovery Metadata for Information Exchange Catalogues, 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. Detailed information is provided in S-100 Part 17.

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

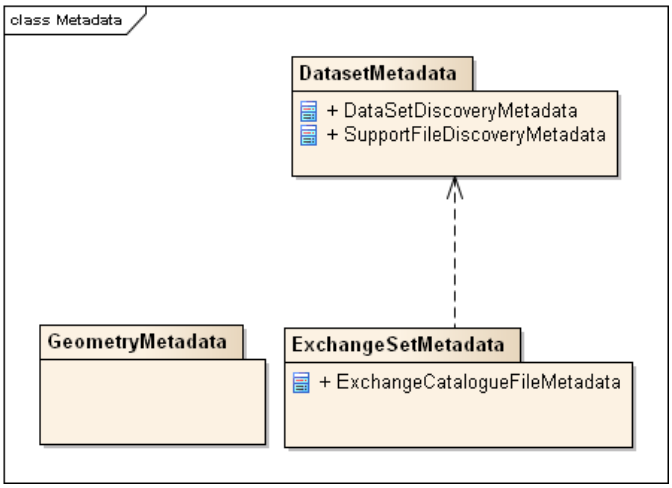


Figure 19-1 – Metadata packages

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.

19.2 Use of S-421 to provide routes in UKC plans

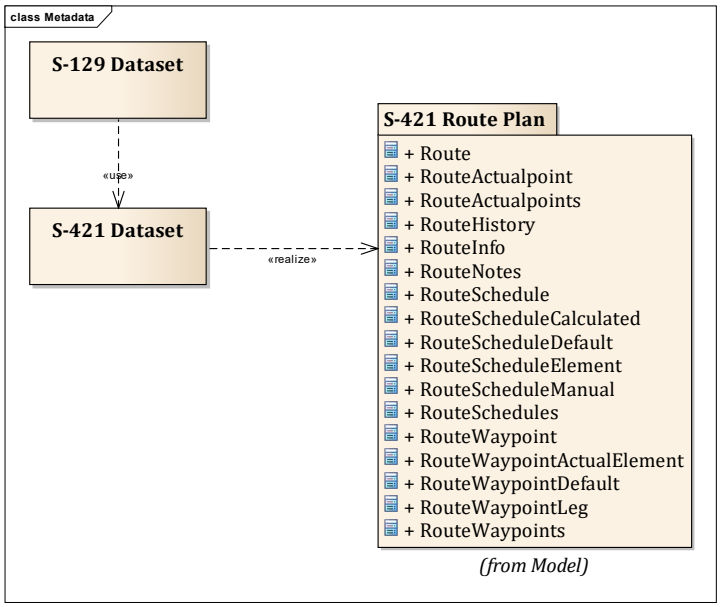


Figure 19-2 – relationship between S-129 and S-421

To provide a UKCM Service, and a UKC route plan in particular, it is recommended that S-421, if available, be used to generate a ship’s route through the UKCM Operational Area. Figure 19-2 shows the relationship between S-129 and S-421.

If S-421 is unavailable, alternative methods, such as RTZ route plan exchange format, can be used to provide or generate a ship’s route information through the UKCM Operational Area.

19.3 Language

The language used for the metadata is English.

19.4 Dataset metadata

Dataset metadata is intended to describe information about a dataset. It facilitates the management and exploitation of data and is an important requirement for understanding the characteristics of a dataset. Whereas dataset metadata is usually fairly comprehensive, there is also a requirement for a constrained subset of metadata elements that are usually required for discovery purposes. Discovery metadata are often used for building web catalogues, and can help users determine whether a product or service is fit for purpose and where they can be obtained.

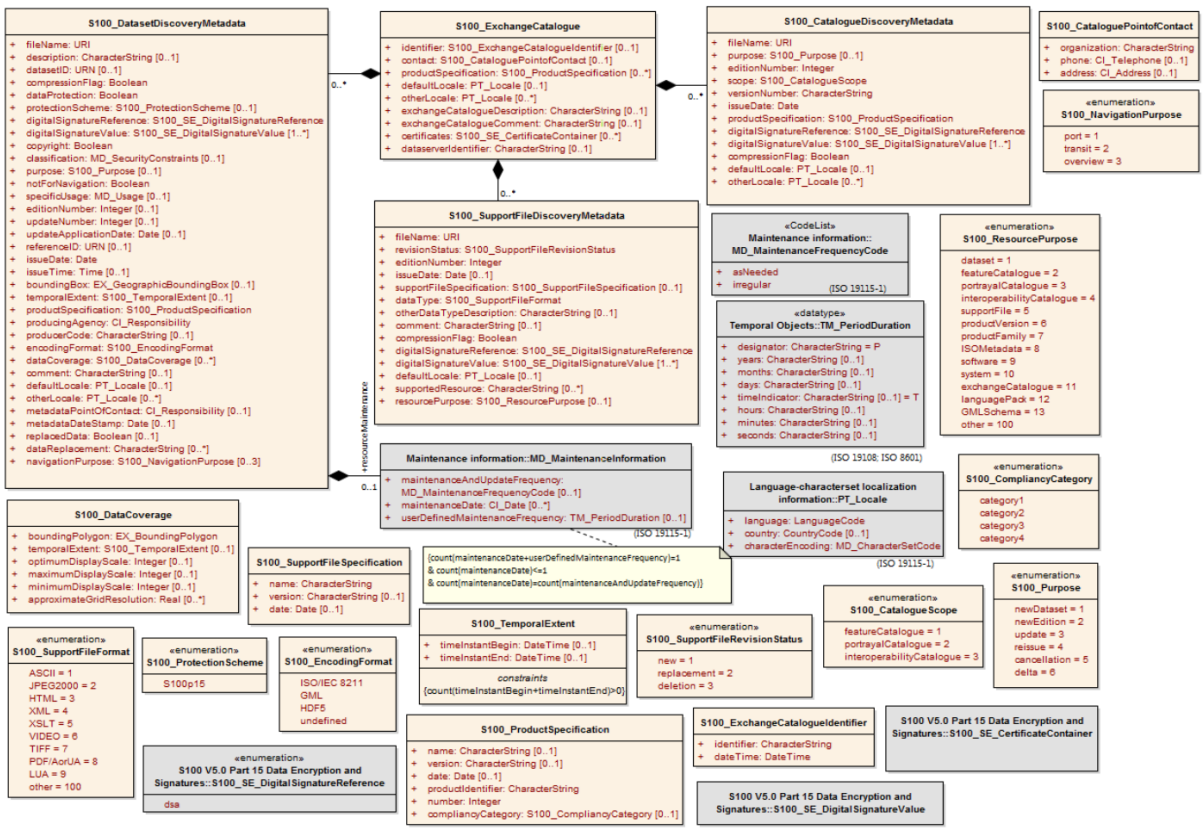


Figure 19-3 – S-129 Exchange catalogue and discovery metadata

NOTE 1: Types with CI, EX, and MD prefixes are from packages defined in ISO 19115-1 and 19115-3 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 inapplicable but mandatory metadata fields must be nulled.

19.5 S100_ExchangeCatalogue

Each exchange set has a single S100_ExchangeCatalogue which contains meta information for the data and support files in the exchange set.

This class is inherited from S100_ExchangeCatalogue, as detailed in S-100 Part 17, Clause 17-4.5, with certain attributes and roles restricted as described below.

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_ExchangeCatalogue	An exchange catalogue contains the discovery metadata about the exchange datasets and support files	-	-	-
Attribute	identifier	Uniquely identifies this exchange catalogue	1	S100_ExchangeCatalogueIdentifier	
Attribute	contact	Details about the issuer of this exchange catalogue	1	S100_CataloguePointOfContact	
Attribute	productSpecification	Details about the Product Specifications used for the datasets contained in the Exchange Catalogue	1	S100_ProductSpecification	Conditional on all the datasets using the same product specification
Attribute	defaultLocale	Default language and character set used for all metadata records in this Exchange Catalogue	1	PT_Locale	Default is English and UTF-8
Attribute	otherLocale	Other languages and character sets used for the localized metadata records in this Exchange Catalogue	0..*	PT_Locale	Required if any localized entries are present in the Exchange Catalogue
Attribute	exchangeCatalogueDescription	Description of what the exchange catalogue contains	1	CharacterString	
Attribute	exchangeCatalogueComment	Any additional Information	0..1	CharacterString	
Attribute	certificates	Signed public key certificates referred to by digital signatures in the Exchange Set	0..*	S100_SE_CertificateContainer	Content defined in S-100 Part 15. All certificates used, except the SA root certificate (installed separately by the implementing system) shall be included
Attribute	dataServerIdentifier	Identifies the data server for the permit	0..1	CharacterString	
Role	datasetDiscoveryMetadata	Exchange catalogues may include or reference discovery metadata for the datasets in the exchange set	0..*	Aggregation S100_DatasetDiscoveryMetadata	

Role Name	Name	Description	Mult	Type	Remarks
Role	catalogueDiscoveryMetadata	Metadata for catalogue	0..*	Aggregation S100_CatalogueDiscoveryMetadata	Metadata for the feature, portrayal, and interoperability catalogues, if any
Role	supportFileDiscoveryMetadata	Exchange catalogues may include or reference discovery metadata for the support files in the exchange set	0..*	Aggregation S100_SupportFileDiscoveryMetadata	

19.5.1 S100_ExchangeCatalogueIdentifier

S-129 uses S100_ExchangeCatalogueIdentifer as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.5.2 S100_CataloguePointofContact

S-129 uses S100_CataloguePointofContact as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.6 S100_DatasetDiscoveryMetadata

This class is inherited from S100_DatasetDiscoveryMetadata, as detailed in S-100 Part 17, Clause 17-4.5, with certain attributes and roles restricted as described below.

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_DatasetDiscoveryMetadata	Metadata about the individual datasets in the exchange catalogue	-	-	-
Attribute	fileName	Dataset file name	1	URI	
Attribute	description	Short description giving the area or location covered by the dataset	0..1	CharacterString	For example, a harbour or port name, between two named locations etc
Attribute	datasetID	Dataset ID expressed as a Marine Resource Name	0..1	URN	The URN must be an MRN
Attribute	compressionFlag	Indicates if the resource is compressed	1	Boolean	*True* indicates a compressed dataset resource *False* indicates an uncompressed dataset resource
Attribute	dataProtection	Indicates if the data is encrypted	1	Boolean	*True* indicates an encrypted dataset resource *False* indicates an unencrypted dataset resource

Role Name	Name	Description	Mult	Type	Remarks
Attribute	protectionScheme	Specification or method used for data protection	0..1	S100_ProtectionScheme	
Attribute	digitalSignatureReference	Specifies the algorithm used to compute digitalSignatureValue	1	S100_DigitalSignatureReference (see Part 15)	Specifies the algorithm used to compute digitalSignatureValue
Attribute	digitalSignatureValue	Value derived from the digital signature	1..*	S100_DigitalSignatureValue	The value resulting from application of digitalSignatureReference
Attribute	copyright	Indicates if the dataset is copyrighted	1	Boolean	*True* indicates the resource is copyrighted *False* Indicates the resource is not copyrighted
Attribute	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 6. sensitive but unclassified 7. for official use only 8. protected 9. limited distribution
Attribute	purpose	The purpose for which the dataset has been issued	1	S100_Purpose	
Attribute	notForNavigation	Indicates the dataset is not intended to be used for navigation	1	Boolean	*True* indicates the dataset is not intended to be used for navigation *False* indicates the dataset is intended to be used for navigation
Attribute	specificUsage	The use for which the dataset is intended	1	MD_USAGE>specificUsage (character string)	For navigation through <name of UKCM Operational Area> by <ship name>.
Attribute	editionNumber	The Edition number of the dataset	1	Integer	When a dataset is initially created, the Edition number 1 is assigned to it. The Edition number is increased by 1 at each new Edition. Edition number remains the same for a re-issue
Attribute	updateNumber	Update number assigned to the dataset and increased by one for each subsequent update	0..1	Integer	Update number 0 is assigned to a new dataset
Attribute	updateApplicationDate	This date is only used for the base cell files (that is new dataset, re-issue and new edition), not update cell files. All updates dated on or before this date must have been applied by the producer	0..1	Date	

Role Name	Name	Description	Mult	Type	Remarks
Attribute	referenceID	Reference back to the datasetID	0..1	URN	Update metadata refers to the datasetID of the dataset metadata. This is used if and only if the dataset is an update The URN must be an MRN
Attribute	issueDate	Date on which the data was made available by the data producer	1	Date	
Attribute	issueTime	Time of day at which the data was made available by the data producer	1	Time	The S-100 datatype Time
Attribute	boundingBox	The extent of the dataset limits	0..1	EX_GeographicBoundingBox	-
Attribute	temporalExtent	Specification of the temporal extent of the dataset.	1	S100_TemporalExtent	The temporal extent is encoded as the date/time of the earliest and latest data records (in coverage datasets) or date/time ranges (in vector datasets) If there is more than one feature in a dataset, the earliest and latest time values of records in all features are used, which means the earliest and latest values may be from different features If date/time information for a feature is not encoded in the dataset, it is treated for the purposes of this attribute as extending indefinitely in the appropriate direction on the time axis, limited by the issue date/time or the cancellation or supersession of the dataset This attribute is encoded if and only if at least one of the start and end of the temporal extent is known
Attribute	productSpecification	The product specification used to create this dataset	1	S100_ProductSpecification	
Attribute	producingAgency	Agency responsible for producing the data	1	CI_Responsibility>CI_Organisation	See Table 17-3, S-100 Ed. 5.0.0
Attribute	producerCode	The official IHO Producer Code from S-62	0..1	CharacterString	
Attribute	encodingFormat	The encoding format of the dataset	1	S100_EncodingFormat	Must be GML
Attribute	dataCoverage	Provides information about data coverages within the dataset	1..*	S100_DataCoverage	
Attribute	comment	Any additional information	0..1	CharacterString	

Role Name	Name	Description	Mult	Type	Remarks
Attribute	defaultLocale	Default language and character set used in the dataset	1	PT_Locale	In absence of defaultLocale the language is English, UTF-8
Attribute	otherLocale	Other languages and character sets used in the dataset	0..*	PT_Locale	
Attribute	metadataPointOfContact	Point of contact for metadata	0..1	CI_Responsibility>CI_Individual or CI_Responsibility>CI_Organisation	Only if metadataPointOfContact is different to producingAgency
Attribute	metadataDateStamp	Date stamp for metadata	1	Date	May or may not be the issue date
Attribute	replacedData	If a data file is cancelled is it replaced by another data file	0..1	Boolean	
Attribute	dataReplacement	Cell name	0..*	CharacterString	A dataset may be replaced by 1 or more datasets
Attribute	navigationPurpose	Classification of intended navigation purpose (for Catalogue indexing purposes)	0..3	S100_NavigationPurpose	If Product Specification is intended for creation of navigational products this attribute should be mandatory
Role	resourceMaintenance	Information about the frequency of resource updates, and the scope of those updates	0..1	MD_MaintenanceInformation	S-100 restricts the multiplicity to 0..1 and adds specific restrictions on the ISO 19115 structure and content. See clause MD_MaintenanceInformation later in this Part Format: PnYnMnDTnHnMnS (XML builtin type for ISO 8601 duration). See clause 17-4.9

19.6.1 S100_DataCoverage

S-129 uses S100_ DataCoverage as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.6.2 S100_NavigationPurpose

S-129 uses S100_NavigationPurpose enumeration as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.6.3 S100_Purpose

S-129 uses S100_Purpose as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.6.4 S100_TemporalExtent

S-129 uses S100_TemporalExtent as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.6.5 S100_EncodingFormat

S-129 uses S100_EncodingFormat with a restriction on the allowed values to permit only the S-100 GML format for S-129 datasets.

Role Name	Name	Description	Code	Remarks
Enumeration	S100_EncodingFormat	The encoding format	-	Only value permitted in S-129 is GML, therefore the rest are removed.
Value	GML	The GML data format as defined in Part 10b		-

19.6.6 S100_ProductSpecification

This class is inherited from S100_ProductSpecification, as detailed in S-100 Part 17, Clause 17-4.5, with certain attributes and roles restricted as described below.

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_ProductSpecification	The Product Specification contains the information needed to build the specified product	-	-	-
Attribute	name	The name of the product specification used to create the datasets	1	CharacterString	129
Attribute	version	The version number of the product specification	1	CharacterString	1.1.0
Attribute	date	The version date of the product specification	1	Date	CCYYMMDD
Attribute	productIdentifer	Machine readable unique identifier of a product type	1	CharacterString (Restricted to Product ID values from the IHO Product Specification Register, in the IHO Geospatial Information Registry)	“S-129”
Attribute	number	The number (registry index) used to lookup the product in the product specification GI registry	1	Integer	From the Product Specification Register in the IHO Geospatial Information Registry
Attribute	compliancyCategory	The level of compliance of the Product Specification to S-100	0..1	S100_CompliancyCategory	See S-100 Part 4a, clause 4a-5.5

19.6.7 S100_CompliancyCategory

S-129 uses S100_ComliancyCategory enumeration as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.6.8 S100_ProtectionScheme

S-129 uses S100_ProtectionScheme enumeration as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.7 S100_SupportFileDiscoveryMetadata

S-129 uses S100_SupportFileDiscoveryMetadata as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.7.1 S100_SupportFileFormat

S-129 uses S100_SupportFileFormat enumeration as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.7.2 S100_SupportFileRevisionStatus

S-129 uses S100_SupportFileRevisionStatus enumeration as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.7.3 S100_SupportFileSpecification

S-129 uses S100_SupportFileSpecification as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.7.4 S100_ResourcePurpose

S-129 uses S100_ResourcePurpose enumeration as detailed in S-100 Part 17, Clause 17-4.5, without modification.

19.8 S100_CatalogueDiscoveryMetadata

This class is inherited from S100_CatalogueDiscoveryMetadata, as detailed in S-100 Part 17, Clause 17-4.5, with certain attributes and roles restricted as described below.

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_CatalogueDiscoveryMetadata	Class for S-100 catalogue metadata.	-	-	-
Attribute	fileName	The name for the catalogue	1	URI	
Attribute	purpose	The purpose for which the Catalogue has been issued	0..1	S100_Purpose (codelist)	The values must be one of the following: *2* new edition *5* cancellation Default is new edition
Attribute	editionNumber	The Edition number of the Catalogue	1	Integer	Initially set to 1 for a given productSpecification.number Increased by 1 for each subsequent newEdition Uniquely identifies the version of the Catalogue
Attribute	scope	Subject domain of the catalogue	1	S100_CatalogueScope	
Attribute	versionNumber	The version number of the product specification	1	CharacterString	Human readable version identifier
Attribute	issueDate	The version date of the product specification	1	Date	
Attribute	productSpecification	The product specification used to create this file	1	S100_ProductSpecification	
Attribute	digitalSignatureReference	Specifies the algorithm used to compute digitalSignatureValue	1	S100_DigitalSignatureReference (see Part 15)	
Attribute	digitalSignatureValue	Value derived from the digital signature	1..*	S100_DigitalSignatureValue (see Part 15)	The value resulting from application of digitalSignatureReference Implemented as the digital signature format specified in Part 15
Attribute	compressionFlag	Indicates if the resource is compressed	1	Boolean	*True* indicates a compressed resource *False* indicates an uncompressed resource

Role Name	Name	Description	Mult	Type	Remarks
Attribute	defaultLocale	Default language and character set used in the Catalogue	1	PT_Locale	In absence of defaultLocale the language is English in UTF-8
Attribute	otherLocale	Other languages and character sets used in thecatalogue	0..*	PT_Locale	

19.8.1 S100_CatalogueScope

S-129 uses S100_CatalogueScope enumeration as detailed in S-100 Part 17, Clause 17-4.5, without modifications.

Page intentionally left blank

Annex A. **Data Classification and Encoding Guide**

A.1 UnderKeelClearancePlan

IHO Definition: UKC plans are specific to a ship and a UKCM Operational Area. There are three kinds of plan: a Pre-plan, an Actual Plan and an Actual Update.

S-129 Metadata Feature: UnderKeelClearancePlan

Super Type:

Primitive: surface

Real World	*Paper Chart Symbol*		*ECDIS Symbol*	
S-129 Attribute	**S-57 Acronym**	**Allowable Encoding Value**	**Type**	**Multiplicity**
Generation Time			DT	0, 1
Vessel ID			TE	0, 1
Source Route Name			TE	0, 1
Source Route Version			IN	0, 1
Maximum Draught			RE	0, 1
Under Keel Clearance Purpose		1: Pre Plan 2: Actual Plan 3: Actual Update	EN	0, 1
Under Keel Clearance Calculation Requested		1: Time Window 2: Maximum Draught	EN	0, 1
Interoperability Identifier			URN	0, 1
Fixed Time Range			C	0, 1
Time Start			(S) DT	0, 1
Time End			(S) DT	0, 1

Introductory remarks.

There are three kinds of UKC plans:

- a Pre-plan is a set of tidal windows available for a ship to transit through a UKCM Operational Area, at a specified draught
- an Actual Plan is specific to a ship and a UKCM Operational Area for a waterway, and contains a route defined by a set of geographical control points with time windows for each control point, and non-navigable and almost non-navigable areas, and
- an Actual Update is a replacement Actual Plan.

Feature/Information associations				
Type	**Association Name**	**Association Ends**		
		Class	**Role**	**Mult**
Asso	UKC Plan Area Composition	**UnderKeelClearancePlanArea**	theComponent	0, *
Asso	UKC Non Navigable Area Composition	**UnderKeelClearanceNonNavigableArea**	theComponent	0, *
Asso	UKC Almost Non Navigable Area Composition	**UnderKeelClearanceAlmostNonNavigableArea**	theComponent	0, *
Asso	UKC Control Point Composition	**UnderKeelClearanceControlPoint**	theComponent	1, *

A.2 UnderKeelClearancePlanArea

IHO Definition: The area for which an under keel clearance plan has been calculated for a particular vessel, for a particular passage.				
S-129 Geo Feature: UnderKeelClearancePlanArea				
Super Type:				
Primitive: noGeometry				
Real World	*Paper Chart Symbol*		*ECDIS Symbol*	
S-129 Attribute	**S-57 Acronym**	**Allowable Encoding Value**	**Type**	**Multiplicity**
Scale Minimum	(SCAMIN)		IN	0, 1
Interoperability Identifier			URN	0, 1
Introductory remarks. The Under Keel Clearance Plan area is spatial information which are included in Actual Plans and Actual Updates. It encompasses under keel clearance non-navigable areas, almost non-navigable areas, and navigable areas.				

Feature/Information associations				
Type	**Association Name**	**Association Ends**		
		Class	**Role**	**Mult**
Comp	UKC Plan Area Composition	**UnderKeelClearancePlan**	theCollection	1, 1

A.3 UnderKeelClearanceNonNavigableArea

IHO Definition: An area within a UKCM Operational Area where UKC for a specific ship is calculated to be less than the UKC limit for the waterway.				
S-129 Geo Feature: UnderKeelClearanceNonNavigableArea				
Super Type:				
Primitive: surface				
Real World	*Paper Chart Symbol*		*ECDIS Symbol*	
S-129 Attribute	**S-57 Acronym**	**Allowable Encoding Value**	**Type**	**Multiplicity**
Scale Minimum	(SCAMIN)		IN	0, 1
Interoperability Identifier			URN	0, 1
Introductory remarks. Non-navigable areas are spatial information which are included in Actual Plans and Actual Updates.				

Feature/Information associations				
Type	**Association Name**	**Association Ends**		
		Class	**Role**	**Mult**
Comp	UKC Non Navigable Area Composition	**UnderKeelClearancePlan**	theCollection	1, 1

A.4 UnderKeelClearanceAlmostNonNavigableArea

IHO Definition: An area within a UKCM Operational Area where UKC for a specific ship is calculated to be approaching the UKC limit for the waterway (within a specified value range).
S-129 Geo Feature: UnderKeelClearanceAlmostNonNavigableArea
Super Type:
Primitive: surface

Real World	*Paper Chart Symbol*		*ECDIS Symbol*	
S-128 Attribute	**S-57 Acronym**	**Allowable Encoding Value**	**Type**	**Multiplicity**
Scale Minimum	(SCAMIN)		IN	0, 1
Distance Above UKC Limit			RE	0, 1
Interoperability Identifier			URN	0, 1

Introductory remarks. Almost non-navigable areas are spatial information which are included in Actual Plans and Actual Updates.

Feature/Information associations

Type	Association Name	Association Ends		
		Class	Role	Mult
Comp	UKC Almost Non Navigable Area Composition	**UnderKeelClearancePlan**	theCollection	1, 1

A.5 UnderKeelClearanceControlPoint

IHO Definition: A geographical position denoting a point along a specific ship's route within a UKCM Operational Area where the ship must pass within a time range or time window (for example start and end time) calculated by the UKCM Service Provider.

S-129 Geo Feature: **UnderKeelClearanceControlPoint**

Super Type:

Primitive: **point**

Real World	*Paper Chart Symbol*		*ECDIS Symbol*	
S-129 Attribute	**S-57 Acronym**	**Allowable Encoding Value**	**Type**	**Multiplicity**
Distance Above UKC Limit			RE	0, 1
Feature Name			C	0, 1
Language			(S) TE	1
Name			(S) TE	1
Name Usage		1: Default Name Display 2: Alternate Name Display	(S) EN	0, 1
Expected Passing Time			DT	0, 1
Expected Passing Speed			RE	0, 1
Interoperability Identifier			URN	0, 1
Fixed Time Range			C	0, 1
Time Start			(S) DT	0, 1
Time End			(S) DT	0, 1

Introductory remarks. Control points are included in Actual Plans and Actual Updates.

Feature/Information associations

Type	**Association Name**	**Association Ends**		
		Class	**Role**	**Mult**
Comp	UKC Control Point Composition	**UnderKeelClearancePlan**	theCollection	1, 1

A.6 Association Names

A.6.1 UKC Plan Area Composition

IHO Definition: A feature association for the binding between Under Keel Clearance Plan Area and Under Keel Clearance Plan

Remarks:

•No remarks.

Role Type	Role	Associated With	Multiplicity
Composition	The Component	**Under Keel Clearance Plan Area**	0, *
	The Collection	**Under Keel Clearance Plan**	1, 1

A.6.2 UKC Non Navigable Area Composition

IHO Definition: A feature association for the binding between Under Keel Clearance Non Navigable Area and Under Keel Clearance Plan

Remarks:

•No remarks.

Role Type	Role	Associated With	Multiplicity
Composition	The Component	**Under Keel Clearance Non Navigable Area**	0, *
	The Collection	**Under Keel Clearance Plan**	1, 1

A.6.3 UKC Almost Non Navigable Area Composition

IHO Definition: A feature association for the binding between Under Keel Clearance Almost Non Navigable Area and Under Keel Clearance Plan

Remarks:

•No remarks.

Role Type	Role	Associated With	Multiplicity
Composition	The Component	**Under Keel Clearance Almost Non Navigable Area**	0, *
	The Collection	**Under Keel Clearance Plan**	1, 1

A.6.4 UKC Control Point Composition

IHO Definition: A feature association for the binding between Under Keel Clearance Control Point and Under Keel Clearance Plan

Remarks:

•No remarks.

Role Type	Role	Associated With	Multiplicity
Composition	The Component	**Under Keel Clearance Control Point**	1, *
	The Collection	**Under Keel Clearance Plan**	1, 1

A.7 Association Roles

A.7.1 The Collection

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

A.7.2 The Component

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

A.8 Attribute and Enumerate Descriptions

A.8.1 Generation Time

IHO Definition: Time the UKC plan was generated.

Remarks:

•No remarks.

A.8.2 Vessel ID

IHO Definition: Vessel identifier, based on MRN. Can be either IMO or MMSI based.

Remarks:

•No remarks.

A.8.3 Source Route Name

IHO Definition: Identification of the route used as a source for the calculation.

Remarks:

May be provided through different methods, such as S-421, RTZ, or as generated by the UKCM service.

If provided, for example, using S-421, the value of “S-421.Route.routeID” is used for machine-readable identification, or the value of “S-421.RouteInfo.routeInfoName” is used for human-readable identification.

A.8.4 Source Route Version

IHO Definition: Identification of the route used as a source for the calculation.

Remarks:

May be provided through different methods, such as S-421, RTZ, or as generated by the UKCM service.

Can be used to supplement information provided by “sourceRouteName”, especially if “sourceRouteName” provides insufficient route information.

If provided, for example, using S-421, the value of “S-421.Route.routeEditionNo” is used.

A.8.5 Maximum Draught

IHO Definition: The maximum vessel draught in metres, used as base for the calculation.

Remarks:

•No remarks.

A.8.6 Scale Minimum

IHO Definition: The minimum scale at which the feature may be used for example for ECDIS presentation.

Remarks:

The modulus of the scale is indicated, that is 1:1 250 000 is encoded as 1250000.

A.8.7 Language

IHO Definition: The method of human communication, either spoken or written, consisting of the use of words in a structured and conventional way.

Remarks:

•No remarks.

A.8.8 Name

IHO Definition: The individual name of a feature.

Remarks:

•No remarks.

A.8.9 Name Usage

IHO Definition: Classification of the type and display level of the name of a feature in an end-user system.

1) **defaultNameDisplay**

IHO Definition: The name is intended to be displayed when the end-user system is set to the default name/text display setting.

2) **alternateNameDisplay**

IHO Definition: The name is intended to be displayed when the end-user system is set to an alternate name/text display setting, for example an alternate language.

Remarks:

•No remarks.

A.8.10 Expected Passing Time

IHO Definition: The expected passing time for a ship for a nominated Under Keel Clearance Control Point.

Remarks:

•No remarks.

A.8.11 Expected Passing Speed

IHO Definition: The expected passing speed for a ship for a nominated Under Keel Clearance Control Point.

Remarks:

•No remarks.

A.8.12 Time Start

IHO Definition: The start time of an active period.

Remarks:

•No remarks.

A.8.13 Time End

IHO Definition: The end time of an active period.

Remarks:

•No remarks.

A.8.14 Distance Above UKC Limit

IHO Definition: The distance of the lowest part of the ship's keel above the established Under Keel Clearance Limit for the waterway, expressed in metres.

Remarks:

•No remarks.

A.8.15 Interoperability Identifier

IHO Definition: A common unique identifier for entities which describe a single real-world feature, and which is used to identify instances of the feature in end-user systems where the feature may be included in multiple data product types.

Remarks:

•No remarks.

A.8.16 Under Keel Clearance Purpose

IHO Definition: The relevant phase of a UKC passage plan.

1) **Pre Plan**

IHO Definition: 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.

2) **Actual Plan**

IHO Definition: A detailed Under Keel Clearance plan that identifies sailing windows and no-go areas, integrating live weather data, hours or days prior to transiting the Under Keel Clearance Management region.

3) **Actual Update**

IHO Definition: A near real-time, detailed, Under Keel Clearance plan that identifies sailing windows and no-go areas, using live weather, vessel position and traffic data, while the vessel is transiting the Under Keel Clearance Management region.

Remarks:

•No remarks.

A.8.17 Under Keel Clearance Calculation Requested

IHO Definition: 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.

1) **Time Window**

IHO Definition: The available time window(s) for a given draught.

2) **Maximum Draught**

IHO Definition: The maximum draught for a given time window.

Remarks:

•No remarks.

Page intentionally left blank

Annex B. **Schema documentation for S129.xsd**

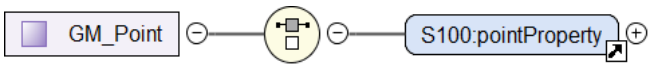
B.1 Schema(s)

B.1.1 Main schema S129.xsd

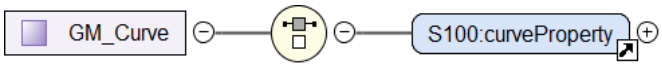
Namespace	http://www.iho.int/S129/gml/cs0/0.1	
Properties	attribute form default:	`unqualified`
	element form default:	`unqualified`
	version:	`0.1-20180531`

B.2 Complex Type(s)

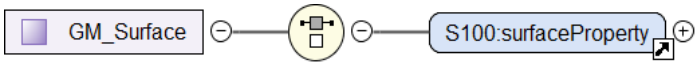
B.2.1 Complex Type — GM_Point

Namespace	http://www.iho.int/S129/gml/cs0/0.1	
Diagram		
Used by	Element	UnderKeelClearanceControlPointType/geometry
Model	pointProperty	
Children	pointProperty	

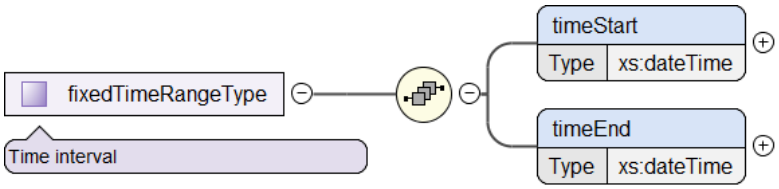
B.2.2 Complex Type — GM_Curve

Namespace	http://www.iho.int/S129/gml/cs0/0.1
Diagram	
Model	curveProperty
Children	curveProperty

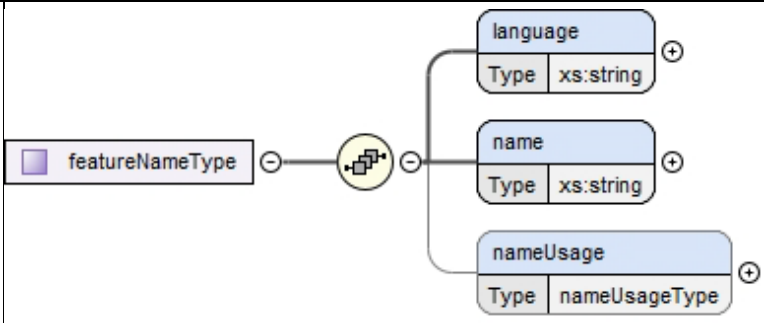
B.2.3 Complex Type — GM_Surface

Namespace	http://www.iho.int/S129/gml/cs0/0.1	
Diagram		
Used by	Elements	UnderKeelClearanceAlmostNonNavigableAreaType/geometry, UnderKeelClearanceNonNavigableAreaType/geometry, UnderKeelClearancePlanAreaType/geometry
Model	surfaceProperty	
Children	surfaceProperty	

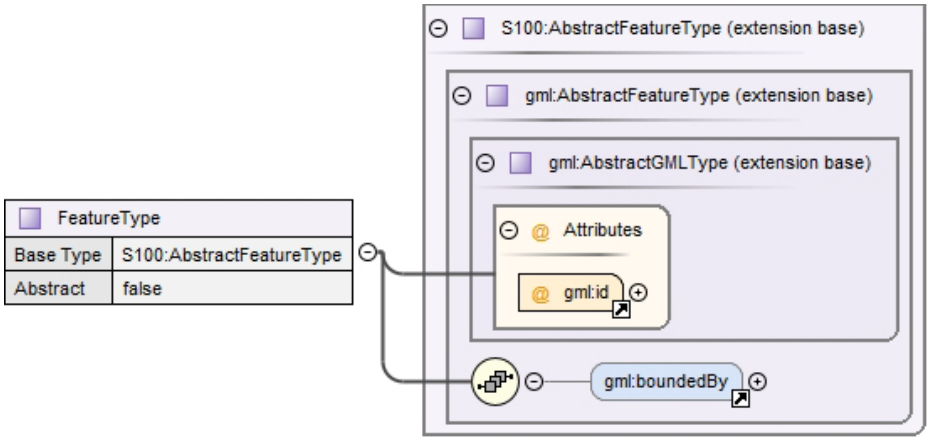
B.2.4 Complex Type — fixedTimeRangeType

Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	`Time interval`
Diagram	
Used by	Elements UnderKeelClearanceControlPointType/fixedTimeRange, UnderKeelClearancePlanType/fixed-TimeRange
Model	timeStart , timeEnd
Children	timeEnd, timeStart

B.2.5 Complex Type — featureNameType

Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	`Provides the name of an entity, defines the national language of the name, and provides the option to display the name at various system display settings.`
Diagram	
Used by	Elements UnderKeelClearanceControlPointType/featureName
Model	language, name, nameUsage
Children	language, name, nameUsage

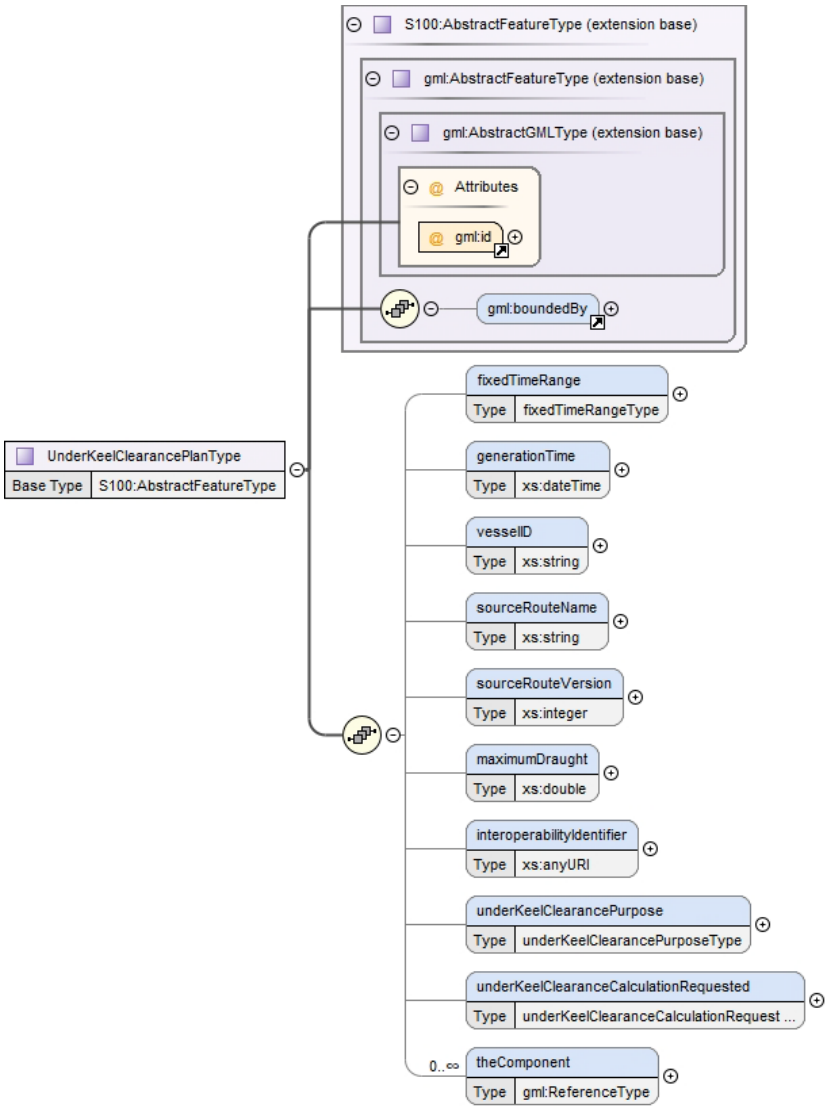
B.2.6 Complex Type — FeatureType

Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	Generalized feature type which carries all the common attributes
Diagram	
Type	extension of AbstractFeatureType
Type hierarchy	1. gml:AbstractGMLType 1. gml:AbstractFeatureType 1. AbstractFeatureType 1. FeatureType
Properties	abstract: true
Used by	Element: FeatureType Complex Types: UnderKeelClearanceAlmostNonNavigableAreaType, UnderKeelClearanceControlPointType, UnderKeelClearanceNonNavigableAreaType, UnderKeelClearancePlanAreaType, UnderKeelClearancePlanType
Model	gml:boundedBy{0,1} , featureObjectIdentifier{0,1} , informationAssociation* , featureAssociation* , invFeatureAssociation*
Children	featureAssociation, featureObjectIdentifier, gml:boundedBy, informationAssociation, invFeatureAssociation

Attributes

QName	Type	Use
gml:id	ID	required
	The attribute gml:id supports provision of a handle for the XML element representing a GML Object. Its use is mandatory for all GML objects. It is of XML type ID, so is constrained to be unique in the XML document within which it occurs.	

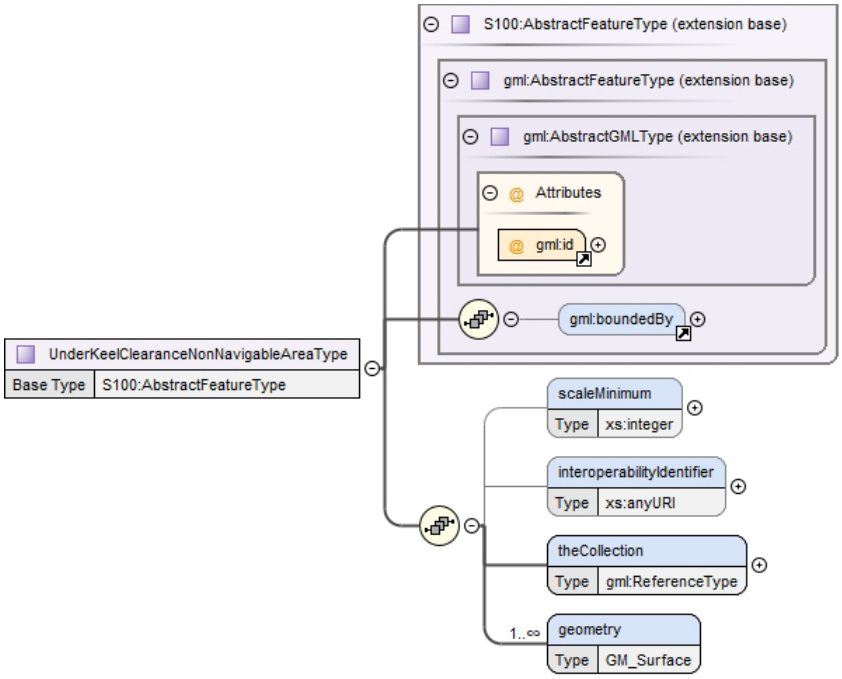
B.2.7 Complex Type — UnderKeelClearancePlanType

Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	A UKC plan calculated for a particular vessel, for a particular passage.
Diagram	
Type	extension of FeatureType
Type hierarchy	1. gml:AbstractGMLType 1. gml:AbstractFeatureType 1. AbstractFeatureType 1. FeatureType 1. UnderKeelClearancePlanType
Used by	Element UnderKeelClearancePlan
Model	gml:boundedBy{0,1} , fixedTimeRange , generationTime , vesselID , sourceRouteName , sourceRouteVersion , maximumDraught , underKeelClearancePurpose , underKeelClearanceCalculationRequested , interoperabilityIdentifier, theComponent+
Children	fixedTimeRange, generationTime, gml:boundedBy, interoperabilityIdentifier, maximumDraught, sourceRouteName, sourceRouteVersion, theComponent, underKeelClearanceCalculationRequested, underKeelClearancePurpose, vesselID

Attributes	QName	Type	Use
	gml:id	ID	required

		The attribute gml:id supports provision of a handle for the XML element representing a GML Object. Its use is mandatory for all GML objects. It is of XML type ID, so is constrained to be unique in the XML document within which it occurs.

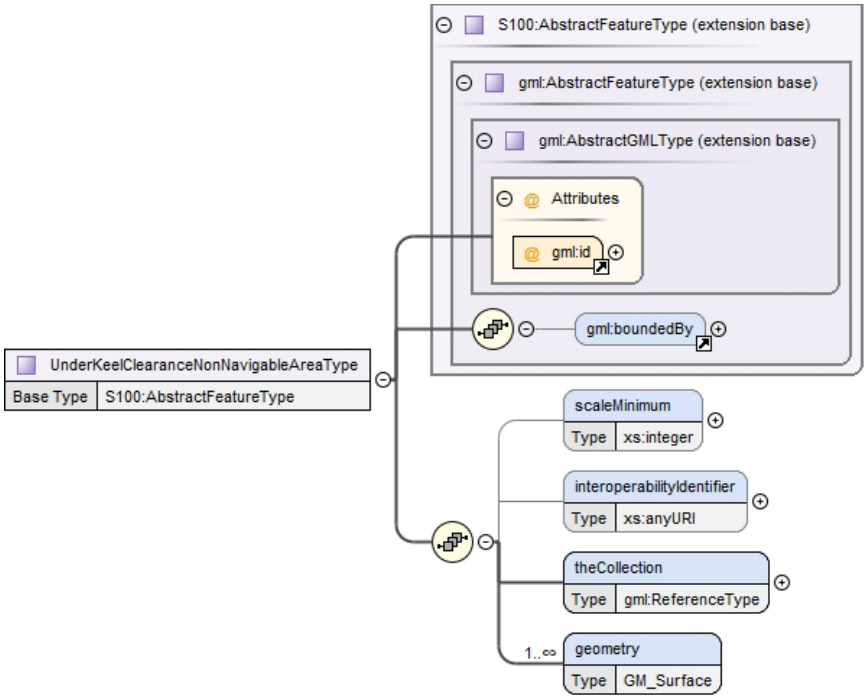
B.2.8 Complex Type – UnderKeelClearancePlanAreaType

Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	The area for which an under keel clearance plan has been calculated for a particular vessel, for a particular passage.
Diagram	
Type	extension of FeatureType
Type hierarchy	2. gml:AbstractGMLType 1. gml:AbstractFeatureType 1. AbstractFeatureType 1. FeatureType 1. UnderKeelClearancePlanAreaType
Used by	Element UnderKeelClearancePlanArea
Model	gml:boundedBy{0,1}, scaleMinimum, interoperabilityIdentifier, geometry, theCollection+
Children	geometry, gml:boundedBy, interoperabilityIdentifier, scaleMinimum, theCollection

Attributes

QName	Type	Use
gml:id	ID	required
	The attribute gml:id supports provision of a handle for the XML element representing a GML Object. Its use is mandatory for all GML objects. It is of XML type ID, so is constrained to be unique in the XML document within which it occurs.	

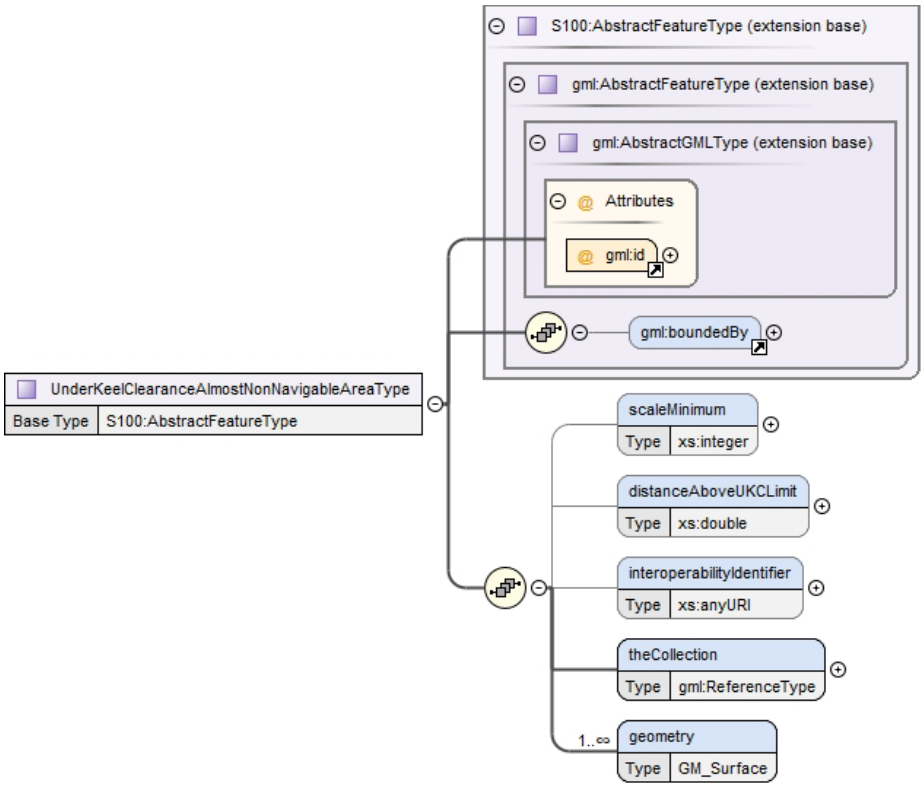
B.2.9 Complex Type — UnderKeelClearanceNonNavigableAreaType

Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	An area of under keel clearance less than the calculated safe limit.
Diagram	
Type	extension of FeatureType
Type hierarchy	1. gml:AbstractGMLType 1. gml:AbstractFeatureType 1. AbstractFeatureType 1. FeatureType 1. UnderKeelClearanceNonNavigableAreaType
Used by	Element UnderKeelClearanceNonNavigableArea
Model	gml:boundedBy {0,1}, scaleMinimum , interoperabilityIdentifier, geometry , theCollection
Children	geometry, gml:boundedBy, interoperabilityIdentifier, scaleMinimum, theCollection

Attributes

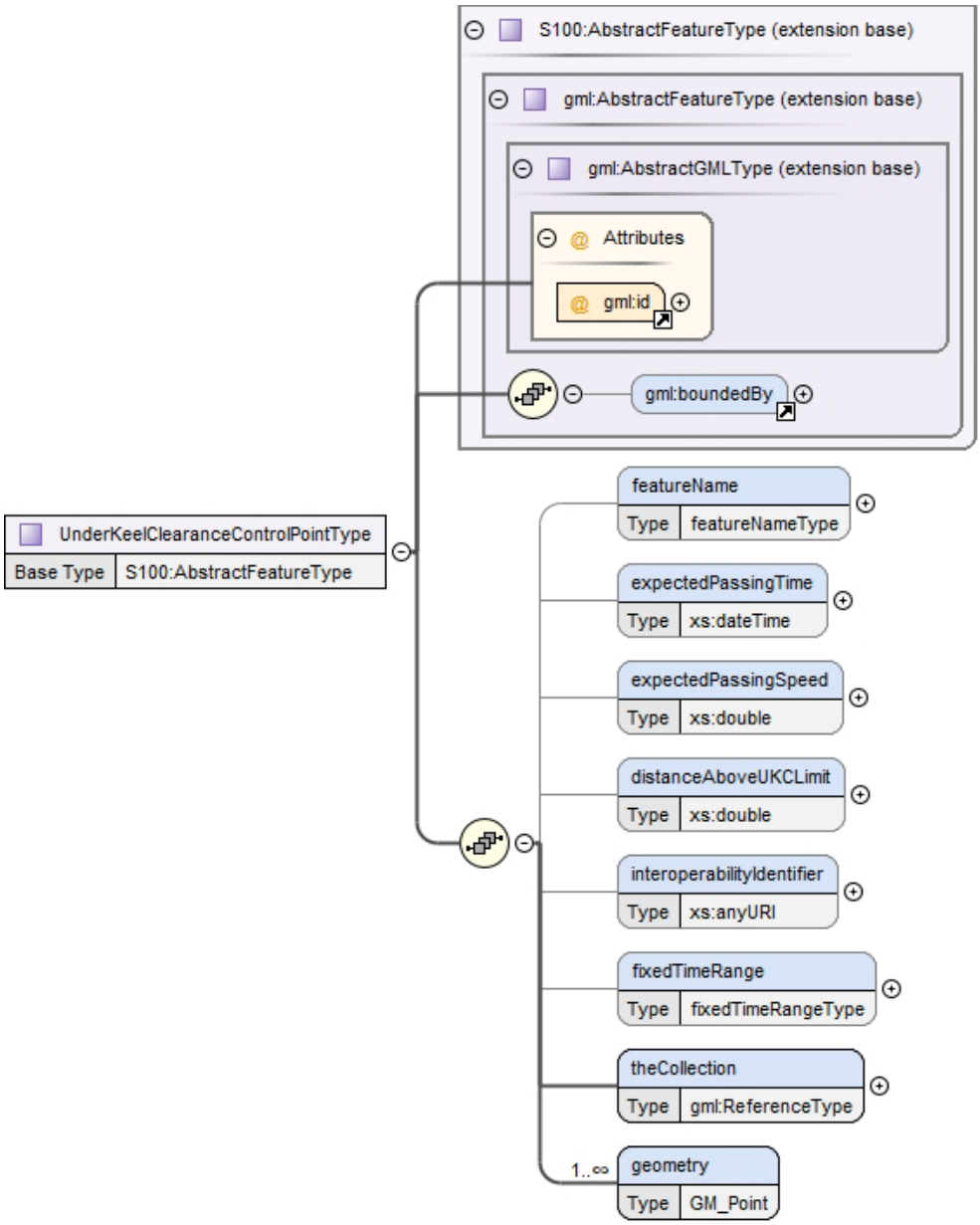
QName	Type	Use
gml:id	ID	required
	The attribute gml:id supports provision of a handle for the XML element representing a GML Object. Its use is mandatory for all GML objects. It is of XML type ID, so is constrained to be unique in the XML document within which it occurs.	

B.2.10 Complex Type—UnderKeelClearanceAlmostNonNavigableAreaType

Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	An area of under keel clearance almost less than the calculated safe limit, as established for the waterway.
Diagram	
Type	extension of FeatureType
Type hierarchy	1. gml:AbstractGMLType 1. gml:AbstractFeatureType 1. AbstractFeatureType 1. FeatureType 1. UnderKeelClearanceAlmostNonNavigableAreaType
Used by	Element UnderKeelClearanceAlmostNonNavigableArea
Model	gml:boundedBy {0,1}, dis- tanceAboveUKCLimit, scaleMinimum, interoperabilityIdentifier, geometry , theCollection
Children	distanceAboveUKCLimit, geometry, gml:boundedBy, interoperabilityIdentifier, theCollection

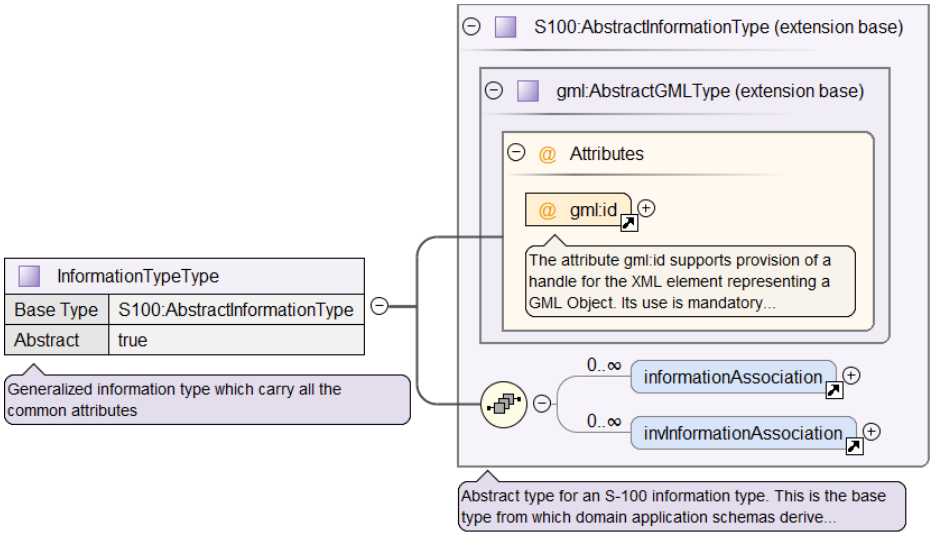
Attributes			
	QName	**Type**	**Use**
	gml:id	ID	required
	QName	The attribute gml:id supports provision of a handle for the XML element representing a GML Object. Its use is mandatory for all GML objects. It is of XML type ID, so is constrained to be unique in the XML document within which it occurs.	

B.2.11 Complex Type — UnderKeelClearanceControlPointType

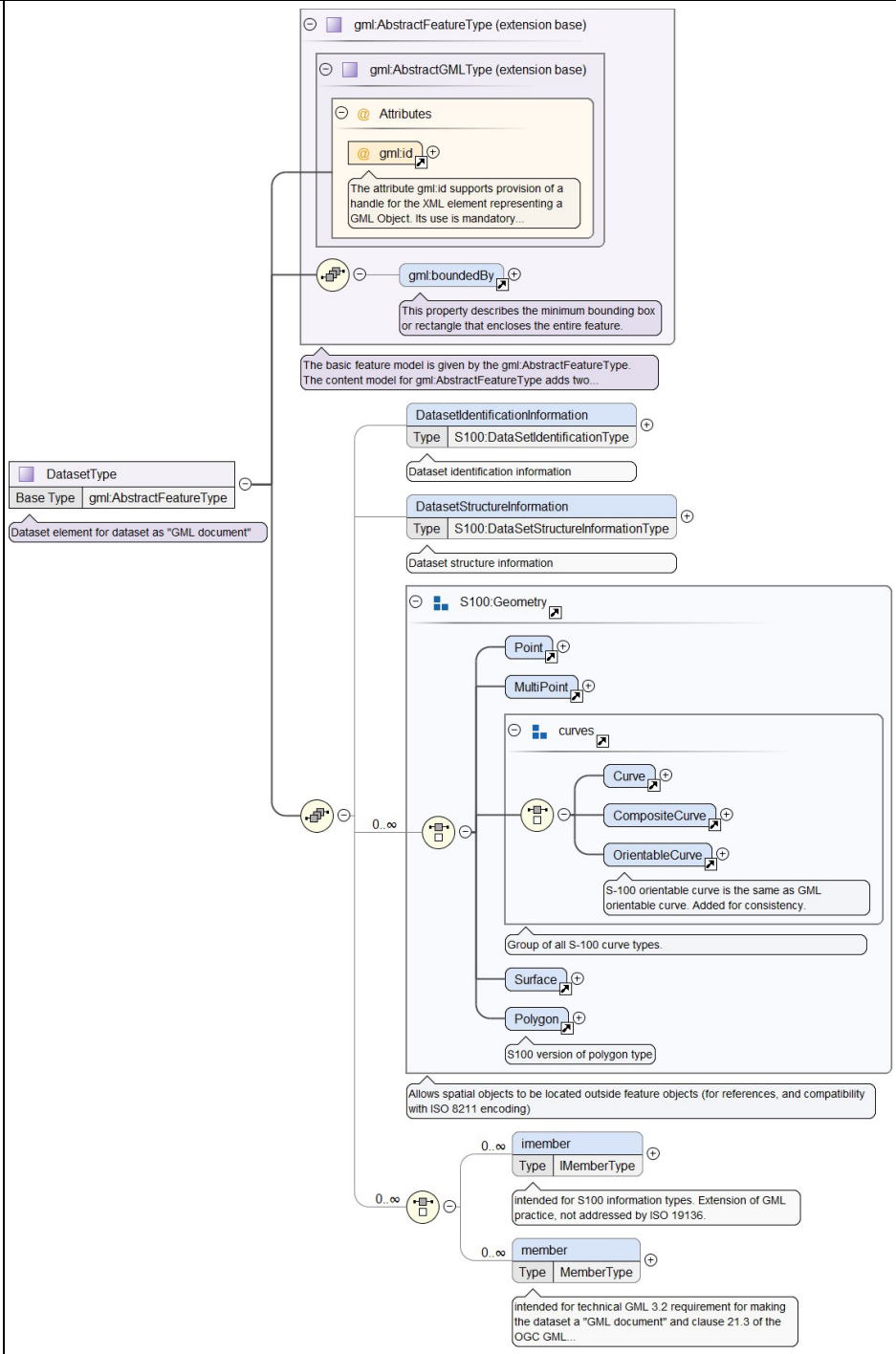
Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	Selected critical passage point or line
Diagram	
Type	extension of FeatureType
Type hierarchy	1. gml:AbstractGMLType 1. gml:AbstractFeatureType 1. AbstractFeatureType 1. FeatureType 1. UnderKeelClearanceControlPointType
Used by	Element UnderKeelClearanceControlPoint
Model	gml:boundedBy{0,1}, distanceAboveUKCLimit{0,1} , expectedPassingSpeed{0,1} , expectedPassingTime{0,1} , featureName{0,1} , fixedTimeRange{0,1} , geometry , theCollection
Children	theCollection, distanceAboveUKCLimit, expectedPassingSpeed, expectedPassingTime, featureName, fixedTimeRange, geometry, gml:boundedBy, name
Attributes	**QName** / **Type** / **Use**

	gml:id	ID	required
		The attribute gml:id supports provision of a handle for the XML element representing a GML Object. Its use is mandatory for all GML objects. It is of XML type ID, so is constrained to be unique in the XML document within which it occurs.	

B.2.12 Complex Type—InformationTypeType

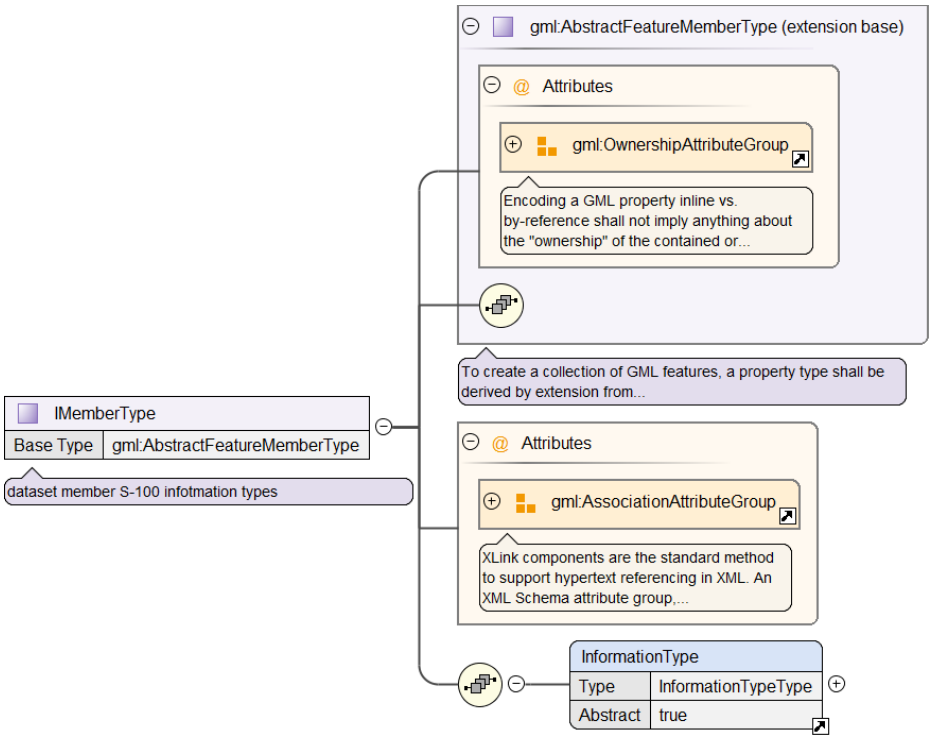
Namespace	http://www.iho.int/S129/gml/cs0/0.1		
Annotations	Generalized information type which carry all the common attributes		
Diagram			
Type	extension of AbstractInformationType		
Type hierarchy	1. gml:AbstractGMLType 1. AbstractInformationType 1. InformationTypeType		
Properties	abstract: true		
Used by	Element InformationType		
Model	informationAssociation*, invInformationAssociation*		
Children	informationAssociation, invInformationAssociation		
Attributes	**QName**	**Type**	**Use**
	gml:id	ID	required
		The attribute gml:id supports provision of a handle for the XML element representing a GML Object. Its use is mandatory for all GML objects. It is of XML type ID, so is constrained to be unique in the XML document within which it occurs.	

B.2.13 Complex Type — DatasetType

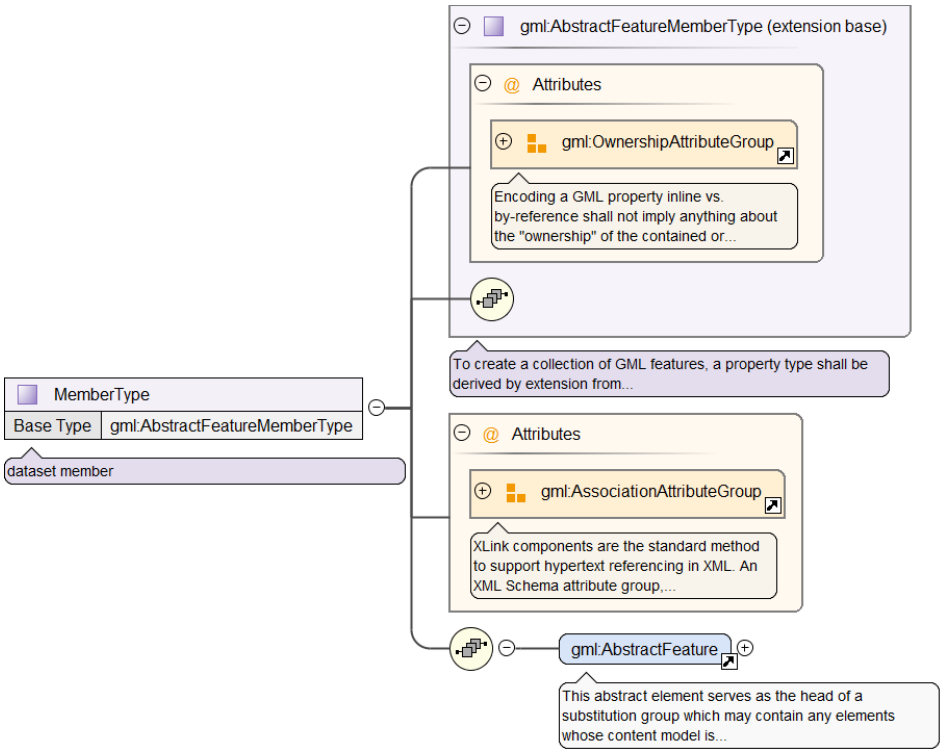
Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	`Dataset element for dataset as "GML document"`
Diagram	
Type	extension of gml:AbstractFeatureType
Type hierarchy	1. gml:AbstractGMLType 1. gml:AbstractFeatureType 1. DatasetType
Used by	Element DataSet
Model	gml:boundedBy{0,1} , DatasetIdentificationInformation{0,1} , DatasetStructureInformation{0,1} , (Point | MultiPoint | Curve | CompositeCurve | OrientableCurve | Surface | Polygon) , (imember* | member*)

Children	CompositeCurve, Curve, DatasetIdentificationInformation, DatasetStructureInformation, MultiPoint, OrientableCurve, Point, Polygon, Surface, gml:boundedBy, imember, member		
Attributes	**QName**	**Type**	**Use**
	gml:id	ID	required
		The attribute gml:id supports provision of a handle for the XML element representing a GML Object. Its use is mandatory for all GML objects. It is of XML type ID, so is constrained to be unique in the XML document within which it occurs.	

B.2.14 Complex Type — IMemberType

Namespace	http://www.iho.int/S129/gml/cs0/0.1					
Annotations	dataset member S-100 information types					
Diagram						
Type	extension of gml:AbstractFeatureMemberType					
Type hierarchy	1. gml:AbstractFeatureMemberType 1. IMemberType					
Used by	Element DatasetType/imember					
Model	InformationType					
Children	InformationType					
Attributes	**QName**	**Type**	**Fixed**	**Default**	**Use**	
	nilReason	gml:NilReasonType			optional	
	owns	boolean		false	optional	
	xlink:actuate	xlink:actuateType			optional	
	xlink:arcrole	xlink:arcroleType			optional	
	xlink:href	xlink:hrefType			optional	
	xlink:role	xlink:roleType			optional	
	xlink:show	xlink:showType			optional	
	QName	**Type**	**Fixed**	**Default**	**Use**	
	xlink:title	xlink:titleAttrType			optional	
	xlink:type	xlink:typeType	simple		optional	

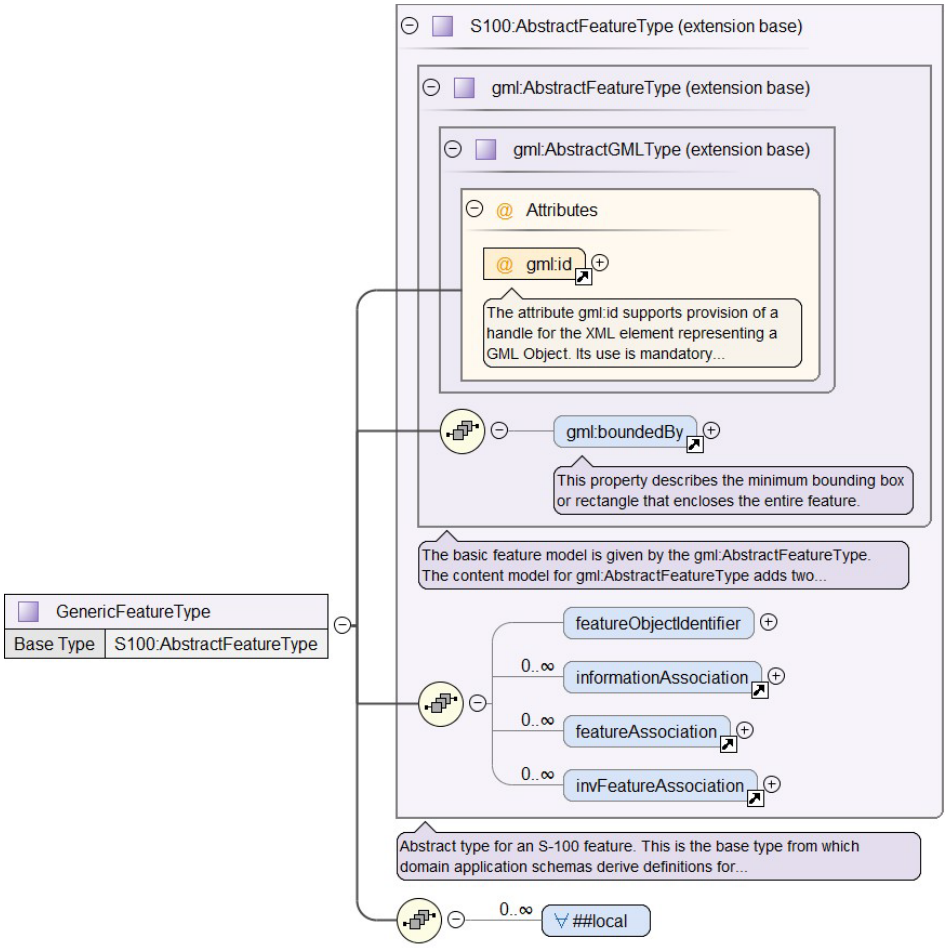
B.2.15 Complex Type — MemberType

Namespace	http://www.iho.int/S129/gml/cs0/0.1
Annotations	`dataset member`
Diagram	
Type	extension of gml:AbstractFeatureMemberType
Type hierarchy	1. gml:AbstractFeatureMemberType 1. MemberType
Used by	Element DatasetType/member
Model	gml:AbstractFeature
Children	gml:AbstractFeature

Attributes

QName	Type	Fixed	Default	Use	
nilReason	gml:NilReasonType			optional	
owns	boolean		false	optional	
xlink:actuate	xlink:actuateType			optional	
xlink:arcrole	xlink:arcroleType			optional	
xlink:href	xlink:hrefType			optional	
xlink:role	xlink:roleType			optional	
xlink:show	xlink:showType			optional	
xlink:title	xlink:titleAttrType			optional	
xlink:type	xlink:typeType	simple		optional	

B.2.16 Complex Type — GenericFeatureType

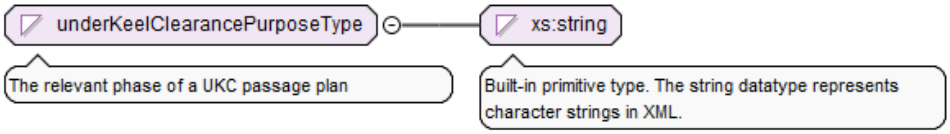
Namespace	http://www.iho.int/S129/gml/cs0/0.1
Diagram	
Type	extension of AbstractFeatureType
Type hierarchy	1. gml:AbstractGMLType 1. gml:AbstractFeatureType 1. AbstractFeatureType 1. GenericFeatureType
Model	gml:boundedBy{0,1} , featureObjectIdentifier{0,1} , informationAssociation* , featureAssociation* , invFeatureAssociation* , ANY element from LOCAL namespace 'No Namespace'
Children	featureAssociation, featureObjectIdentifier, gml:boundedBy, informationAssociation, invFeatureAssociation
Attributes	**QName** / **Type** / **Use** **gml:id** / ID / required `The attribute gml:id supports provision of a handle for the XML element representing a GML Object. Its use is mandatory for all GML objects. It is of XML type ID, so is constrained to be unique in the XML document within which it occurs.`

B.3 Simple Type(s)

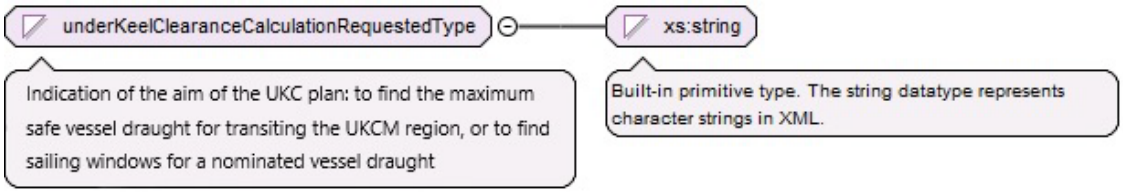
B.3.1 Simple Type — nameUsageType

Namespace	http://www.iho.int/S129/gml/cs0/0.1		
Annotations	Classification of the type and display level of the name of a feature in an end-user system.		
Diagram			
Type	restriction of xs:string		
Facets	enumeration	default name display	The name is intended to be displayed when the end-user system is set to the default name/text display setting.
	enumeration	alternate name display	The name is intended to be displayed when the end-user system is set to an alternate name/text display setting, for example an alternate language.
Used by	Element	nameUsageType	

B.3.2 Simple Type — underKeelClearancePurposeType

Namespace	http://www.iho.int/S129/gml/cs0/0.1		
Annotations	The relevant phase of a UKC passage plan		
Diagram			
Type	restriction of xs:string		
Facets	enumeration	Pre Plan	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.
	enumeration	Actual Plan	A detailed UKC plan that identifies sailing windows non-navigable and almost non-navigable areas, integrating live weather data, hours or days prior to transiting the UKCM region.
	enumeration	Actual Update	A near real-time, detailed, UKC plan that identifies sailing windows and non-navigable and almost non-navigable areas, using live weather, vessel position and traffic data, while the vessel is transiting the UKCM region.
Used by	Element	UnderKeelClearancePlanType/underKeelClearancePurposeType	

B.3.3 Simple Type — underKeelClearanceCalculationRequestedType

Namespace	http://www.iho.int/S129/gml/cs0/0.1		
Annotations	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		
Diagram			
Type	restriction of xs:string		
Facets	enumeration	Time Window	The available time window(s) for a given draught.
	enumeration	Maximum Draught	The maximum draught for a given time window.
Used by	Element	UnderKeelClearancePlanType/underKeelClearanceCalculationRequestedType	

Annex C. **Feature Catalogue**

The Feature catalogue (FC) 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 clause 7.2 of this Product Specification with GML and it is verified by the FCB (Feature Catalogue Builder) published by KHOA on behalf of IHO.

C.1 Catalogue header information

Name: Under Keel Clearance Management

Scope: Dynamic under keel clearance management information

Field of Application: Under keel clearance management

Version Number: 2.0.0

Version date: 2024-09-28

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

C.2 Definition Sources

No definition sources in catalogue.

C.3 Simple Attributes

C.3.1 Generation Time

Name: Generation Time

Definition: Time the UKC plan was generated.

Code: '`generationTime`'

Remarks:

Aliases: (none)

Value Type: dateTime

C.3.2 Vessel ID

Name: Vessel ID

Definition:

Code: '`vesselID`'

Remarks: Vessel identifier, based on MRN. Can be either IMO or MMSI based.

Aliases: (none)

Value Type: text

C.3.3 Source Route Name

Name: Source Route Name

Definition: Identification of the route used as a source for the calculation.

Code: '`sourceRouteName`'

Remarks: May be provided through different methods, such as S-421, RTZ, or as generated by the UKCM service. If provided, for example, using S-421, the value of “S-421.Route.routeID” is used for machine-readable identification, or the value of “S-421.RouteInfo.routeInfoName” is used for human-readable identification.

Aliases: (none)

Value Type: text

C.3.4 Source Route Version

Name: Source Route Version

Definition: Identification of the route used as a source for the calculation.

Code: '`sourceRouteVersion`'

Remarks: May be provided through different methods, such as S-421, RTZ, or as generated by the UKCM service. Can be used to supplement information provided by “sourceRouteName”, especially if “sourceRouteName” provides insufficient route information. If provided, for example, using S-421, the value of “S-421.Route.routeEditionNo” is used.

Aliases: (none)

Value Type: integer

C.3.5 Maximum Draught

Name: Maximum Draught

Definition: The maximum vessel draught in metres, used as base for the calculation.

Code: '`maximumDraught`'

Remarks:

Aliases:

Value Type: real

Unit of measure:

name: metre

symbol: m

Constraints:

String Length	Text Pattern	Range		Precision
(not specified)	(none)	lowerBound	0	(not specified)
		upperBound	(not specified)	
		closure	gtSemiInterval	

C.3.6 Distance Above UKC Limit

Name: Distance Above UKC Limit

Definition: The distance of the lowest part of the ship's keel above the established Under Keel Clearance Limit for the waterway, expressed in metres.

Code: '`distanceAboveUKCLimit`'

Remarks:

Aliases:

Value Type: real

Unit of measure:

name: metre

symbol: m

C.3.7 Scale Minimum

Name: Scale Minimum

Definition: The minimum scale at which the feature may be used for example for ECDIS presentation.

Code: '`scaleMinimum`'

Remarks: The modulus of the scale is indicated, that is 1:1 250 000 is encoded as 1250000.

Aliases:

Value Type: integer

C.3.8 Language

Name: Language

Definition: The method of human communication, either spoken or written, consisting of the use of words in a structured and conventional way.

Code: ‘`language`’

Remarks:

Aliases:

Value Type: text

C.3.9 Name

Name: Name

Definition: The individual name of a feature.

Code: ‘`name`’

Remarks:

Aliases:

Value Type: text

C.3.10 Expected Passing Time

Name: Expected Passing Time

Definition: The expected passing time for a ship for a nominated Under Keel Clearance Control Point.

Code: '`expectedPassingTime`'

Remarks:

Aliases:

Value Type: dateTime

C.3.11 Expected Passing Speed

Name: Expected Passing Speed

Definition: The expected passing speed for a ship for a nominated Under Keel Clearance Control Point.

Code: '`expectedPassingSpeed`'

Remarks:

Aliases:

Value Type: real

Unit of measure:

name: metres per second

symbol: m/s

Constraints:

String Length	Text Pattern	Range		Precision
(not specified)	(none)	lowerBound	0	(not specified)
		upperBound	(not specified)	
		closure	geSemiInterval	

C.3.12 Interoperability Identifier

Name: Interoperability Identifier

Definition: A common unique identifier for entities which describe a single real-world feature, and which is used to identify instances of the feature in end-user systems where the feature may be included in multiple data product types.

Code: ' `interoperabilityIdentifier` '

Remarks:

Aliases:

Value Type: URN

C.3.13 Time Start

Name: Time Start

Definition: The start time of an active period.

Code: ‘`timeStart`’

Remarks:

Aliases:

Value Type: dateTime

C.3.14 Time End

Name: Time End

Definition: The end time of an active period.

Code: ‘`timeEnd`’

Remarks:

Aliases:

Value Type: dateTime

C.4 Enumerations

C.4.1 Name Usage

Name: Name Usage

Definition: Classification of the type and display level of the name of a feature in an end-user system.

Code: 'nameUsage'

Remarks:

Aliases: (none)

Value Type: enumeration

Listed Values

Label	Definition	Code	Remarks
'defaultNameDisplay' Aliases: (none)	The name is intended to be displayed when the end-user system is set to the default name/text display setting.	1	
'alternateNameDisplay' Aliases: (none)	The name is intended to be displayed when the end-user system is set to an alternate name/text display setting, for example an alternate language.	2	

C.4.2 Under Keel Clearance Purpose

Name: Under Keel Clearance Purpose

Definition: The relevant phase of a UKC passage plan.

Code: 'underKeelClearancePurpose'

Remarks:

Aliases: (none)

Value Type: enumeration

Listed Values

Label	Definition	Code	Remarks
'Pre Plan' Aliases: (none)	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.	1	
'Actual Plan' Aliases: (none)	A detailed Under Keel Clearance plan that identifies sailing windows and no-go areas, integrating live weather data, hours or days prior to transiting the Under Keel Clearance Management region.	2	
'Actual Update' Aliases: (none)	A near real-time, detailed, Under Keel Clearance plan that identifies sailing windows and no-go areas, using live weather, vessel position and traffic data, while the vessel is transiting the Under Keel Clearance Management region.	3	

C.4.3 Under Keel Clearance Calculation Requested

Name: Under Keel Clearance Calculation Requested

Definition: 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.

Code: 'underKeelClearanceCalculationRequested'

Remarks:

Aliases: (none)

Value Type: Enumeration

Listed Values

Label	Definition	Code	Remarks
'Time Window' Aliases: (none)	The available time window(s) for a given draught.	1	
'Maximum Draught' Aliases: (none)	The maximum draught for a given time window.	2	

C.5 Complex Attributes

C.5.1 Fixed Time Range

Name: Fixed Time Range

Definition: Time interval.

Code: '`fixedTimeRange`'

Remarks:

Aliases: (none)

Sub-Attributes

Sub-attribute	Type	Mult.	Permitted Values	sequential
timeStart	dateTime	[0..1]		false
timeEnd	dateTime	[0..1]		false

C.5.2 Feature Name

Name: Feature Name

Definition: Provides the name of an entity, defines the national language of the name, and provides the option to display the name at various system display settings.

Code: '`featureName`'

Remarks:

Aliases: (none)

Sub-Attributes

Sub-attribute	Type	Mult.	Permitted Values	sequential
language	text	[1]		false
name	text	[1]		false
nameUsage	enumeration	[0..1]	1: defaultNameDisplay 2: alternateNameDisplay	false

C.6 Roles

C.6.1 Associations

Association(name): UKC Plan Area Composition

Definition: A feature association for the binding between Under Keel Clearance Plan Area and Under Keel Clearance Plan

Role Type: Composition

Code: UnderKeelClearancePlanAreaComposition

Multiplicity: 0..* / 1

Role: 'theComponent / theCollection'

Feature type: UnderKeelClearancePlanArea / UnderKeelClearancePlan

Remarks: It must be in all feature types that they have connection. The featuretype attribute is target feature.

Association(name): UKC Non Navigable Area Composition

Definition: A feature association for the binding between Under Keel Clearance Non Navigable Area and Under Keel Clearance Plan

Role type: Composition

Code: UnderKeelClearanceNonNavigableAreaComposition

Multiplicity: 0..* / 1

Role: 'theComponent / theCollection'

Feature type: UnderKeelClearancePlanNonNavigableArea / UnderKeelClearancePlan

Remarks: It must be in all feature types that they have connection. The featuretype attribute is target feature.

Association(name): UKC Almost Non Navigable Area Composition

Definition: A feature association for the binding between Under Keel Clearance Almost Non Navigable Area and Under Keel Clearance Plan

Role type: Composition

Code: UnderKeelClearanceAlmostNonNavigableAreaComposition

Multiplicity: 0..* / 1

Role: 'theComponent / theCollection'

Feature type: UnderKeelClearanceAlmostNonNavigableArea / UnderKeelClearancePlan

Remarks: It must be in all feature types that they have connection. The featuretype attribute is target feature.

Association(name): UKC Control Point Composition

Definition: A feature association for the binding between Under Keel Clearance Control Point and Under Keel Clearance Plan

Role type: Composition

Code: UnderKeelClearanceControlPointComposition

Multiplicity: 1..* / 1

Role: 'theComponent / theCollection'

Feature type: UnderKeelClearanceControlPoint / UnderKeelClearancePlan

Remarks: It must be in all feature types that they have connection. The featuretype attribute is target feature.

C.6.2 The Collection

Name: of the Collection

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

Code: '`theCollection`'

Aliases: (none)

C.6.3 The Component

Name: The Component

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

Code: '`theComponent`'

Aliases: (none)

C.7 Feature Types

C.7.1 UnderKeelClearancePlan

Name: Under Keel Clearance Plan

Abstract type: false

Definition: A UKC plan calculated for a particular vessel, for a particular passage

Code: '`UnderKeelClearancePlan`'

Remarks:

Aliases: (none)

Supertype: FeatureType

Feature use type: geographic

Permitted primitives: noGeometry

Attribute Bindings

Attribute	Type	Mult.	Permitted Values	Sequential
generationTime	Simple	[0..1]		false
vesselID	Simple	[0..1]		false
sourceRouteName	Simple	[0..1]		false
sourceRouteVersion	Simple	[0..1]		false
maximumDraught	Simple	[0..1]		false
underKeelClearancePurpose	Enumeration	[0..1]	1: Pre Plan 2: Actual Plan 3: Actual Update	false
UnderKeelClearanceCalculationRequested	Enumeration	[0..1]	1: Time Window 2: Maximum Draught	false
interoperabilityIdentifier	URN	[0..1]		false
fixedTimeRange	Complex	[0..1]		false

C.7.2 UnderKeelClearancePlanArea

Name: Under Keel Clearance Plan Area

Abstract type: false

Definition: The area for which an under keel clearance plan has been calculated for a particular vessel, for a particular passage.

Code: `'UnderKeelClearancePlanArea'`

Remarks:

Aliases: (none)

Supertype: FeatureType

Feature use type: geographic

Permitted primitives: surface

Attribute Bindings

Attribute	Type	Mult.	Permitted Values	Sequential
scaleMinimum	Simple	0..1		false
interoperabilityIdentifier	URN	0..1		false

C.7.3 UnderKeelClearanceNonNavigableArea

Name: Under Keel Clearance Non Navigable Area

Abstract type: false

Definition: An area of under keel clearance less than the calculated safe limit.

Code: `'UnderKeelClearanceNonNavigableArea'`

Remarks:

Aliases: (none)

Supertype: FeatureType

Feature use type: geographic

Permitted primitives: surface

Attribute Bindings

Attribute	Type	Mult.	Permitted Values	Sequential
scaleMinimum	Simple	0..1		false
interoperabilityIdentifier	URN	0..1		false

C.7.4 UnderKeelClearanceAlmostNonNavigableArea

Name: Under Keel Clearance Almost Non Navigable Area

Abstract type: false

Definition: An area of under keel clearance almost less than the calculated safe limit, as established for the waterway.

Code: '`UnderKeelClearanceAlmostNonNavigableArea`'

Remarks:

Aliases: (none)

Supertype: FeatureType

Feature use type: geographic

Permitted primitives: surface

Attribute Bindings

Attribute	Type	Mult.	Permitted Values	Sequential
scaleMinimum	Simple	0..1		false
distanceAboveUKCLimit	Simple	0..1		false
interoperabilityIdentifier	URN	0..1		false

C.7.5 UnderKeelClearanceControlPoint

Name: Under Keel Clearance Control Point

Abstract type: false

Definition: Selected critical passage point or line.

Code: '`UnderKeelClearanceControlPoint`'

Remarks:

Aliases: (none)

Supertype: FeatureType

Feature use type: geographic

Permitted primitives: point

Attribute Bindings

Attribute	Type	Mult.	Permitted Values	Sequential
featureName	Complex	0..1		false
distanceAboveUKCLimit	Simple	0..1		false
expectedPassingTime	Simple	0..1		false
expectedPassingSpeed	Simple	0..1		false
interoperabilityIdentifier	URN	0..1		false
fixedTimeRange	Complex	0..1		false

Annex D. **Portrayal Catalogue**

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

D.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: 2.0.0

Version date: 2024-10-09

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

D.2 Definition Sources

No definition sources in catalogue.

D.3 Color Profiles

D.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

D.4 Symbols

D.4.1 UKCCONPT

Name: UKCCONPT

Description: Symbol for Under Keel Clearance Control Point

ID: UKCCONPT

Language: en (English)

Remarks:

File Name: UKCCONPT.svg

File Type: Symbol

File Format: SVG

D.4.2 EMUKCARE

Name: EMUKCARE

Description: Embedded complex line symbol for Under Keel Clearance Plan Area

ID: EMUKCARE

Language: en (English)

Remarks:

File Name: EMUKCARE.svg

File Type: Symbol

File Format: SVG

D.4.3 EMAREMG1

Name: EMAREMG1

Description: Embedded symbol

ID: EMAREMG1

Language: en (English)

Remarks:

File Name: EMAREMG1.svg

File Type: Symbol

File Format: SVG

D.4.4 DIAMOND1P

Name: DIAMOND1P

Description: area of depth less than the safety contour

ID: DIAMOND1P

Language: en (English)

Remarks: adopted for UnderKeelClearanceNonNavigableArea portrayal to enhance discernibility from UnderKeelClearanceAlmostNonNavigableArea in night mode display

File Name: DIAMOND1P.svg

File Type: Symbol

File Format: SVG

D.5 Line styles

D.5.1 UKCARE01

Name: UKCARE01

Description: Boundary of Under Keel Clearance Plan Area

ID: UKCARE01

Language: en (English)

Remarks:

File Name: EMAREMG1.xml

File Type: LineStyle

File Format: XML

D.6 Area Fills

(No description)

D.7 Fonts

(No description)

D.8 Viewing Group

D.8.1 UKC Plan Area

Name: UKC Plan Area

Description: Toggles visibility of UKC Plan Area features

ID: 29010

Language: en (English)

D.8.2 UKC Almost Non-Navigable Area

Name: UKC Almost Non-Navigable Area

Description: Toggles visibility of UKC Almost Non-Navigable Area features

ID: 29020

Language: en (English)

D.8.3 UKC Non-Navigable Area

Name: UKC Non-Navigable Area

Description: Toggles visibility of UKC Non-Navigable Area features

ID: 29030

Language: en (English)

D.8.4 UKC Control Point

Name: UKC Control Point

Description: Toggles visibility of UKC Control Point features

ID: 29050

Language: en (English)

D.8.5 UKC Planned Route

Name: UKC Planned Route

Description: Toggles visibility of UKC Planned Route

ID: 29060

Language: en (English)

D.8.6 UKC Information Box

Name: UKC Information Box

Description: Toggles visibility of UKC Information Box

ID: 29070

Language: en (English)

D.8.7 UKC Non-Navigable Area Pattern

Name: UKC Non-Navigable Area Pattern

Description: Toggles visibility of UKC Non-Navigable Area pattern

ID: 29040

Language: en (English)

D.9 Viewing Group Layer

D.9.1 UKCViewingGroupLayer

Name: UKC Viewing Group Layer

Description: Contains UKC Viewing Groups

ID: UKCViewingGroupLayer

Language: en (English)

D.9.2 UKCNonNavigableAreaPattern

Name: UKC Non-Navigable Area Pattern

Description: UKC Non-Navigable Area Pattern

ID: UKCNonNavigableAreaPattern

Language: en (English)

D.10 Context

D.10.1 PlainBoundaries

Name: Plain boundaries

Description: Line symbol style

ID: PlainBoundaries

Language: en (English)

D.11 Rules

D.11.1 Main

Name: main

Description: Top level rule

ID: main

Remarks:

File Name: main.xsl

File Type: Rule

File Format: XSLT

Rule Type: TopLevelTemplate

D.11.2 UnderKeelClearancePlanArea

Name: UnderKeelClearancePlanArea

Description: Rules for feature type UnderKeelClearancePlanArea

ID: UnderKeelClearancePlanArea

Remarks:

File Name: UnderKeelClearancePlanArea.xsl

File Type: Rule

File Format: XSLT

Rule Type: SubTemplate

D.11.3 Control Point

Name: ControlPoint

Description: Rules for feature type UnderKeelClearanceControlPoint

ID: ControlPoint

Remarks:

File Name: ControlPoint.xsl

File Type: Rule

File Format: XSLT

Rule Type: SubTemplate

D.11.4 Information Box

Name: InformationBox

Description: Rules for Information Box

ID: InformationBox

Remarks:

File Name: InformationBox.xsl

File Type: Rule

File Format: XSLT

Rule Type: SubTemplate

D.11.5 Almost Non Navigable Area

Name: AlmostNonNavigableArea

Description: Rules for feature type UnderKeelClearanceAlmostNonNavigableArea

ID: AlmostNonNavigableArea

Remarks:

File Name: AlmostNonNavigableArea.xsl

File Type: Rule

File Format: XSLT

Rule Type: SubTemplate

D.11.6 Non Navigable Area

Name: NonNavigableArea

Description: Rules for feature type UnderKeelClearanceNonNavigableArea

ID: NonNavigableArea

Remarks:

File Name: NonNavigableArea.xsl

File Type: Rule

File Format: XSLT

Rule Type: SubTemplate

Annex E. **Data Validation Checks**

The validation checks specific to S-129 Under Keel Clearance Management datasets are included in IHO Publication S-158:129. This document specifies the minimum checks that producers of S-129 ENC validation tools should include in their validation software. Validation software must be used by S-129 data producers to ensure that their S-129 datasets are compliant with the S-129 Under Keel Clearance Management Product Specification.

The S-158:129 S-129 Validation Checks can be found in the Standards and Publications page of the IHO web site, www.iho.int.

Page intentionally left blank

Annex F. **Geometry**

F.1 Introduction

F.1.1 ISO 19125-1:2004 geometry

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

F.1.1.1 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:

1. *Polygon – A Polygon has a geometric dimension of 2. It consists of a boundary and its 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.*

2. *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.*

3. *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.*

4. *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.*

5. *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.

6. *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

F.1.1.2 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:

1. Neither interior nor exterior include the boundary (i.e. I, E and B are mutually exclusive).
2. The boundary of a Polygon includes its set of outer and inner rings.
3. 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.
4. A Point does not have a boundary.

F.1.2 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 (for example, a.Disjoint(b) $\Leftrightarrow$ a $\cap$ b = $\varnothing$) 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.

F.1.3 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.

F.2 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.

F.2.1 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.

Figure F-1 – 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-129, a GM_Object is any spatial object as described in F.1.1.1 (Polygons, LineStrings, and Points). A spatial object is always equal to itself, that is, **a** EQUALS **a** is always true.

F.2.2 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:

$$\boldsymbol{a}.Disjoint(\boldsymbol{b}) \Leftrightarrow \boldsymbol{a} \cap \boldsymbol{b} = \varnothing$$

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

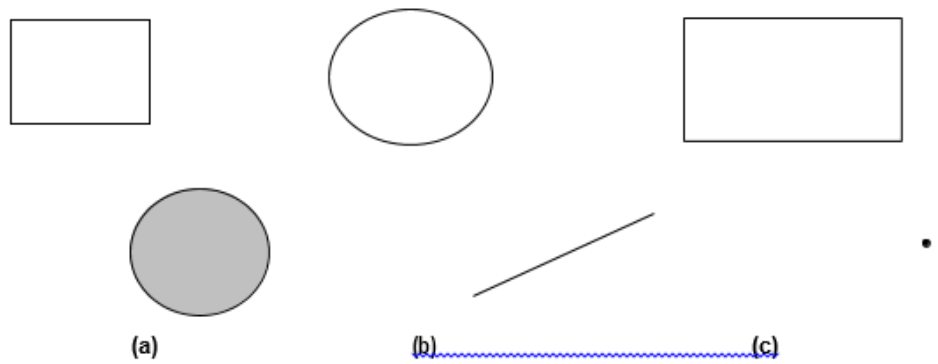


Figure F-2 – Examples of the DISJOINT relationship

F.2.3 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:

$$\boldsymbol{a}.Touch(\boldsymbol{b}) \Leftrightarrow (I(\boldsymbol{a}) \cap I(\boldsymbol{b}) = \varnothing) \wedge (\boldsymbol{a} \cap \boldsymbol{b}) \neq \varnothing$$

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.

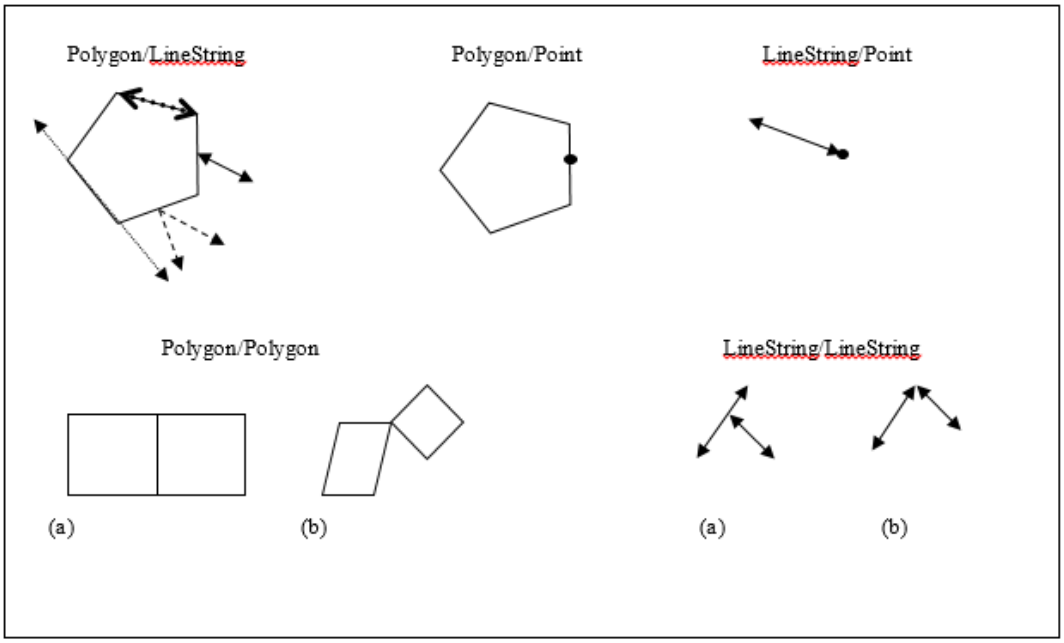


Figure F-3 – Examples of the TOUCHES relationship

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.

F.2.4 WITHIN

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

WITHIN includes EQUALS.

The definition of WITHIN is:

$$\mathbf{a}.\ \text{Within}(\mathbf{b}) \Leftrightarrow (\mathbf{a} \cap \mathbf{b} = \mathbf{a}) \wedge (\text{I}(\mathbf{a}) \cap \text{I}(\mathbf{b}) \neq \varnothing)$$

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.

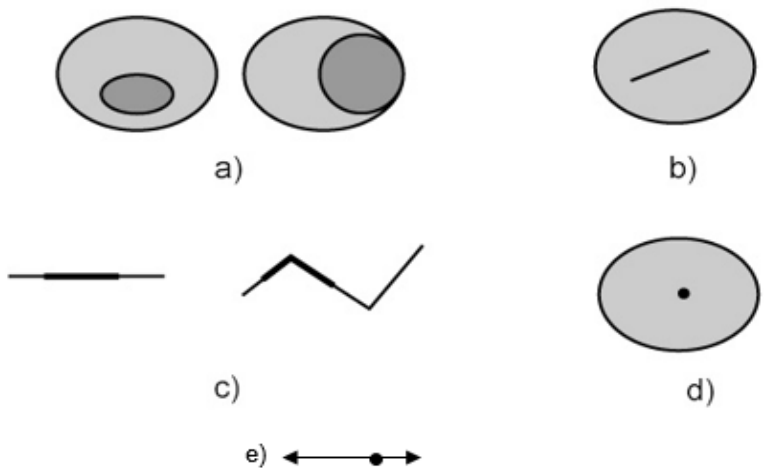


Figure F-4 – Examples of the WITHIN relationship — Polygon/Polygon (a), Polygon/LineString (b), LineString/LineString (c), Polygon/Point (d), and LineString/Point (e)

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.

F.2.5 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:

$$\mathbf{a}.Overlaps(\mathbf{b}) \Leftrightarrow (dim(I(\mathbf{a})) = dim(I(\mathbf{b})) = dim(I(\mathbf{a}) \cap I(\mathbf{b}))) \wedge (\mathbf{a} \cap \mathbf{b} \neq \mathbf{a}) \wedge (\mathbf{a} \cap \mathbf{b} \neq \mathbf{b})$$

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**.

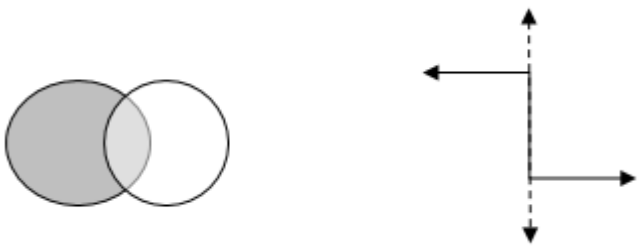


Figure F-6 – Examples of the OVERLAPS relationship

Note Lines that OVERLAP are also COINCIDENT.

F.2.6 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:

$$\mathbf{a}.Cross(\mathbf{b}) \Leftrightarrow (I(\mathbf{a}) \cap I(\mathbf{b}) \neq \emptyset) \wedge (dim(I(\mathbf{a}) \cap I(\mathbf{b})) < max(dim(I(\mathbf{a})), dim(I(\mathbf{b})))) \wedge (\mathbf{a} \cap \mathbf{b} \neq \mathbf{a}) \wedge (\mathbf{a} \cap \mathbf{b} \neq \mathbf{b})$$

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 "$(I(\mathbf{a}) \cap I(\mathbf{b}) \neq \emptyset) \wedge$ " 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.

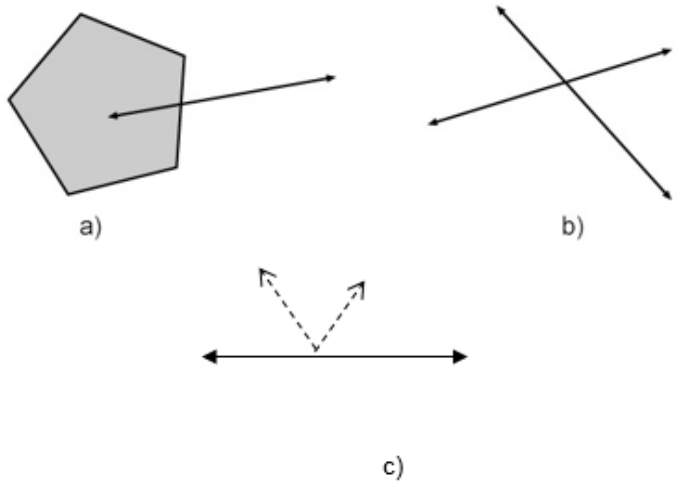


Figure F-7 – Examples of the CROSSES relationship

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.

F.2.7 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.

F.2.8 CONTAINS

is the reciprocal of WITHIN.

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

F.2.9 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.

Figure F-8 – COVERED_BY relationship

F.2.10 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)

F.2.11 COINCIDENT

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**

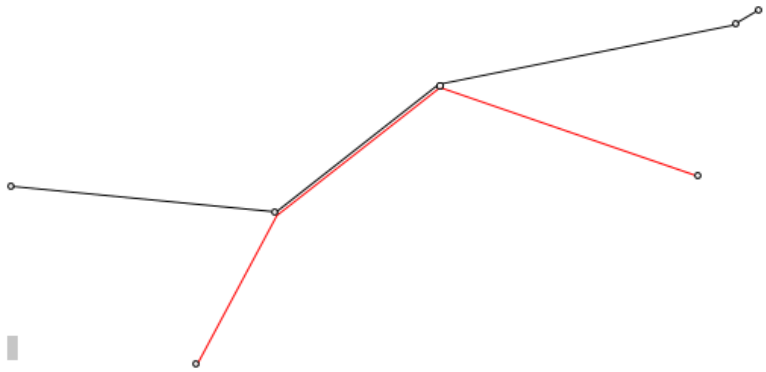


Figure F-9 – Example of COINCIDENT relationship (line geometry)

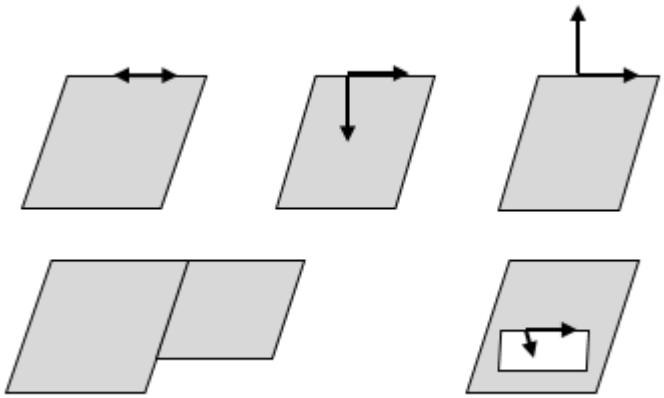


Figure F-10 – Example of COINCIDENT relationship (polygon boundary)

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.

Page intentionally left blank